Department of Health

Health Technical Memorandum 04-01: Safe water in healthcare premises

Part B: Operational management

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Executive summary

Preamble

This current review and update of HTM 04-01 is intended to move users of the document towards a holistic management of water systems via Water Safety Groups (WSGs), Water Safety Plans (WSPs) and other initiatives.

This version draws together and updates the previous guidance and includes recommendations for the safe management of water systems, via the integration of the principle of WSGs and WSPs (first introduced in the HTM 04-01 *P. aeruginosa* addendum – published in March 2013), and how to manage and minimise the risks to health from various aspects, ranging from clinical risks, microbial and chemical contamination, changes to the water system, resilience of the water supply etc. It also introduces a stronger emphasis on staff competencies and the implementation of water hygiene awareness training.

Introduction

The development, construction, installation, commissioning and maintenance of hot and cold water supply systems are vital for public health. Healthcare premises are dependent upon water to maintain hygiene and a comfortable environment for patients and staff, and for treatment and diagnostic purposes.

Interruptions in water supply can disrupt healthcare activities. The design of systems should ensure that sufficient reserve water storage is available to minimise the consequence of disruption, while at the same time ensuring an adequate turnover of water to prevent stagnation in storage vessels and distribution systems.

This Health Technical Memorandum (HTM) gives comprehensive advice and guidance to healthcare management, design engineers, estate managers, operations managers, contractors and the supply chain on the legal requirements, design applications, maintenance and operation of hot and cold water supply, storage and distribution systems in all types of healthcare premises. It is equally applicable to both new and existing sites.

Aims of this guidance

The current review and update of HTM 04-01 is intended to move users of the document towards a holistic management of water systems via WSGs, WSPs and other initiatives.

It has been written to promote good practice for those responsible for the design, installation, commissioning, operation and maintenance of water services in healthcare premises, by:

- highlighting the need for robust governance and management;
- outlining the remit of the WSG and how this relates to the provision of safe water in healthcare premises;
- outlining key criteria and system arrangements to help stop the ingress of chemical and microbial contaminants and microbial colonisation and bacteria proliferation;
- illustrating temperature regimes for sanitary outlets to maintain water hygiene;
- ensuring the safe delivery of hot water;
- outlining how the correct selection of system components and correct use by occupants can help preserve the quality and hygiene of water supplies;

- providing a point of reference to legislation, standards and other guidance pertaining to water systems;
- providing a basic overview of possible potential waterborne pathogens;
- giving an overview of some of the different water systems (including components) and their safe installation, commissioning and operation and maintenance;
- providing typical system layouts and individual component location;
- providing information on thermostatic mixing valve configurations, appropriate usage and maintenance requirements;
- identifying key commissioning, testing and maintenance requirements for referral by designers, installers, commissioners, operators and management.

Controlling waterborne pathogens

The guidance gives comprehensive guidance on measures to control waterborne pathogens. While *Legionella* control is, in the main, associated with poor engineering configuration and maintenance, with no evidence of patient-to-patient or patient-to-outlet transfer, *P. aeruginosa* may be transferred to and from outlets and the water from both patients and staff. Suspected *P. aeruginosa* waterborne infections require additional investigations to determine the source and interventions from infection control specialists and microbiologists. Therefore, a temperature control regime is the traditional strategy for reducing the risk from *Legionella* and for reducing the growth and colonisation of other waterborne organisms within water systems. To prevent growth of *P. aeruginosa* and other waterborne pathogens, controls are necessary to manage the water system before and after the outlet.

As with all control measures, temperatures should be monitored at regular intervals to verify effective control.

Because of the complexity of hot and cold water distribution systems and the difficulty of maintaining a temperature control regime in some healthcare facilities, this guidance suggests that additional chemical, physical and other water control methods that have been shown to be capable of controlling microbial colonisation and growth may also be considered.

Main changes from the 2006 edition of HTM 04-01

- This 2016 edition of HTM 04-01 provides comprehensive guidance on measures to control waterborne pathogens such as *Pseudomonas aeruginosa Stenotrophomonas maltophilia, Mycobacteria* as well as *Legionella*.
- This edition has been updated to align with the Health and Safety Executive's (HSE's) recently revised Approved Code of Practice for *Legionella* (L8) and its associated HSG274 guidance documents.
- The Addendum to HTM 04-01 published in 2013 (and now Part C of HTM 04-01) introduced the concept of WSGs and WSPs. Part B of the HTM now includes updated guidance on the remit and aims of the WSG and WSP.
- New guidance has been included on the hygienic storing and installation of fittings and components and on the competency of installers/plumbers working on healthcare water systems. The guidance also outlines that any person working on water distribution systems or cleaning water outlets needs to have completed a water hygiene awareness training course. An example course outline is included.
- Guidance on sampling techniques for, testing for, and the microbiological examination of *Pseudomonas aeruginosa* samples – originally in the HTM 04-01 Addendum – is now included in Part B to complement similar guidance on *Legionella*.

Acknowledgements

The Department of Health would like to thank the Steering Group for their advice and support, and all those who contributed to the consultation phase of the document.

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David Way BEAMA

Davy Burns Health Estates, Northern Ireland

Elise Maynard Water Management Society

George McCracken Belfast Health & Social Care Trust

Graham Thompson Water Management Society

Ian Storrar Health Facilities Scotland

Jimmy Walker Public Health England

John Newbold Health & Safety Executive

Lorraine Medcalf Health & Safety Executive

Mark Gapper NHS Wales Shared Services Partnership

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Mike Weinbren Chesterfield Royal Hospital NHS Foundation Trust

Nick Hill Institute of Healthcare Engineering and Estate Management (IHEEM)

Paul Millard Water Regulations Advisory Scheme (WRAS)

Paul Taylor NSF/BuildCert

Paul Weaving Infection Prevention Society

Philip Ashcroft Department of Health

Reginald Brown BSRIA

Robert Pitchers WRc

Simon Benton Drinking Water Inspectorate

Susanne Lee Royal Society for Public Health

Tom Makin Envirocloud Ltd

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Glossary and abbreviations

In addition to the definitions listed below, other definitions can be found in the Water Supply (Water Fittings) Regulations 1999; BS 6100; BS 8558; and BS EN 806.

Alert organisms: Alert organisms are microorganisms that have the potential to cause harm and disease in individuals and which can cause an outbreak of infection in a hospital environment. An alert organism is identified by the microbiology laboratory and referred to the infection prevention and control (IPC) team for assessment of possible healthcare-associated acquisition and to identify any possible environmental/equipment sources.

Augmented care units/settings – There is no fixed definition of "augmented care"; individual providers may wish to designate a particular service as one where water quality must be of a higher microbiological standard than that provided by the supplier. While this document provides broad guidance, the water quality required will be dependent on both the type of patient and its intended use. Most care that is designated as augmented will be that where medical/nursing procedures render the patients susceptible to invasive disease from environmental and opportunistic pathogens such as *Pseudomonas aeruginosa* and other alert organisms. In broad terms, these patient groups will include:

a. those patients who are severely immunosuppressed because of disease or treatment: this will include transplant patients and similar heavily immunosuppressed patients during high-risk periods in their therapy;

b. those cared for in units where organ support is necessary, for example critical care (adult paediatric and neonatal), renal, respiratory (may include cystic fibrosis units) or other intensive care situations;

c. those patients who have extensive breaches in their dermal integrity and require contact with water as part of their continuing care, such as in those units caring for burns.

Backflow – Flow upstream, that is in a direction contrary to the intended normal direction of flow, within or from a water fitting.

Biofilm: A biofilm is a complex layer of microorganisms that have attached and grown on a surface. This form of growth provides a niche environment for a wide range of microorganisms to interact and where the secretion of exopolysaccharides by bacteria will form an extracellular matrix for both bacteria and other unicellular organisms such as amoebae and flagellates to remain in a protected state.

Colony forming unit: Unit that gives rise to a bacterial colony when grown on a solid medium; this may be a single bacterial cell or a clump of cells.

Dead-leg – a length of water system pipework leading to a fitting through which water only passes infrequently when there is draw-off from the fitting, providing the potential for stagnation.

Flow straightener: A device inserted into the spout outlet of a tap to modify flow, take out turbulence and create an even stream of water.

Healthcare-associated infections (HCAI): encompasses any infection by any infectious agent acquired as a consequence of a person's treatment or which is acquired by a healthcare worker in the course of their duties.

Healthcare facility/building – all buildings: infrastructure, equipment, plant, embedded systems and related items that support the delivery of healthcare and services of all types, irrespective of their ownership or operation by third parties.

Healthcare organisations: organisations that provide or intend to provide healthcare services for the purposes of the NHS.

Legionellosis: a collective term for diseases caused by *Legionella* bacteria including the most serious Legionnaires' disease, as well as the similar but less serious conditions of Pontiac fever and Lochgoilhead fever.

Manual mixing tap – a tap that controls both the flow and temperature of water delivered.

Point-of-use (POU) filter: a filter with a maximal pore size of 0.2 μm applied at the outlet, which removes bacteria from the water flow.

Redundant pipework (also known as blind end): a length of pipe closed at one end through which no water passes.

Remediation: Any process that reduces the risk from harmful agents such as microorganisms.

Thermostatic mixing tap: a tap that controls the flow and by thermostatic means the temperature of water delivered.

Thermostatic mixing valve: valve with one outlet, which mixes hot and cold water and automatically controls the mixed water to a user-selected or pre-set temperature.

Transmission: Any mechanism by which an infectious agent is spread from a person or environmental source to a susceptible person.

Waterborne pathogen: microorganism capable of causing disease that may be transmitted via water and acquired through ingestion, bathing, or by other means.

Water outlet: (In this document) refers mainly to taps and showerheads, but other outlets, as indicated by risk assessments, may be considered important.

Water Safety Group (WSG): A multidisciplinary group formed to undertake the commissioning and development and ongoing management of the water safety plan (WSP). It also advises on the remedial action required when water systems or outlets are found to be contaminated and the risk to susceptible patients is increased.

Water safety plan (WSP): A risk-management approach to the safety of water that establishes good practices in local water distribution and supply. It will identify potential hazards, consider practical aspects, and detail appropriate control measures.

Water supply [to the healthcare facility]: The water supplied can be via:

- the mains water supply from the local water undertaker;
- a borehole (operated by the healthcare organisation as a private water supply);
- a combination of mains water and borehole supply;
- emergency water provision (bulk tankered water or bottled drinking water).

Water undertaker – the role of a water undertaker is defined in a number of sections of the Water Industry Act 1991.

Wholesomeness: standards of wholesomeness are defined in section 67 of the Water Industry Act 1991. Separate legislation for public and private supplies sets out the prescribed concentrations and values for water and are detailed in the following legislation: the Water Supply (Water Quality) Regulations 2000 for water from a public supply; or the Private Water Supplies Regulations 2009 for water from a private supply.

List of abbreviations

cfu – colony forming units

COSHH – Control of Substances Hazardous to Health [Regulations]

CQC – Care Quality Commission

DWI – Drinking Water Inspectorate

EA – Environment Agency

EPDM – ethylene propylene diene monomer

HBN – Health Building Note

HSE – Health & Safety Executive

HSG274 Part 2 – The Health & Safety Executive's technical guidance on the control of Legionnaires' disease in hot and cold water systems.

HTM – Health Technical Memorandum

MCA: milk cetrimide agar

MRD: maximum recovery diluent

POU – point-of-use

PWTAG – Pool Water Treatment Advisory Group

SHTM – Scottish Health Technical Memorandum

WRAS – Water Regulations Advisory Scheme

WSG – Water Safety Group

WSP – Water safety plan

0 Policy and regulatory overview: water safety and the healthcare estate

Introduction

0.1 The National Health Service (NHS) has a corporate responsibility to account for the stewardship of its publicly funded assets. This includes the provision, management and operation of an efficient, safe estate that supports clinical services and strategy.

0.2 This corporate responsibility is carried by all accountable officers, directors with responsibility for estates and facilities and their equivalents, chairs, chief executive officers and non-executive board members. Together they have a responsibility to enact the principles set out in this document, provide leadership and work together to implement the necessary changes to provide a safe, efficient high quality healthcare estate.

0.3 To achieve this, quality and fitness-for-purpose of the healthcare estate is vital. Health Technical Memorandum (HTM) 04-01 seeks to set out the quality of, and standards for, water safety in the healthcare estate.

0.4 A healthcare organisation's Water Safety Group (WSG) (see Part B) is pivotal in ensuring that decisions affecting the safety and integrity of the water systems and associated equipment do not go ahead without being agreed by them. This includes consultations relating to decisions on the procurement, design, installation and commissioning of water services, equipment and associated treatment processes.

0.5 The quality and fitness-for-purpose of the estate are assessed against a set of legal requirements and governance standards. Adhering to the guidance outlined in this HTM will be taken into account as evidence towards compliance with these legal requirements and governance standards.

Compliance of the healthcare estate

0.6 Principles related to the safety of healthcare estates and facilities are enshrined in the Health and Social Care Act 2008 (Regulated Activities) Regulations 2014, specifically Regulation 12(2)(h) and Regulation 15 of the Act.

> **Note**
>
> There are numerous other statutes and legal requirements that NHS organisations, supporting professionals, contractors and suppliers must comply with. These are covered in the respective Health Building Notes (HBNs), Health Technical Memoranda (HTMs) and the NHS Premises Assurance Model (NHS PAM).

Health and Social Care Act 2008 (Regulated Activities) Regulations 2014

0.7 Regulation 12(2)(h) decrees that registered providers must assess:

- the risk of, and prevent, detect and control the spread of, infections, including those that are health care associated.

0.8 Appropriate standards of cleanliness and hygiene should be maintained in premises used for the regulated activity. DH (2015) issued '[The Health and Social Care Act 2008 Code of Practice on the prevention and control of infections and related guidance]' (the HCAI Code of Practice), which contains statutory guidance about compliance with regulation 12(2)(h) (see paragraphs 0.15–0.17).

0.9 Regulation 15 of the Act states that:

(1) All premises and equipment used by the service provider must be –

a. clean,

b. secure,

c. suitable for the purpose for which they are being used,

d. properly used,

e. properly maintained, and

f. appropriately located for the purpose for which they are being used.

(2) The registered person must, in relation to such premises and equipment, maintain standards of hygiene appropriate for the purposes for which they are being used.

Note

The "registered person" means, in respect of a regulated activity, the person who is the service provider or a registered manager in respect of that activity.

A "service provider" means a person registered with the CQC under Chapter 2 of Part 1 of the Health and Social Care Act 2008 as a service provider in respect of that regulated activity.

Regulator requirements

0.10 The CQC independently regulates all providers of regulated health and adult social care activities in England. The CQC's (2015) 'Guidance for providers on meeting the regulations' explains how to meet regulations 12(2)(h) and 15 outlined above.

0.11 Failure to comply with the Health and Social Care Act 2008 (Regulated Activities) Regulations 2014 and the Care Quality Commission (Registration) Regulations (2009) is an offence, and the CQC has a wide range of enforcement powers that it can use if a provider is not compliant. These include the issue of a warning notice that requires improvement within a specified time, prosecution, and the power to cancel a provider's registration, removing its ability to provide regulated activities.

Examples of governance and assurance mechanisms arising from primary legislation (not exhaustive)

NHS Constitution

0.12 The Health Act 2009 places a duty on bodies providing and commissioning NHS services to have regard to the NHS Constitution. The Health and Social Care Act 2012 further applied this duty to the new bodies created by that Act or by amendments to the 2012 Act.

0.13 The NHS Constitution "sets out rights to which patients, public and staff are entitled". It also outlines "the pledges which the NHS is committed to achieve, together with responsibilities that the public, patients and staff owe to one another to ensure that the NHS operates fairly and effectively".

0.14 It commits the NHS to ensuring "**that services are provided in a clean and safe environment that is fit for purpose, based on national best practice (pledge)".** In order to deliver on this pledge, the NHS should take account of:

- the NHS Premises Assurance Model (NHS PAM) – the NHS PAM identifies where the NHS Constitution needs to be considered and where assurance is required;

- national best practice guidance for the design and operation of NHS healthcare facilities (such as HBNs and HTMs).

The HCAI Code of Practice

0.15 A complex range of issues distinguishes healthcare environments from most other building types. One of the most important of these relates to the control of infection. Infection prevention and control teams should be consulted on any design decisions and a risk analysis conducted on the many issues of design involving water systems (see HBN 00-09 – 'Infection control in the built environment'). To manage and monitor the prevention and control of infections effectively, the HCAI Code of Practice requires a WSG and a water safety plan (WSP) to be in place.

0.16 The information outlined in HBN 00-09 follows the general principles given in the HCAI Code of Practice, which sets out criteria against which a registered provider will be judged on how it complies with Regulation 12(2)(h) of the Health and Social Care Act 2008 (Regulated Activities) Regulations 2014 on the prevention, detection and control of infections, particularly waterborne infections in relation to this document.

0.17 The law states that the HCAI Code of Practice must be taken into account by the CQC when it makes decisions about registration against the cleanliness and infection control requirement. The regulations also say that providers must have regard to the Code when deciding how they will comply with registration requirements. Therefore, by following the Code, registered providers will be able to show that they meet the requirement set out in the regulations. However, the Code is not mandatory. A registered provider may be able to demonstrate that it meets the regulations in a different way (equivalent or better) from that described in this document. The Code aims to exemplify what providers need to do in order to comply with the regulations.

Figure 1 illustrates how DH estates and facilities best practice guidance (such as the NHS PAM and HTMs) aligns with the statutory and policy framework. This guidance is fundamental to ensuring that NHS trusts are able to deliver on their commitments under the NHS Constitution and to comply with the CQC's fundamental standards.

Never events

0.18 NHS England's never events policy framework defines "never events" as serious, largely preventable patient safety incidents that should not occur if the available preventive measures have been implemented by healthcare providers. On the list of never events is scalding of patients. The risk of scalding for vulnerable patients (children and young people, older people, and disabled people) is a particular problem in healthcare premises. HTM 04-01 provides guidance on reducing the risk of scalding.

Health and safety legislation

0.19 In the UK, the control of *Legionellae* falls within the requirements of the Health and Safety at Work etc. Act. This Act also places duties on design teams, suppliers and installers to ensure that articles or substances for use at work are safe and without risks to health and that any information related to the article or substance is provided. The Management of Health and Safety at Work Regulations 1999 provide a broad framework for controlling health and safety at work. The Control of Substances Hazardous to Health Regulations 2002 (COSHH) provide a framework of actions designed to assess, prevent or control the risk from bacteria like *Legionella* and take suitable precautions.

0.20 The Health & Safety Executive's (HSE) (2013) Approved Code of Practice 'Legionnaires' disease: The control of *Legionella* bacteria in water systems (L8)' contains practical guidance on how to manage and control the risks in water systems. The HSE has published complementary technical guidance in HSG274, which is split into three specific areas:

- Part 1 – evaporative cooling systems;
- Part 2 – hot and cold water systems; and
- Part 3 – other risk systems.

0.21 In addition, under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR), there is a duty for employers to report any cases of legionellosis in an employee who has worked on hot and cold water systems that are likely to be contaminated with *Legionella*. Cases of legionellosis are reportable under RIDDOR if:

a. a doctor notifies the employer; and

b. the employee's current job involves work on or near cooling systems that are located in the workplace and use water; or work on water-service systems located in the workplace which are likely to be a source of contamination.

0.22 With regard to enforcement responsibilities, the HSE will take the lead with regard to incidents involving *Legionella*. See the Health and Safety Executive/Care Quality Commission/Local Government Association's (2015) 'Memorandum of understanding between the Care Quality Commission, the Health and Safety Executive and local authorities in England'.

Security

0.23 Accessibility to all plant and equipment should be limited to authorised personnel only (see NHS Protect's (2012) 'Guidance on the security and management of NHS assets').

Water regulations

0.24 As well as complying with the recommendations outlined in this document, the design and installation of the hot and cold water services, new or extended, in any healthcare premises should also comply with:

- the Water Supply (Water Fittings) Regulations 1999;
- Defra's guidance to the Water Supply (Water Fittings) Regulations;
- recommendations of the water suppliers in the Water Regulations Advisory Scheme's (WRAS) 'Water Regulations Guide'; and
- any other requirements of the local water undertaker.

Water Supply (Water Fittings) Regulations 1999

0.25 These Regulations set legal requirements for the design, installation, operation and maintenance of plumbing systems, water fittings and water-using appliances. They have a specific purpose to prevent misuse, waste, undue consumption or erroneous measurement of water and, most importantly, to prevent contamination of drinking water.

0.26 These Regulations apply in all types of premises supplied, or to be supplied, with water from a water undertaker. They apply from the point where water enters the property's underground pipe, to where the water is used in plumbing systems, water fittings and water-using appliances. However they do not apply in premises that have no provision of water from the public mains supply.

Water Supply (Water Quality) Regulations 2000

0.27 These Regulations cover the quality of water supplied by water undertakers for public distribution which is intended for domestic purposes; these purposes include drinking, cooking, food preparation, washing and sanitation. Water supplied meeting these quality requirements is referred to as wholesome water.

Private Water Supplies Regulations 2009

0.28 These Regulations cover private sources of water intended for human consumption including drinking, cooking, food preparation or other domestic purposes, such as boreholes and wells. Water meeting these quality requirements is referred to as wholesome water. These Regulations also place duties for monitoring and control of the quality of public water supplies where these are then further distributed to other users on separate premises by the water company's bill payer (this arrangement is often referred to as onward distribution).

0.29 Local authorities are the regulators for private water supplies and have a number of statutory duties under the Private Water Supplies Regulations.

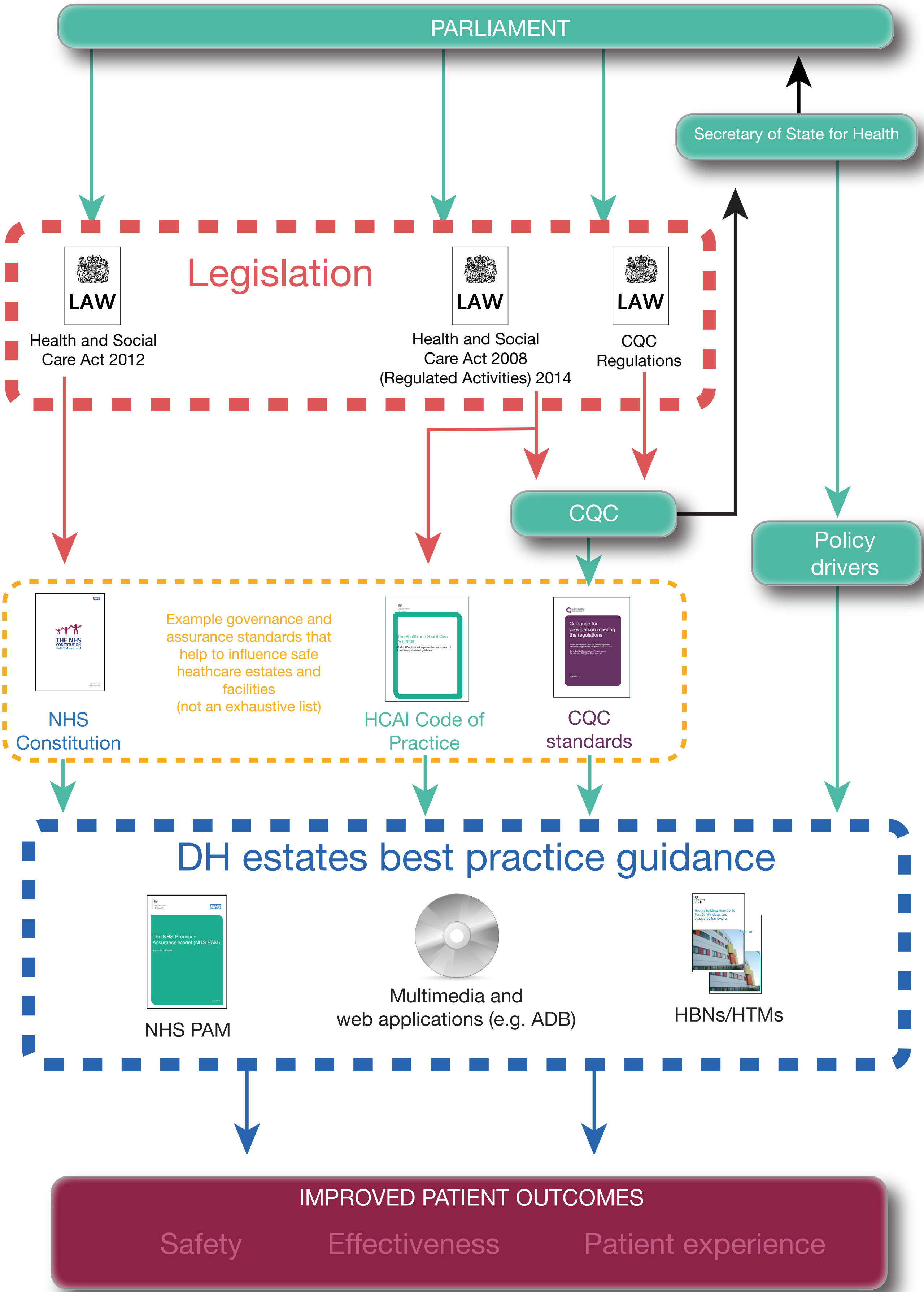


Figure 1 How best practice guidance on the safety and quality of healthcare estates and facilities fits in with the legislative and policy framework. (The statutes and mandatory requirements shown in this figure are not exhaustive. See Note after paragraph 0.6.)

1 Introduction

1.1 This edition of HTM 04-01 – 'Safe water in healthcare premises' supersedes HTM 04-01 – 'The control of *Legionella*, hygiene, "safe" hot water, cold water and drinking water systems' published in 2006. It is also based on the guidance given in HTM 04-01: Addendum '*Pseudomonas aeruginosa* – advice for augmented care units'. It has been revised to take account of revisions to the HSE's (2013) Approved Code of Practice L8 and technical guidance HSG274.

1.2 This HTM gives comprehensive advice and guidance to healthcare management, design engineers, estate managers, operations managers and infection control specialists on the legal requirements, design applications, installation, commissioning, maintenance and operation of hot and cold water supply, storage and distribution systems and associated equipment and systems in all types of healthcare premises. It is equally applicable to both new and existing sites.

1.3 In its new form, the document is divided in three parts. This part (Part B) covers operational management, including the control of *Legionella, P. aeruginosa* and other important waterborne pathogens. This document should be read in conjunction with Part A which outlines the principles involved in the design, installation, commissioning and testing of the hot and cold water supply, and storage and distribution systems for healthcare premises. Some variation may be necessary to meet the differing provision arrangements of the various water undertakers and complexity of distribution systems. Part C covers water safety in augmented care settings.

General

1.4 Current statutory legislation requires both "employers" and "employees" to be aware of their individual and collective responsibility for the provision of safe wholesome hot and cold water supplies, and storage and distribution systems in healthcare premises. Ultimate responsibility for management will fall to the statutory duty holder of the premises (see paragraph 1.8 for a definition of the statutory duty holder).

1.5 Healthcare premises are dependent on water to maintain hygiene and a comfortable environment for patients, visitors and staff, and for clinical and surgical care.

1.6 Intelligent design, construction, installation, commissioning and maintenance of hot and cold water supply systems to minimise the risks of waterborne illness are vital for public health.

1.7 Interruptions in water supply can disrupt healthcare activities. Procedures should be in place to minimise the consequence of disruption, while at the same time ensuring an adequate turnover of water to prevent stagnation in storage vessels and distribution systems (see paragraphs 2.16–2.17 in HTM 04-01 Part A and also HBN 00-07 – 'Planning for a resilient healthcare estate').

Duty holder

1.8 In this document, the statutory duty holder is either the employer or the person in control of the healthcare premises. Typically these could be the owner, chief executive, board of directors, or other person who is ultimately accountable, and on whom the duty falls, for the safe operation of healthcare premises.

Shared premises

1.9 In estate management, it is increasingly common for there to be several duty holders in one building. In such cases, duties may arise where persons or organisations have clear responsibility through an explicit agreement such as a contract or tenancy agreement.

1.10 The extent of the duty will depend on the nature of that agreement. For example, in a building occupied by one leaseholder, the agreement may be for the owner or leaseholder to take on the full duty for the whole building or to share the duty. In a multi-occupancy building, the agreement may be that the owner takes on the full duty for the whole building. Alternatively, it might be that the duty is shared where, for example, the owner takes responsibility for the common parts while the leaseholders take responsibility for the parts they occupy. In other cases, there may be an agreement to pass the responsibilities to a managing agent. Where a managing agent is used, the management contract should clearly specify who has responsibility for maintenance and safety checks, including managing the risk from waterborne hazards.

1.11 Where there is no contract or tenancy agreement in place or it does not specify who has responsibility, the duty is placed on whoever has control of the premises or part of the premises.

Areas this HTM does not cover

1.12 Although many of this HTM's recommendations will be applicable, it does not set out to cover water supply for fire-fighting services nor water supply for technical, industrial or other specialist purposes, other than to indicate precautions that should be taken when these are used in association with domestic water services. The point at which a domestic activity becomes an industrial process has not been defined, and the applicability will need to be considered in each case.

1.13 This HTM does not cover wet cooling systems such as cooling towers. Guidance on these systems is given in HSE's Approved Code of Practice and guidance 'Legionnaires' disease: The control of *Legionella* bacteria in water systems (L8)' and HSG274 technical guidance Part 1.

1.14 While some guidance on other water-service applications is included, it is not intended to cover them fully. For:

- process waters used for laundries, see HTM 01-04 – 'Decontamination of linen in health and social care';
- endoscopy units, see HTM 01-06 – 'Decontamination of flexible endoscopes';
- primary care dental premises, see HTM 01-05 – 'Decontamination in dental practices';
- renal units, see HBNs 07-01 and 07-02, the Renal Association's guidelines, BS EN ISO 13959 and BS EN ISO 11663;
- sterile services departments, see HBN 13 – 'Sterile services department';
- hydrotherapy pools, see the PWTAG's 'Swimming pool water: treatment and quality standards for pools and spas';
- spa pools, see HSE/PHE's 'Management of spa pools: controlling the risks of infection';

Note

This document is currently being revised and will become HSG274 Part 4 – 'The control of *Legionella* and other infectious agents in spa pool systems'.

- birthing pools, see HBN 09-02 – 'Maternity care facilities' and PWTAG's 'Swimming pool water: treatment and quality standards for pools and spas'.

2 Governance and management responsibility

> **Note**
>
> Governance is concerned with how an organisation directs, manages and monitors its activities to ensure compliance with statutory and legislative requirements while ensuring the safety of patients, visitors and staff is not compromised.
>
> To help achieve this, healthcare organisations need to ensure that sound policies are approved by the board of directors. These should:
>
> - ensure safe processes, working practices and risk-management strategies are in place to safeguard all their stakeholders and assets in order to prevent and reduce harm or loss; and
> - be backed up with adequate resources and suitably qualified, competent and trained staff.

2.1 This guidance should be applied to all healthcare premises, however small, where there is a duty of care under the Health and Safety at Work etc. Act 1974.

2.2 To ensure governance with regard to water safety, the duty holder will:

- identify and assess sources of risk;
- if appropriate, prepare a written scheme for preventing or controlling the risk;
- implement, manage and monitor precautions;
- keep records of the precautions;
- appoint a competent person with sufficient authority and knowledge of the installation to help take the measures needed to comply with the law.

2.3 To implement the above legal duties in a healthcare organisation, the duty holder should appoint a WSG to undertake the commissioning, development, implementation and review of a WSP. The aim of the WSG is to ensure the safety of all water used by patients/residents, staff and visitors, and to minimise the risk of infection associated with waterborne pathogens. This is supported by the HCAI Code of Practice (see paragraphs 0.15–0.17), which recommends that management and monitoring arrangements should ensure that a WSG and WSP are in place.

2.4 The WSP should demonstrate that any person on whom the statutory duty falls has fully appreciated the requirement to provide an adequate supply of hot and cold water of suitable quality. Though compliance with this guidance may be delegated to staff or undertaken by contractors, accountability cannot be delegated. The WSG should ensure that appropriate expertise and competence is available to ensure the delivery of safe water for all uses throughout the organisation. This group should have clearly identified lines of accountability up to the CEO and board. For membership of the group, see paragraphs 6.5–6.6.

2.5 The WSG should include persons who are fully conversant with the design principles and requirements of water systems and should be fully briefed in respect of the cause and effect all waterborne hazards.

2.6 The WSP is a holistic approach to manage water for all uses (including diagnostic and treatment purposes) so that it is safe for all users including those most at risk of waterborne infections as a consequence of their illness or treatment (see paragraphs 6.16–6.22).

2.7 All regular tests and checks set out in the WSP should be carried out even if they cause minor disruption to healthcare services, and comprehensive records should be maintained in accordance with the healthcare organisation's management policy.

2.8 A risk assessment forms an integral component of the WSP and is a legal requirement to identify potential hazards (which may be microbial, chemical or physical) in the system, risks of infection to patients, staff and visitors, and other indicators of water quality (for example, taste, odour, flavour and appearance if intended for drinking). See paragraphs 6.23–6.26 for typical examples of issues to consider in the risk assessment.

2.9 The risk assessment should be carried out by a competent person or persons. If the provision of risk assessments is contracted to an external organisation, it is recommended that those engaged to carry out any risk assessments associated with water safety should be able to demonstrate to the WSG their experience and competence in assessing specific risks from microbiological, chemical and physical hazards on the specific healthcare population. They should also be able to give advice on how to manage the systems/ equipment to minimise the risks etc. It is the responsibility of the WSG to determine the method of demonstrating this competence. Core requirements including accredited training and personal examples of recent water safety risk assessments in the healthcare sector presented orally and/or by interview should be considered options. Detailed knowledge and expertise requirements of the risk assessor(s) are provided in the World Health Organization's (WHO) (2011) 'Water safety in buildings'.

2.10 The risk assessor(s) should be given access to competent assistance from the client. This may be in the form of:

- engineering and building expertise;
- as-fitted drawings and schematic diagrams;
- clinical expertise;
- knowledge of building occupancy and use including vulnerability of patient groups;
- bespoke equipment plus policies, procedures and any protocols (for example cleaning of wash-hand basins and disposal of clinical effluent etc).

2.11 In addition access should be made available to all required areas (and associated systems and equipment) unless deemed inaccessible by legislation (for example areas that contain asbestos).

2.12 For *Legionella* risk assessments, contractors should be able to demonstrate a full understanding of, and work to, BS 8580. In addition to guidance provided above, the documents below should also be referenced in relation to the specification, procedures and general requirements for completing robust and fit-for-purpose water safety risk assessments:

- HSG274 Part 2 (2014) – 'The control of *Legionella* bacteria in hot and cold water systems'.
- BS 8580 – 'Water quality: risk assessments for *Legionella* control – Code of Practice'.
- BSRIA's (1999) FMS 4/99 – 'Guidance and the standard specification for water services risk assessment'.
- BSRIA's (2015) BG 57/2015 – 'Legionnaires' disease – risk assessment'.

2.13 Management procedures should ensure that compliance is continuing and not notional. The prime purpose of the assessment is to be able to demonstrate that the WSG is aware of all the relevant factors that may pose a risk of waterborne infection, that effective corrective or preventive action has been implemented, and that monitoring is in place to ensure the plans are effective in controlling the risk.

2.14 Healthcare organisations should be aware of the legal duty to notify the water undertaker when it is proposed to carry out works on any systems conveying water from the public water supply (see the WRAS website).

Note

Water undertakers can carry out a fittings inspection to ensure that work has been properly carried out and that the public water supply remains protected for work carried out.

3 Statutory requirements

3.1 It is the responsibility of the duty holder to ensure that their premises comply with all statutes.

3.2 Duty holders have an overriding general duty of care under the Health and Safety at Work etc. Act 1974. Therefore, they should ensure that the water supply, storage and distribution services are installed and operated within the terms of the following legislation.

Health and Safety at Work etc. Act 1974

3.3 Employers have a general duty under the Health and Safety at Work etc. Act 1974 to ensure, so far as is reasonably practicable, the health, safety and welfare of patients, visitors and staff and the public who may be affected by workplace activities.

3.4 These duties are legally enforceable, and the HSE has successfully prosecuted employers including health organisations under this statute. It falls upon owners and occupiers of premises to ensure that there is a management regime for the proper design, installation and maintenance of plant, equipment and systems. Failure to have a proper system of working and adequate control measures can also be an offence even if an outbreak of, for example, Legionnaires' disease or other such incident has not occurred.

The Management of Health and Safety at Work Regulations 1999

3.5 These regulations provide a broad framework for controlling health and safety at work. They require every employer to make a suitable and sufficient assessment of all risks to health and safety of employees and the public caused by work activities, and require employers to have access to competent help in applying the provisions of health and safety law. In addition to *Legionella* and other waterborne pathogens, other risks from a hot and cold water distribution system include deterioration of water quality, scalding at hot water outlets and danger due to pipe bursts at excessive pressures.

Control of Substances Hazardous to Health (COSHH) Regulations 2002

3.6 These regulations provide a framework of actions designed to control the risk from a range of harmful substances including waterborne pathogens such as *Legionella* and the chemicals that may be used to control the growth of microorganisms in water supplies. Employers have a duty to assess the risks from exposure to these substances to ensure that they are adequately controlled.

Public Health (Infectious Diseases) Regulations 1988

3.7 The Public Health (Infectious Diseases) Regulations 1988 require that a properly appointed officer inform the chief medical officer for England or for Wales, as the case may be, of any serious outbreak of any disease that to his/her knowledge has occurred in the district.

Note

Appendix 2.3 of HSE's *Legionella* technical guidance HSG274 Part 2 (2013) contains further advice and guidance on communication and cooperation with the consultant in communicable disease control (CCDC), and on arrangements for support of the CCDC and for this person to have access to provider units including healthcare organisations.

Water Supply (Water Quality) Regulations 2000

3.8 The Water Supply (Water Quality) Regulations 2000 apply to water supplied by a water undertaker to any premises that are used for domestic purposes such as drinking, cooking, personal hygiene, washing or food production.

Note

Two additional sources of advice on drinking water quality are:

a. the director of public health;

b. WHO's 'Guidelines for drinking water quality'.

Private Water Supplies Regulations 2009

3.9 These regulations cover private sources of water such as boreholes and wells intended for human consumption including drinking, cooking, food preparation or other domestic purposes. These regulations also place duties for monitoring and control of the quality of public water supplies where these are then further distributed to separate premises by the bill payer other than the water undertaker or licensed water supplier (often referred to as onward distribution).

Food Safety Act 1990

3.10 The Food Safety Act 1990 covers water used for food preparation or food manufacture and also includes water used for drinking. The Food Safety and Hygiene (England) Regulations 2013 are also relevant.

The Health and Safety Executive's (4th edition) Approved Code of Practice L8 2013

3.11 The HSE's (2013) Approved Code of Practice L8 (4th edition) came into effect on 7 November 2013 and is supported by the technical guidance (HSG274 Parts 1–3). It replaced the earlier publication entitled 'Legionnaires' disease: The control of *Legionella* bacteria in water systems – Approved Code of Practice and guidance' (L8 3rd edition). The onus is on the duty holder to demonstrate that procedures in place are as good as, or better than, those required by L8.

3.12 The Approved Code of Practice L8 has a special legal status. If a person or organisation is prosecuted for a breach of health and safety law and it is proved that they did not follow the provisions of the Code, they will need to show that they have complied with the law in some other equally effective way or a court will find them at fault. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance.

3.13 Compliance with HSG274 will satisfy the Approved Code of Practice L8.

3.14 The health service, with responsibility for the wider aspects of public health and the operation of healthcare premises, is expected to be particularly vigilant.

3.15 The incidence of healthcare-associated waterborne illness including Legionnaires' disease is relatively low, but cases and outbreaks are considered to be avoidable. Management, operators and contractors should be aware that incidents or outbreaks cause widespread concern, especially if associated with healthcare premises. Investigation of these outbreaks has shown that they are generally related to poor training, flaws in system design, poor commissioning and risk assessments, defects and breakdowns. However, by far the greatest contributors to outbreaks of Legionnaires' disease are poor or inappropriate maintenance and control procedures and ineffective communication and systems management.

Water Supply (Water Fittings) Regulations 1999

3.16 These regulations set legal requirements for the design, installation, operation and maintenance of plumbing systems, water fittings and water-using appliances. They have a specific purpose to prevent misuse, waste, undue consumption or erroneous measurement of water and, most importantly, to prevent contamination of drinking water. These regulations are enforced by the local water undertaker.

3.17 These regulations apply in all types of premises supplied, or to be supplied, with water from a water undertaker. They apply from the point where water enters the property's underground pipe, to where the water is used in plumbing systems, water fittings and water-using appliances. However they do not apply in premises that have no provision of water from the public mains supply.

3.18 These regulations are set out – along with the Department for Environment, Food and Rural Affairs' (Defra) guidance on the regulations and the water industry's recommendations for fulfilling these provisions – in the 'Water Regulations Guide' published by the Water Regulations Advisory Scheme (WRAS).

British and European Standards

- The BS EN 805 series covers design and installation requirements for systems and components outside buildings.
- The BS EN 806 series covers installations inside buildings conveying water for human consumption.
- BS 8558 provides UK-specific complementary guidance to the BS EN 806 series of standards, replacing BS 6700.
- BS 1710 is the British Standard specification for identification of pipelines and services.
- PD 855468 – 'Guide to the flushing and disinfection of services supplying water for domestic use within buildings and their curtilages'.
- BS 8551 – 'Provision and management of temporary water supplies and distribution networks (not including provisions for statutory emergencies). Code of practice'.
- BS 8554 – 'Code of practice for the sampling and monitoring of hot and cold water services in buildings'.
- BS 7592 – 'Sampling for *Legionella* bacteria in water systems. Code of practice'.

4 *Legionella*: overview

Source of the bacteria

4.1 *Legionella* bacteria are ubiquitous in both the natural and constructed aquatic environment and are widespread in natural freshwater including rivers, lakes, streams and ponds and may also be found in damp soil.

4.2 Airborne dispersal may occur when aerosols or droplet nuclei are created. There is a strong likelihood of low concentrations of *Legionella* existing in all open water systems including those of building services; therefore, the main emphasis should be on preventing *Legionella* from multiplying in water systems in healthcare premises.

Ecology

4.3 The following factors have been found to influence the colonisation and growth of *Legionella*:

a. Water temperature between 20°C and 45°C will promote growth.

b. Areas of poor flow, stagnation or inappropriate components.

c. Biofilms play an important role in harbouring and providing favourable conditions in which *Legionella* can grow. Biofilms in water systems are heterogeneous and will consist of bacteria, fungi, algae, protozoa, debris and corrosion products. Nutrients can be provided to the biofilm from the incoming water, particularly where there is increased turbidity and also from scale, sediment, corrosion products, trapped organic and inorganic molecules supplied by the flowing water and a range of surface materials.

d. *Legionella* are unable to grow in sterile water as they require other microorganisms for growth. *Legionella* have also been shown to proliferate rapidly in association with some waterborne protozoa including amoebae.

e. Water fittings, pipework and materials used in the construction of water systems can encourage the growth of waterborne pathogens. Water quality can deteriorate within the system and in components such as terminal fittings, particularly when utilisation is low. Pipework downstream of thermostatic mixing valves may pose a particular problem as the lower temperature can encourage the growth of waterborne pathogens.

Epidemiology

4.4 Legionnaires' disease is often described as an atypical acute pneumonia of rapid onset often with gastrointestinal symptoms, which can confuse the diagnosis. Legionnaires' disease is predominantly caused by inhalation of *L. pneumophila* serogroup 1, which is the commonest cause of Legionnaires' disease accounting for around 85% of cases within the EU (see the European Centre for Disease Prevention and Control's (ECDC) website). However, other non-*pneumophila* species have also been shown to cause disease in hospitals. Pontiac fever is a self-limiting form of legionellosis which usually requires no treatment. Outbreaks of Pontiac fever have been associated with patients showering.

4.5 The risk of healthcare-associated legionellosis depends on a number of factors such as:

- the presence of *Legionella* in sufficient numbers (see also paragraph 4.15);
- conditions suitable for multiplication of the organisms (for example temperatures between 20°C and 45°C);
- source of nutrients (for example scale, sludge, rust, protozoa, and other available organic carbon, bacteria and biofilms);
- a means of creating and disseminating aerosols (a typical droplet size of <5 μm can be inhaled deep into the lungs) that contain viable *Legionella* (potential sources, for example, include showers and most other water draw-offs that are capable of creating an aerosol);

Note

Some cases of Legionnaires' disease in healthcare premises have been associated with aspiration of contaminated ingested water rather than inhalation of aerosols.

- the presence of people who may have compromised immune or respiratory systems or have other risk factors that increase their susceptibility to *Legionella* infection.

4.6 Many, if not all, of these factors are likely to be encountered in healthcare premises.

Control measures

See also:

- paragraphs 5.11–5.16 on management of control;
- Chapter 4 in Part A on water treatment and control programmes for hot and cold water systems.

4.7 A temperature control regime is the traditional means of controlling *Legionella* in hot and cold water services. Hot and cold water systems should be maintained to keep cold water, where possible, at a temperature below 20°C, and to keep hot water stored at 60°C and distributed so that it reaches the outlets at 55°C within one minute. Owing to the complexity of hot and cold water systems found in healthcare facilities and the difficulty of maintaining a temperature control regime at all times, in all areas, chemical and other water treatments that have been shown to be capable of controlling microbial colonisation and growth may need to be considered as an additional control measure.

4.8 Validation of treatment systems is important to ensure that the design and operation of a new or modified system is effective. Ongoing verification by operational monitoring is essential to ensure that the control measures remain effective. The monitoring of treatment programmes should demonstrate that they are working within legislation and the established guidelines, and are effective in controlling the target waterborne pathogens. The frequency of monitoring and test procedures will vary according to the method selected.

4.9 The use of biocides requires meticulous monitoring and their use can have an effect on water quality including taste and odour.

4.10 Where biocides are used, risk assessments (which have been agreed with the WSG) should identify at-risk patient groups (and/or equipment) to ensure there are no unforeseen consequences for patients (for example, patients in neonatal units and renal units).

Route of infection

4.11 The principal route of infection for Legionnaires' disease is through inhalation of the bacteria into the lungs via aerosols. The risk rises with increasing numbers of inhaled bacteria. Aspiration of contaminated drinking water into the airways has also been described as a mode of transmission of Legionnaires' disease. Aspiration can be a significant source of legionellosis in certain vulnerable patients including those using nasogastric tubes, stroke patients, those taking sedatives and narcotics, and those with motor neurone disease. Sucking ice made from contaminated water has been linked to some nosocomial cases of Legionnaires' disease.

Aerosol generation

4.12 Contaminated water presents a risk when dispersed into the air as an aerosol with smaller aerosols (<5 μm diameter) remaining airborne for longer, penetrating deeply into the lungs (alveoli). However, larger droplets can evaporate and still contain several organisms. Amoebic vacuoles, typically 3 μm, may contain many *Legionella* and potentially provide an infectious dose.

4.13 Water services are capable of generating aerosols from the process of water splashing on to wash-hand basins, sinks, and baths, in shower cubicles and when flushing toilets. Equipment that uses or is cleaned by water should be assessed for its potential to produce aerosols both in normal and abnormal (for example during maintenance) operating conditions.

Number of infectious bacteria

4.14 The number of organisms that cause infection has not been reliably determined and is likely to vary from person to person.

4.15 Two factors determine the number of bacteria deeply inhaled:

a. The concentration of bacteria in the air is determined both by the concentration of bacteria in the water and by the amount of contaminated water dispersed into a given air volume. The concentration of live bacteria in the air reduces rapidly with distance from the source; however this depends on the humidity and temperature.

b. The duration of exposure to the contaminated air:

   i. exposure in a shower is usually limited to a few minutes, while exposure in a bath is much longer;

   ii. the risk increases with the number of *Legionella* in the air, the respiratory rate of the individual and the length of time the person is exposed. The chances of *Legionella* infections occurring increase with the number and susceptibility of people exposed.

Susceptibility of individuals

4.16 While previously healthy people may develop Legionnaires' disease, there are a number of factors that increase susceptibility:

a. increasing age, particularly over the age of 50 (children are rarely infected);

b. men are approximately three times more likely to be infected than women (this may change with altered smoking habits);

c. existing respiratory disease that makes the lungs more vulnerable to infection;

d. illnesses and conditions such as cancer, diabetes, kidney disease or alcoholism, which weaken the natural defences;

e. smoking, particularly heavy cigarette smoking, because of the probability of impaired lung function;

f. patients who are immunocompromised as a result of illness or treatment (for example, those on immunosuppressant drugs that inhibit the body's natural defences against infection).

5 *Pseudomonas aeruginosa* and other waterborne pathogens: overview

Ecology

5.1 *P. aeruginosa* is a Gram-negative bacterium, commonly found in wet or moist environments. It is commonly associated with disease in humans with the potential to cause infections in almost any organ or tissue, especially in patients compromised by underlying disease, age or immune deficiency. As a pathogen the significance of *P. aeruginosa* is exacerbated by its resistance to antibiotics, virulence factors and its ability to adapt to a wide range of environments and nutrients.

5.2 *P. aeruginosa* thrives in relatively nutrient-poor environments such as water systems at a range of different temperatures and can exist as planktonic cells in water or as biofilms where mixed populations of bacteria are bound to surfaces. Biofilms can become detached to contaminate the water phase or flow.

Transmission

5.3 *P. aeruginosa* is an opportunistic pathogen that can colonise and cause infection in patients who are immunocompromised or whose defences have been breached (for example, via a surgical site, tracheostomy or indwelling medical device such as a vascular catheter). In most cases, colonisation will precede infection. Some colonised patients will remain well but can act as sources for colonisation and infection of other patients. As a microorganism that is often found in water, the more frequent the direct or indirect contact between a susceptible patient and contaminated water, and the greater the microbial contamination of the water, then the higher the potential for patient colonisation or infection.

5.4 Contaminated water in a healthcare setting can transmit *P. aeruginosa* to patients through the following ways:

- direct contact with the water through:
  - ingesting;
  - bathing;
  - contact with mucous membranes or surgical site; or
  - through splashing from water outlets or basins (where the flow from the outlet causes splashback from the surface);
- inhalation of aerosols from respiratory equipment, devices that produce an aerosol or open suctioning of wound irrigations;
- medical devices/equipment rinsed with contaminated water;
- indirect contact via healthcare workers' hands following washing hands in contaminated water, from surfaces contaminated with water or from contaminated equipment such as reusable wash-bowls or refillable spray cleaning bottles.

Source

5.5 It is generally accepted in the case of *Legionella* that the source of bacteria in hot and cold water systems is the incoming water supply and that it becomes a problem where there is a failure of the recommended control measures (for example, maintenance of temperatures or water treatment regimes). In contrast to *Legionella*, the origin of *P. aeruginosa* is less certain and its presence is particularly evident within the last two metres before the point of discharge.

5.6 Devices fitted to, or close to, the tap outlet (for example mixing valves, solenoids or outlet fittings) may exacerbate the problem by providing the conditions and nutrients that support microbial growth (for example, appropriate temperatures, a high surface-area-to-volume ratio or a high surface area for oxygenation of water, and leaching of nutrients from materials such as ethylene propylene diene monomer (EPDM)). The source, therefore, could be:

- the incoming water supply from the water provider;
- the water supply within the building (both from the storage and distribution system), usually within biofilms;
- the wastewater system (see Breathnach et al. 2012); or
- via external retrograde contamination from:
  - clinical areas due to the discarding of patient secretions or where medical equipment may have been washed in the wash-hand basin;
  - outlet users where hands may have been contaminated by *P. aeruginosa*;
  - poor hygiene or processes during cleaning, resulting in contamination from the drain or surrounding environment to the outlet fitting;
  - splashback from contaminated drains;
  - contaminated cloths/mops etc.

5.7 Given this variety, the challenge for the WSG is to risk-assess operational practices in an attempt to minimise contamination from any of these sources.

Mycobacteria

5.8 Non-tuberculous mycobacteria have been associated with healthcare outbreaks worldwide. These outbreaks usually involve sternal wound infections, plastic-surgery wound infections or post-injection abscesses.

5.9 Mycobacterial infections in patients undergoing dialysis treatment have also been reported. Other infections have been attributed to the transmission of *Mycobacterium chimaera* from contaminated heater cooler units used in theatre during cardiothoracic surgery (see also paragraph 8.23).

Stenotrophomonas

5.10 There are at least 14 species of *Stenotrophomonas*; the most important waterborne pathogen is *Stenotrophomonas maltophilia.* This is an emerging opportunistic environmental pathogen that causes healthcare-associated infections and is found in aqueous habitats including water sources. *S. maltophilia* is an organism with various molecular mechanisms for colonisation and infection, and can be recovered most notably from the respiratory tract of cystic fibrosis patients with *P. aeruginosa*. Its habits within the healthcare environment are very similar to *P. aeruginosa;* however, it is more heat-sensitive and will not grow above 40°C. Good temperature management should reduce the risk of colonisation. It has been associated with the colonisation of taps/tap water, sinks/sink traps, showers, hydrotherapy pools, ice-makers, disinfectant solutions, haemodialysers, nebuliser chambers, humidifier reservoirs, bronchoscopes and ventilator circuits. *S. maltophilia* isolated from tap water has been shown to be responsible for the colonisation/infection of five neonates in a neonatal intensive-care unit. Where clinical results indicate water may be a vector in the transmission of *Stenotrophomonas* spp., then water sampling should be carried out as per *P. aeruginosa* (see Appendix E).

Other emerging pathogens of concern in healthcare

Other organisms may have particular pathogenicity in certain circumstances. Specialist microbiological advice should be sought until their management and control within heathcare can be documented more fully.

Management of control

5.11 Management of water systems to reduce the risk of waterborne pathogens is vital to patient safety. It requires surveillance and maintenance of control measures including temperature control, usage, cleaning and disinfection measures as identified within the risk assessment and WSP for both hot and cold water systems.

5.12 To prevent the growth of waterborne pathogens, controls are necessary to manage the water system before and after the outlet.

5.13 The WSG should ensure that estates and facilities staff have up-to-date accurate records and drawings/diagrams showing the layout and operational manuals of the whole water system. Estates and facilities staff should have received adequate hygiene training (see paragraphs 6.29–6.30) and be fully aware of the extent of their responsibilities to prevent microbial contamination of plumbing components (see paragraphs 1.21–1.26 in HTM 04-01 Part A). There should be strict adherence to the recommendations in HSG274 Part 2.

5.14 The WSG should also ensure that infection prevention and control (IPC) teams have received adequate training and that there is compliance with national evidence-based guidelines for preventing healthcare-associated infections. Best practice advice relating to clinical wash-hand basins should be followed to minimise the risk of contamination of surfaces, outlets and drains due to waterborne pathogens (see Chapter 3 in HTM 04-01 Part C).

5.15 IPC teams and WSGs should continue to monitor clinical isolates of waterborne pathogens including the presence of *P. aeruginosa* in risk-assessed augmented care units as an alert organism and be aware of possible outbreaks or clusters of infection with this microorganism.

5.16 The HCAI Code of Practice sets out the criteria against which a registered provider's compliance with the requirements relating to cleanliness and infection control will be assessed by the Care Quality Commission. It also provides guidance on how the provider can interpret and meet the registration requirement and comply with the law. Regulations 12 and 15 state that providers should provide and maintain a clean and appropriate environment in managed premises that facilitates the prevention and control of infections (see paragraphs 0.15–0.17).

6 Operational management

Introduction

6.1 Healthcare organisations have an explicit duty under the Health and Safety at Work Act etc. 1974 to assess and manage the risks posed by water systems on their premises. In accordance with the HCAI Code of Practice (see paragraphs 0.15–0.17), the healthcare organisation's chief executive is responsible for having systems in place to manage and monitor the prevention and control of infection. These systems should make use of WSPs and risk assessments to consider how susceptible patients are at risk from their environment and from others. Ensuring these elements are in place will assist the organisation to fulfil its duties in relation to the provision of safe water systems. A programme of audit should be in place to ensure that key policies and practices are being implemented appropriately. This will inform the organisation's assurance framework.

6.2 Each healthcare organisation, through its WSG and WSP, should be able to demonstrate that they have suitable governance, competence and accountability arrangements in place to deliver safe water in healthcare premises.

The Water Safety Group (WSG)

6.3 The WSG is a multidisciplinary group formed to oversee the commissioning, development, implementation and review of the WSP. The aim of the WSG is to ensure the safety of all water used by patients/residents, staff and visitors, to minimise the risk of infection associated with waterborne pathogens. It provides a forum in which people with a range of competencies can be brought together to share responsibility and take collective ownership for ensuring it identifies water-related hazards, assesses risks, identifies and monitors control measures and develops incident protocols.

Note

Where estates and facilities provider services are part of a contract (including PFI), it is essential that these providers participate fully in all those aspects of estate and facilities management that can affect patients. This includes responding to specific requests from the IPC team and WSG, which may be in addition to relevant guidance and documentation.

6.4 The WSG should have clearly identified lines of accountability up to the duty holder. The roles, responsibility and accountability of the WSG should be defined (see Chapter 2).

6.5 The group should ensure that there is the appropriate expertise available to ensure that all elements of the WSP are fully implemented. This will require assurance from installers, maintainers and users with regard to the safety of all water used by patients/residents, staff and visitors, to minimise the risk of infection associated with waterborne pathogens. The WSG may typically comprise personnel who:

- are familiar with all water systems and associated equipment in the building(s) and the factors that may increase risk of infection from *Legionella, P. aeruginosa* and other waterborne pathogens (that is, the materials and components, the types of use and modes of exposure, together with the susceptibility to infection of those likely to be exposed);

- have knowledge of the particular vulnerabilities of the at-risk population within the facility; as part of its wider remit, the WSG should include representatives from areas where water may be used in therapies, medical treatments or decontamination processes where exposure to aerosols may take place.

6.6 This would normally involve representation from estates (operations and projects), infection control, medical microbiology, nursing, augmented care, housekeeping/support services, an Authorising Engineer/independent adviser, medical technical officers, specialist users of water (such as renal units and departments offering aquatic therapy), and sterile services departments (SSDs). See Figure 2 for an example structure and see also the Note under paragraph 6.3.

6.7 As and when required, the local security management specialist (LSMS) should provide a security management input. The LSMS should be consulted in any vulnerability and risk assessments being undertaken, to ensure that the security of the water systems is fully considered and proportionate security measures are implemented.

6.8 The WSG should be led and chaired by a person who has appropriate management responsibility, knowledge, competence and experience. Where required, it may appoint in writing an independent professional adviser/Authorising Engineer (Water) with a brief to provide services in accordance with this HTM and the HSE's technical guidance HSG274 Part 2.

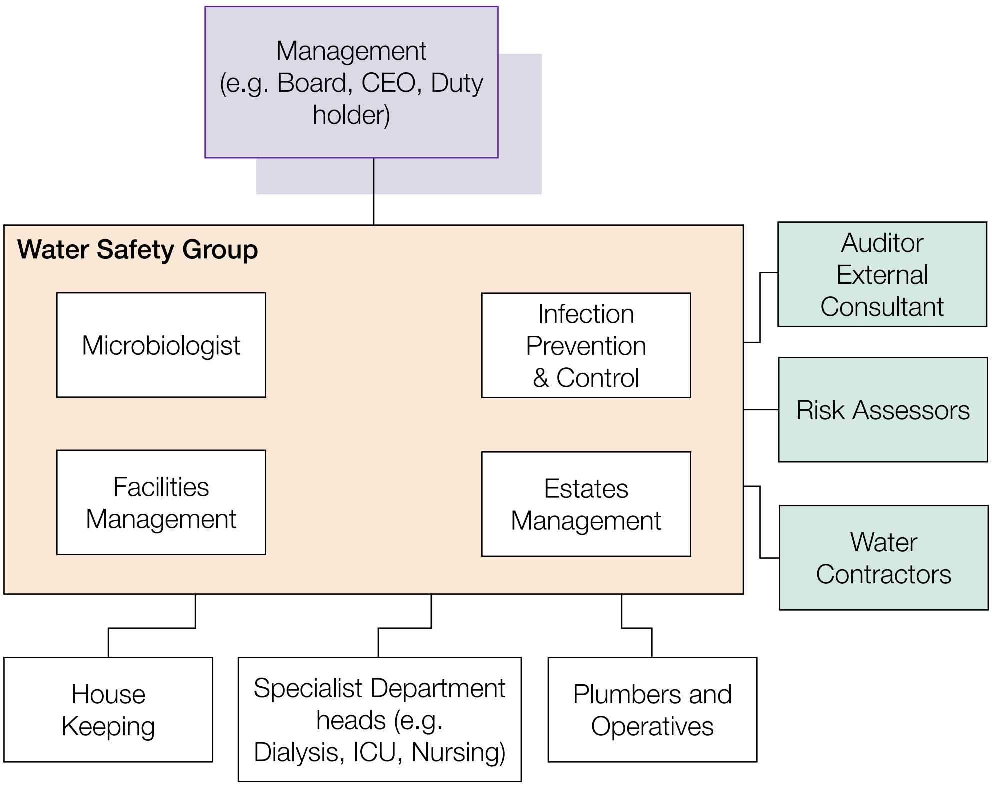


Figure 2 Example WSG structure

Remit of the WSG

6.9 The following is a typical list of tasks assigned to the WSG:

- to work with and support the IPC team;
- to ensure effective ownership of water quality management for all uses;
- to determine the particular vulnerabilities of the at-risk population;
- to review the risk assessments;
- to ensure the WSP is kept under review including risk assessments and other associated documentation;
- to ensure all tasks indicated by the risk assessments have been allocated and accepted;
- to ensure new builds, refurbishments, modifications and equipment are designed, installed, commissioned and maintained to the required water standards;
- to ensure maintenance and monitoring procedures are in place;
- to review clinical and environmental monitoring data;
- to agree and review remedial measures and actions, and ensure an action plan is in place, with agreed deadlines, to ensure any health risks pertaining to water quality and safety are addressed;
- to determine best use of available resources;
- to be responsible for training and communication on water-related issues;
- to oversee water treatment with operational control monitoring and to provide an appropriate response to out-of-target parameters (that is, failure to dose or overdosing of the system);
- to oversee adequate supervision, training and competency of all staff;
- to ensure surveillance of both clinical and environmental monitoring.

6.10 Detailed minutes of the group meetings should be recorded, distributed promptly and retained in accordance with the management policy to demonstrate good management, appropriate and timely actions and good governance.

6.11 The WSG should always act in an appropriate and timely manner. Individual responsibilities should not be restricted by the need to hold formal meetings.

6.12 Episodes of colonisation or infection of patients that could be related to the water system should be referred by the IPC team to the chair of the WSG for any additional action to be determined.

6.13 The WSG should review any proposed or existing developments associated with the water supply and distribution system to ensure that they:

- minimise the risk to patients/service-users, especially those treated in augmented care settings;
- are compliant with all extant legislation and DH policy and guidance.

6.14 All systems and equipment that use water to which patients, staff and visitors could be exposed should be approved by the WSG. When buying equipment, assurance should be sought from the manufacturer regarding safety for patients and service-users.

6.15 The WSG will need to ensure that decisions affecting the safety and integrity of the water system do not proceed without its agreement.

Water safety plans (WSPs)

6.16 To assist with understanding and mitigating risks associated with waterborne hazards in distribution and supply systems and associated equipment, healthcare organisations should develop a WSP, which provides a risk-management approach to the safety of water and establishes good practices in local water usage, distribution and supply (see Figure 3). It will identify potential water-related hazards, consider practical aspects and detail appropriate control measures. The content of a WSP will depend on the size and complexity of the healthcare organisation's water system. The plan will include governance arrangements related to the management of water safety. See paragraph 6.21 for a list of elements that the WSP should incorporate.

6.17 Those organisations with existing robust water management policies for waterborne hazards will already have in place much of the integral requirements for developing a WSP.

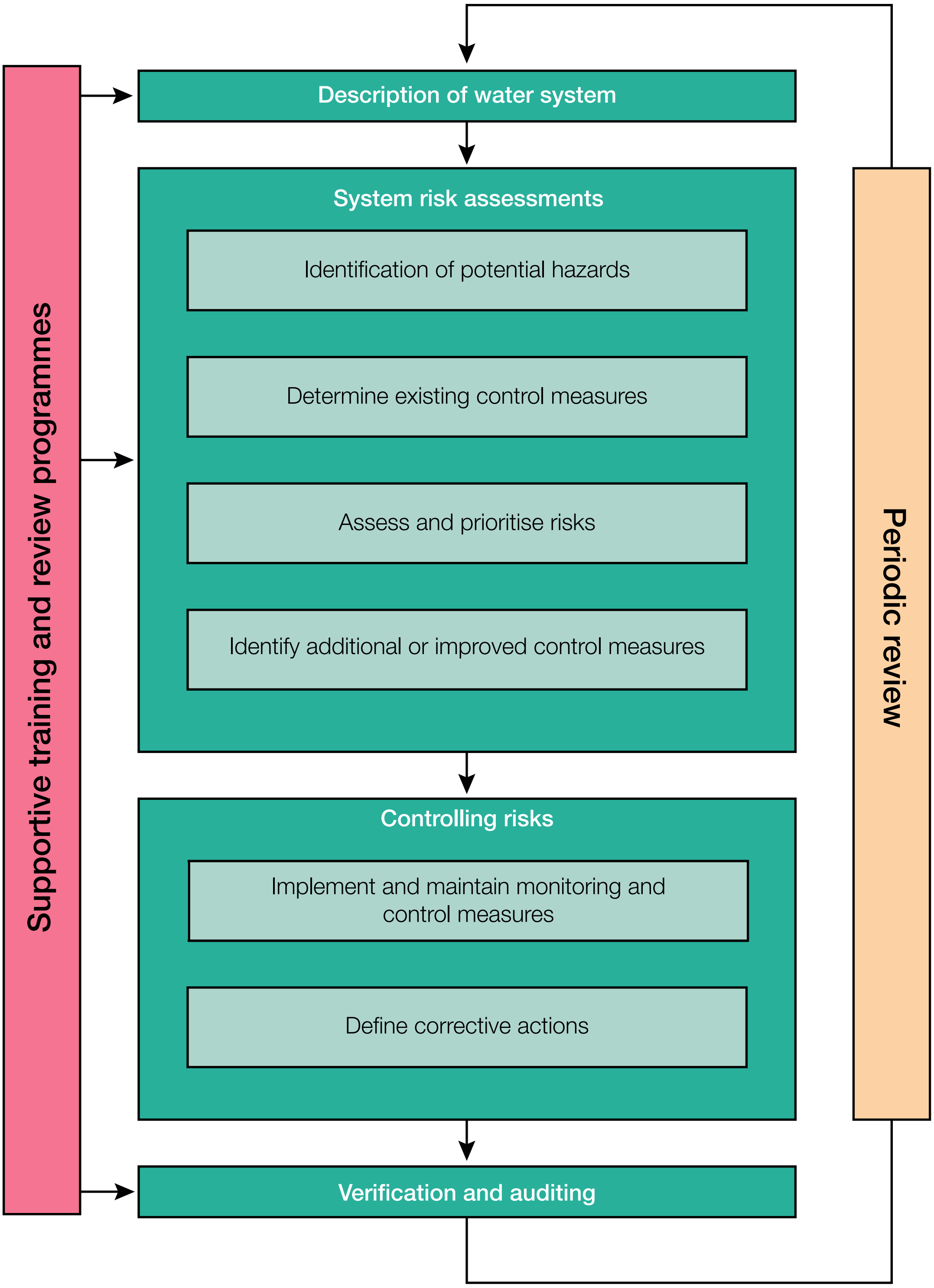


Figure 3 Documentation of management procedures (adapted from Figure 4.1 in WHO's 'Water safety in buildings')

6.18 The WSP is a living document. It should be kept under continual review and ensure the adequate assessment and control of the risks from a wide range of waterborne pathogens. It should be a standing agenda item at WSG meetings.

6.19 The first step in the development of a WSP is to gain a comprehensive understanding of the water system, including the range of potential hazards, hazardous events and risks that may arise during storage, delivery and use of water. It may require an understanding of the quality and management of the water as provided and how that water is used. Fundamental to this and any subsequent investigation or review is the provision and availability of accurate records. Schematic diagrams are useful for assisting understanding of how entire water systems operate; however, more advanced drawings (as-built) are often needed in complex buildings. The WSP should also be cross-referenced to the healthcare organisation's security management strategy and business continuity plan.

6.20 WSPs include the need to:

- assess the risks that may be posed to patients (including those with particular susceptibility), staff and visitors;
- put into place appropriate management systems to ensure the risks are adequately controlled;
- ensure there are supporting programmes, including communication, training and competency checks.

6.21 With respect to physical, chemical and microbiological hazards, the WSP should incorporate:

- a clinical risk assessment to identify those settings where patients are at significant risk from waterborne pathogens;
- an engineering and bacterial risk assessment of all water systems;
- operational monitoring of control measures and record-keeping methodology;
- information on the age and condition of the water distribution system and materials of construction (as different materials hold differing risks and react differently to chemicals);
- links to clinical surveillance;
- early warnings of poor or unsuitable water quality (for example, taste, odour, flavour and appearance if intended for drinking);
- plans for the sampling and microbiological testing of water in identified at-risk units (see Chapter 10 and Appendices E and F);

Note

Appendix F has been developed to provide technical guidance for a range of laboratories, including NHS, Public Health England (PHE) and commercial laboratories that have the capability and capacity to undertake water sampling and testing.

- adequate supervision, training and competency for all levels of staff including housekeeping staff and those employed by facilities management organisations;
- communication and documentation;
- appropriate design, installation, commissioning and maintenance of all components and equipment;
- remedial actions to be taken to remedy high counts for *P. aeruginosa* and *Legionella* and other relevant pathogens where appropriate;
- adjustments to clinical practice until remedial actions have been demonstrated to be effective;
- regular removal/cleaning/descaling or replacement of the water outlets, hoses and thermostatic mixing valves (TMVs) and other components where risk assessment necessitates;

- amendments when changes are carried out including new builds, refurbishments and recently decommissioned clinical departments or units;
- amendments made when changes are made at the annual review.

6.22 The WSP should identify potential alert organisms and microbiological hazards caused by *Legionella*, *P. aeruginosa* and other relevant pathogens, consider practical aspects and detail appropriate control measures.

Risk assessments

6.23 The risk assessments that inform the WSP should identify potential hazards caused by *Legionella*, *P. aeruginosa* and other relevant pathogens, chemicals, temperature and events that may arise during supply, storage, delivery, maintenance and use of water in healthcare facilities.

6.24 Once potential hazards and hazardous events have been identified, the severity of risk needs to be assessed so that priorities for risk management can be established. The risk assessment needs to consider the likelihood and severity of hazards and hazardous events in the context of exposure (type, extent and frequency) and the vulnerability of those exposed. Although many hazards may threaten water quality, not all will represent a high risk. The aim should be to distinguish between high and low risks so that attention can be focused on mitigating risks that are more likely to cause harm (see BS 8580 for guidance on *Legionella* risk assessments). Typical examples of issues to consider may include the following:

- governance and accountability;
- the susceptibility of all who may be exposed to water (including ice) used for diagnosis and treatment;
- scalding risk and the appropriate installation of TMVs;
- failure to maintain necessary hot and cold system supply temperatures;
- clinical practice where water may come into contact with patients and their invasive devices;
- the appropriate cleaning of the environment and equipment;
- the disposal of blood, body fluids and patients' wash-water;
- the maintenance and cleaning of wash-hand basins and associated taps, specialist baths and other water outlets;
- suitable siting and installation of wash-hand basins including the appropriate positioning of soap and antimicrobial hand-rub dispensers;
- change in use (for example, clinical area changed to office accommodation or vice-versa) due to refurbishment or operational necessity;
- other devices that increase/decrease the temperature of water (for example, ice-making machines, water chillers) which may not be appropriate where patients are at particular risk such as in augmented care settings;
- engineering assessment of water systems, including appropriate design, installation, commissioning, maintenance and verification of the effectiveness of control measures (see also the Water Supply (Water Fittings) Regulations 1999);
- infrequently used outlets;
- previous risk assessment, current control measures and documentation;
- policies and procedures;
- the unnecessary use of flexible hoses and any containing inappropriate lining materials;
- sampling, monitoring and testing programmes that needs to be put in place;
- backflow protection;
- safe access to equipment;

- prevention of unauthorised access to equipment;
- education and training.

6.25 Situations will arise where venous catheter sites and surgical wounds may become contaminated from water outlets such as showers. Similarly the practice of soaking leg ulcers or syringing ears may require consideration of the microbiological quality of water used and will require local assessment.

6.26 The likelihood of hazardous events is influenced by the size and complexity of the water system and can be exacerbated by poor or overcomplicated design, construction, commissioning, operation and maintenance.

Staff training and competence

6.27 The WSG should implement a programme of staff training to ensure that those appointed to devise strategies, carry out control measures and undertake associated monitoring are appropriately informed, instructed and trained. They should also be assessed as to their competency. It is also essential that they have an overall appreciation of the practices affecting water hygiene and safety, and that they can interpret the available guidance and perform their tasks in a safe and technically competent manner.

6.28 The WSG should review the competence of staff on a regular basis, and refresher training should be given; records of training attendance need to be maintained. Although training is an essential element of ensuring competence, it should be viewed within the context of experience, knowledge and other personal qualities that are needed to work safely. Competence is dependent on specific needs of individual installations and the nature of risks involved.

Water hygiene training

6.29 Individuals to whom tasks have been allocated (supervisors and managers as well as operatives) need to have received adequate training in respect of water hygiene and microbiological control appropriate to the task they are responsible for conducting. The training and competence assessment should be clearly defined and should include those responsible for simple housekeeping tasks such as outlet flushing and the cleaning of wash-hand basins, through to maintenance staff and up to individuals who define strategy and develop procedures.

6.30 It is important that any person working on water distribution systems or cleaning water outlets should have completed a water hygiene awareness training course so that they can gain an understanding of the need for good hygiene when working with water distribution systems and water outlets, and of how they can prevent contamination of the water supply and/or outlets.

Water hygiene training

As part of helping to ensure the delivery of safe wholesome water at all outlets and preventing contamination, which may lead to healthcare-associated infections, it is recommended that healthcare organisations implement a water hygiene training scheme.

Consideration should also be given to integrating a health screening element into the training to help ensure those undergoing the training are not carriers of any waterborne diseases on the date of training and are aware of their responsibilities towards the water supply. It is important that individuals are aware of their duty to protect the health of patients, staff and visitors and that they are responsible for ensuring that they inform their line manager if they come into contact with any disease that has the potential to cause harm.

The course should encompass the following topics (not exhaustive):

- organisational governance arrangements in relation to water hygiene and safety;
- familiarisation with local policies/procedures in relation to the management and provision of water hygiene and safety;
- information on prominent waterborne pathogens and their consequences;
- the ways in which water distribution systems, water outlets, components and any associated equipment can become contaminated;
- the responsibilities of individuals to prevent the contamination of the water distribution system and water outlets and assisting in ensuring control measures in place are effective;
- how the safety of water can be maintained by good hygiene practices;
- when not to work with water intended for domestic purposes;
- system design;
- components/accessories (taps, TMVs);
- disinfection and cleaning equipment/materials;
- how to store and handle pipes;
- organisation-specific control measures;
- the impact of getting it wrong;
- role of persons being trained;
- personal hygiene along with dealing with clothing, footwear, cleaning equipment/materials, tools and storage when considering water hygiene (as applicable to each role).

Management of water safety risks and issues

6.31 Identified water safety risks and issues should be assessed, prioritised and included on a risk register for discussion and management by the WSG and advice given on when these should be escalated to senior management/board level. Consideration should also be given to the potential and known threats from unauthorised access to the water supply for malicious purposes (see also NHS Protect's (2012) guidance on the security and management of NHS assets).

6.32 When the risks have been identified, an action plan needs to be developed with defined roles and responsibilities, and agreed timescales to minimise these risks. The action plan should include:

- appropriate remedial actions, monitoring details and schedules for validation that show the remedial actions are effective and subject to ongoing verification (completion dates should be defined);
- any training and competency issues required to ensure compliance with this guidance.

Advice on exposure of augmented care patients to *P. aeruginosa* is covered in HTM 04-01 Part C.

Documentation

6.33 All records pertaining to the risk assessment and action plan should be held and managed by the WSG.

Safe hot water temperature

6.34 See paragraphs 10.57–10.59 in HTM 04-01 Part A for guidance on safe water temperatures and delivery devices. See also HSE's 'Managing the risks from hot water and surfaces'.

6.35 To reduce the risk of scalding, thermostatic mixing devices are required for specific hot water outlets (see Table 2 in HTM 04-01 Part A). A scalding risk assessment is necessary to establish the need and type of device to be installed.

6.36 As with any safety device, routine checks will be essential to ensure continued satisfactory operation (see Chapter 11 of HTM 04-01: Supplement – 'Performance specification D 08: thermostatic mixing valves (healthcare premises)'). Such devices, however, should not be a substitute for caution. For example, when performing assisted bathing, it is often necessary to set the delivery temperature to a higher level than that normally considered safe to allow for the cooling effect of large baths that are required.

6.37 Before lowering or assisting patients into the bath, the water temperature must be checked with a thermometer to ensure that it has fallen to a safe value.

Utilisation

6.38 One of the critical factors affecting the quality of water within hot and cold water distribution systems is the extent of utilisation.

6.39 Where stagnation occurs or utilisation is low, cold water temperature can increase significantly and approach the range that is conducive to the growth of a variety of waterborne pathogens such as *Legionella*. Where hot and cold water is mixed, further opportunities arise for deterioration in water quality.

6.40 TMVs should not be installed in series with mixing taps (thermostatic or manual) (see also paragraphs 6.52–6.58 on maintenance practice).

6.41 The WSG needs to ensure that there is good liaison between the estates officers/ maintenance providers and clinicians to ensure that the water services are sufficiently used.

6.42 HSG274 Part 2 recommends that generally, for infrequently used outlets, flushing is carried out once a week but that in healthcare facilities the risk assessment, as agreed by the WSG, may indicate a higher frequency, and water draw-off should form part of the daily cleaning process. The procedure for such practice should be fully documented and covered by written instructions.

6.43 Monitoring of water usage on a building-by-building basis can indicate when usage falls and the risk increases. Reductions in normal usage patterns should be investigated and remedial measures introduced following investigations by the WSG.

Note

Regular flushing applies to all infrequently used outlets. The use of portable temperature-monitoring devices may assist in identifying where additional flushing is necessary.

Temporary closure of wards/departments

6.44 During the temporary closure of wards or departments, a flushing regime should be instigated to maintain system hygiene. Flushing should be continued until stable temperatures are achieved. Advice and guidance is also provided in BSI's PD855468.

6.45 Alternatively, when this is impracticable, or should the temporary closure become permanent, it should be disconnected from the rest of the system, ensuring there are no dead-legs. Before reconnecting, the system should be recommissioned and disinfected in accordance with Chapter 15 of HTM 04-01 Part A.

Leak detection/water conservation

6.46 It is essential to regularly check systems and all components for signs of leakage; for example, a tap left dripping can waste in excess of 14,000 L of water each year. Particular attention should be given to WCs as leakage appears as a dribble at the back of the pan, which often goes undetected.

6.47 Consumption should be monitored; if it increases for no apparent reason, this may indicate a leak. Wet or soggy patches of ground may identify underground leaks, for example areas of greenery that are more lush than their surroundings.

6.48 Where water conservation measures are to be considered, a risk assessment should be undertaken to ensure there is no detrimental impact that may cause stagnation or low water usage in the existing water or drainage systems.

6.49 For further guidance, see HTM 07-04 – 'Water management and water efficiency'.

Water treatment undertaken by the local water undertaker

6.50 Local water undertakers use different types of water treatment, which may include the use of chloramine, and add additional compounds such as fluoride. It is recommended that regular contact is maintained with the local water undertaker to keep up to date with changes that may affect water quality or other operational changes affecting the premises.

Energy management

6.51 Efforts should be taken to minimise energy consumption without compromising water safety management. An effective maintenance plan will also contribute to this. Further guidance is given in HTM 07-02 – 'EnCO$_2$de'.

Maintenance practice

Note

See also Chapter 11 in HTM 04-01: Supplement – 'Performance specification D 08: thermostatic mixing valves (healthcare premises)'.

6.52 Healthcare organisations should ensure that all personnel that work on water systems can demonstrate competence and have been inducted in local procedures, which should include safe water hygiene practices (see paragraphs 6.29–6.30).

6.53 There are legal, operational and economic reasons for introducing good maintenance practice. There is a legal requirement under the Water Supply (Water Fittings) Regulations 1999 to maintain water fittings to comply with the regulations. It sets a requirement to protect and preserve water quality for the safety of patients, staff and visitors. Complying with the law is generally given the highest priority and is the minimum requirement that must be satisfied. Chapter 3 lists specific statutes that must be complied with. Additional advice is provided in BS EN 806-5 and BS 8558.

Note

BS EN 806-5 and complementary guidance in BS 8558 covers the operation and maintenance of water systems, in which a number of aspects are covered:

- operation;
- interruptions to operation and disconnection;
- resumption of supply;
- damage and faults (change in water quality, insufficient water supply, noise emission);
- alterations, extensions and refurbishment;
- accessibility of installation components;
- maintenance.

6.54 Regulations require notification to the water undertaker of any proposed changes and additions to the water supply system in the premises. Before making any changes, a risk assessment should be carried out and audited by an independent assessor. Further details can be found on the WRAS website.

6.55 Maintenance is required to achieve optimum economic life and maintain maximum operational efficiency of the plant.

6.56 There should be a risk assessment to decide the appropriate type of maintenance (for example scheduled, corrective or condition-based) for the different items of plant. The following should be considered:

a. Would a breakdown of a particular service during working, or outside normal, hours pose a risk to patient safety and wellbeing?

b. How long can a breakdown of particular plant be tolerated?

c. What cost can be justified to avoid breakdown of particular plant such as standby pumps, dosing pumps etc?

d. The availability of suitable spares.

6.57 If response to failure is critical for certain items of plant, the maintenance organisation will require a planned strategy of calling out skilled staff to achieve an agreed response time and to minimise the interval between breakdown and the diagnosis and repair of the plant.

6.58 The approach for healthcare premises should be based on that of planned preventive maintenance (PPM) as any failure in the water services would be seriously detrimental to the provision of healthcare. The PPM programme and any subsequent amendments should be agreed by the WSG (see also Chapter 5 on maintenance in HTM 00 – 'Policies and principles of healthcare engineering').

Maintenance responsibility

6.59 A maintenance manager should be given responsibility for implementation of a risk-based operational maintenance strategy. These responsibilities will include:

a. the provision of adequately trained and supervised labour (see also paragraph 6.30 on water hygiene training);

b. clear definitions of the equipment and services to be maintained, together with the procedures to be carried out on them;

c. monitoring of the quality of the work carried out to ensure that it is consistently acceptable;

d. the identification of appropriate resources and the implementation of financial control procedures.

Note

The maintenance manager should ensure that risk assessments have been carried out for all maintenance activities, and be particularly aware of any specific risks associated with hot and cold water installations (for example, hazards associated with gaining access to cisterns, the discharge of large volumes of hot water to enable the inspection of calorifiers and hot water storage vessels, and the possibility that these may have become colonised by *Legionella*).

Contract maintenance

6.60 The increasing complexity of building services equipment has resulted in a growing reliance on contractors for the provision of maintenance services. The decision to use either a contractor or in-house staff should be taken in the light of local circumstances.

6.61 Contracts between contractors and healthcare organisations should clearly define the responsibilities of both parties. See Chapter 2 of HBN 00-08 – '(Estatecode) Part B: Supplementary information for Part A' for further guidance. BSRIA's BG3: 'Maintenance for building services' also provides advice on aspects to be considered when obtaining contract maintenance.

6.62 All staff who work on or with water systems should have the necessary qualifications, regulatory knowledge, competence and experience needed to complete safely and effectively their specific tasks. Each individual should have a full understanding of their role and the impact of their actions on patient care (see also paragraph 6.30 on water hygiene training).

6.63 Only installers with the appropriate qualifications, regulatory knowledge and competence should be used to install and maintain water installations. There are seven Approved Contractors' Schemes (APHC, Aplus, CIPHE, Snipef, Taps, WaterMark and WIAPS) authorised through the Water Supply (Water Fittings) Regulations 1999. In addition to plumbing installers, four schemes (Aplus, Taps, WaterMark and WIAPS) operate sector memberships for specialist areas of work covering external water services (below-ground pipe etc), catering equipment and point-of-use (chilled-water) equipment.

6.64 The WaterSafe register holds details from all seven Approved Contractors' Schemes for businesses that have registered plumbing installers.

6.65 A recognised benefit to using an Approved Contractor (including sector installers) is they can carry out some work without the need to provide advanced notification to the water undertaker, and their work will be certified upon completion. A "work completed" certificate issued by a WaterSafe-recognised plumber provides a defence for property owners who are challenged by a water undertaker enforcing the Water Supply (Water Fittings) Regulations 1999 or during legal proceedings.

Maintenance brief

6.66 The maintenance manager requires a brief that is in line with all the requirements of the WSP and approved by the WSG. This will include (among others):

a. the scope of work;

b. budgeting – overall and single item limits;

c. level of reliability;

d. response time required to correct faults;

e. criteria for quality of service, works and equipment;

f. reporting procedure;

g. accountability and responsibility;

h. energy-saving policy;

j. health and safety policy;

k. environmental and sustainability factors.

6.67 The above requirements are necessary regardless of whether the work is carried out by contractors or in-house staff.

Performance monitoring

6.68 This involves the regular inspection of systems and records, which should be in such detail as to enable the WSG to form an opinion regarding compliance with the agreed criteria.

6.69 If a contractor is commissioned to carry out maintenance but in-house expertise is not available to monitor their performance, it may be necessary to seek advice from an independent professional adviser (this may be available from a neighbouring healthcare organisation). Using another maintenance contractor in a monitoring role could lead to a conflict of interest.

6.70 Performance monitoring should establish that:

a. the required level of service is met;

b. all the required plant is being maintained;

c. system performance is being maintained (that is, by the implementation of microbial sampling and temperature/biocide-level-monitoring regimes);

d. maintenance is being carried out to the agreed standard;

e. correct replacement parts are being used;

f. the agreed spares stocks are being held on site;

g. records are being correctly maintained;

h. the agreed standards, number of staff, and number of visits are being achieved;

i. plant is being operated to achieve optimum energy usage;

j. health and safety requirements are being complied with;

k. only agreed subcontractors with the appropriate knowledge and competence are being employed (see paragraphs 6.60–6.65);

l. the client and typical users of the building are satisfied;

m. invoices accurately reflect the work carried out, including materials expended;

n. breakdowns do not occur too often;

o. adequate consideration is being given to the potential environmental impact of contractors' actions, for example disposal of lubricants, chemicals, worn parts etc that cannot be recycled.

Monitoring systems

6.71 Where monitoring systems are provided to assist in the management of hot and cold water systems, they should be subject to a routine maintenance and calibration regime. Systems should be in place to ensure all set alarms should be responded to in a timely manner.

Emergency action

6.72 Contingency plans should be available in the event of the following:

a. A power or energy interruption or a plant failure resulting in the temperature control strategy or the delivery of effective control measures being maintained as designed.

b. A water supply failure that could last beyond the period for the designed storage capacity.

> **Note**
>
> The WSG should ensure that plans are in place for the supply and distribution of alternative safe water for drinking to vulnerable patients and those unable to collect supplies from distribution points within the healthcare facility. This will include the use of sterile water if appropriate.

c. Monitoring and sampling results that indicate patient safety may be compromised unless remedial action is undertaken with immediate effect.

d. Emergency action in the event of a case or an outbreak of a healthcare-associated waterborne infection (see also Appendix B for action to take on an outbreak of legionellosis).

e. Tampering and sabotage of the water supply which could impact on patient and staff safety.

6.73 Guidance on temporary supplies is provided in BS 8551.

> **Note**
>
> Under the Security and Emergency Measures Direction, water suppliers should liaise with healthcare authorities to develop emergency plans to maintain supplies for domestic purposes to healthcare premises.
>
> These plans may include:
>
> - Adequate storage cistern capacity and distribution arrangements within the healthcare facility to provide minimum volumes of water at the outset of a major incident to maintain hygiene and health for an initial period until other temporary arrangements can be introduced.
> - The provision of facilities to connect to, and distribute water from, temporary storage cisterns such as pillow tanks at key locations within the site. Ground-level storage cisterns will require provision of booster pumps to either lift the water to existing storage cisterns or distribute it directly through existing or temporary site water mains.
> - The provision of connection points to existing storage cisterns at suitable locations for delivery of emergency supplies of water, for example from tankers.
> - Plans for the supply and distribution of alternative safe water for drinking to vulnerable patients and those unable to collect supplies from distribution points within the healthcare facility.

Data management and record-keeping

6.74 Given the amount of data that must be managed to facilitate the effective management of large and complex water systems, it is recommended that electronic data management tools be utilised to facilitate the intelligent use of data for the WSG to easily monitor trends and analyse chemical and microbiological parameters.

6.75 It is essential to have comprehensive operational manuals for all items of plant that include requirements for servicing, maintenance tasks and frequencies of inspection.

6.76 This information should be kept together with all commissioning data.

6.77 Documentation should also be drawn up as part of the health and safety file for the healthcare facility.

6.78 As a minimum, the following items should be recorded:

a. the names and positions of those responsible for conducting risk assessments, and managing and implementing the WSP;

b. the significant findings of risk assessments;

c. details of the procedures including sufficient detail to identify that the work was completed correctly and when the work was carried out; and

d. results of any monitoring inspection, test or checks carried out.

6.79 Records should be kept for at least five years unless they are required to be kept longer by the organisation's data management policy.

As-fitted drawings

6.80 The availability of accurate as-fitted drawings is essential for the safe operation of hot and cold water service systems and to inform the risk assessment. The drawings will be necessary to perform the temperature control checks on the systems and will assist in identifying any potential problems with poor hot water circulation and cold water dead-legs where flow to infrequently used outlets can be low. Such information should identify all key components in the installations, for example water meters, cisterns, filtration equipment (where fitted), calorifiers, and the location of isolating valves in the systems. Drawings should be kept up to date and amended when any changes are made to the system.

Schematic drawings

6.81 Separate schematic drawings should be prepared and displayed such that all plant items, control valves etc can be identified. A schematic diagram is an important tool to inform the risk assessment process. These are not formal technical drawings and are intended to be easy-to-read without specialised training or experience. While providing only an indication of the size and scale, they allow someone unfamiliar with the layout of a system to understand the positions and connections of the relevant components quickly. Drawings should be kept up to date and amended when any changes are made to the system.

Note

All drawings should be available to each person working on the systems and while conducting risk assessments.

6.82 In addition to drawings, there should be comprehensive schedules of outlets, lists of sentinel taps (outlets), other outlets to be tested (frequency as per the WSP) and other components in the system.

Asset register

6.83 The WSG should ensure that an accurate record of all assets relating to the hot and cold water distribution systems is set up and regularly maintained. They should also ensure that records of all maintenance, inspection and testing activities are kept up-to-date and properly stored.

6.84 The asset register should be designed to provide the following information:

a. an inventory of plant and water-associated equipment;

b. a basis for identifying plant details;

c. a basis for recording the maintenance requirements;

d. a basis for recording and accessing information associated with maintenance;

e. a basis for accounting to establish depreciation and the provision needed for plant replacement;

f. information for insurance purposes.

6.85 When completing records, it is essential that there is an audit trail in place indicating the individual concerned and dates/times where appropriate.

6.86 Further information on the monitoring of performance and effectiveness in carrying out maintenance tasks can be found in CIBSE's Guide M – 'Maintenance engineering and management'.

7 Description of systems, operational considerations and requirements

Source of supply

7.1 See Chapter 2 in HTM 04-01 Part A for comprehensive guidance and information on sources of water supply.

7.2 If supplies are taken from local boreholes or wells etc, the water should be tested to comply with the requirements of the Private Water Supplies Regulations 2009. The results of all analyses should be kept and recorded. Private supplies should be registered with the local authority.

Temperature control regime

7.3 A temperature control regime is the traditional strategy to control *Legionella* and other waterborne pathogens. This will require monitoring on a regular basis. Frequencies are listed in Table 1.

> **Note**
>
> The flow temperature of hot water out of the calorifier should be a minimum of 60°C. It should be a minimum of 55°C on flow and returns to all outlets and at the start of the hot water return. It should be a minimum of 50°C at the final connection to the calorifier.

7.4 Whereas many of the checks will, of necessity, require the use of separate thermometric equipment, some of the temperature checks can be carried out by continuous monitoring such as sensors and reporting systems (optionally linked to a building management system (BMS)). Where a BMS is used, it will be essential to ensure that regular calibration and physical tests are performed in accordance with the manufacturer's instructions.

7.5 More extensive use of automatic sensors and reporting systems should be considered for surveillance of systemic temperature profiling. Sensors should be located throughout the whole hot and cold water systems to ensure they give representative temperature values.

Biocide regimes

> **Note**
>
> Any biocidal treatment is likely to adversely affect the lifecycle of the installation.

7.6 In addition to maintaining a temperature control regime, there may be occasions where additional biocidal treatment is required for the effective control of *Legionella* and other waterborne pathogens. However, the selection of a suitable treatment is complex and depends on a number of parameters. Moreover the chosen biocide needs to be properly managed. This is particularly the case with cold water services compared with hot water services where, with the benefit of circulation, water is returned to the calorifier/water heater and is then pasteurised. However, it should be taken into consideration that effective concentrations of some biocides are difficult to achieve in hot water systems due to gassing off. For water intended for consumption, the biocide concentrations must not exceed prescribed concentrations for drinking water.

7.7 The WSG should be actively involved in the decision-making process and should involve consultation with the water undertaker to ensure the suitability of biocidal products for their intended application.

For further information on biocidal treatment, see Chapter 4 of HTM 04-01 Part A. For ongoing checks, see HSG274 Part 2.

Metal contamination

7.8 See Chapter 5 in HTM 04-01 Part A.

Water softening

7.9 See Chapter 6 in HTM 04-01 Part A.

Filtration

7.10 See Chapter 7 in HTM 04-01 Part A for guidance on point-of-entry filtration. See paragraphs 7.45–7.49 and paragraph D22(k) in Appendix D and also Chapter 4 in HTM 04-01 Part A for guidance on POU filtration.

Metering

7.11 Metered data should be logged and recorded by an automatic metering system (see also HTM 07-04 – 'Water management and water efficiency'). Where water meters are installed in below-ground meter chambers, the chambers should be kept clean of debris and water; this will enable quick and accurate reading of the meters.

7.12 Meters should be periodically checked to ensure that they are operating and providing accurate readings.

7.13 Meters, other than the water undertaker's meter, should be removed at such intervals as recommended by the manufacturer for cleaning and renewal of worn parts and should be tested for accuracy and disinfected prior to replacement.

7.14 Meters should ideally provide a pulse output that can be monitored by a BMS, but if not should be read on a regular basis (monthly) and consumption monitored. Data from the meter should be reviewed over time for anomalies (typically low or high consumption rates). Graphical methods may be beneficial. Where it is desirable to connect to the water undertaker's meter, its authorisation must be gained in advance.

7.15 Consumption should be checked against the utility bill and any discrepancies investigated.

Water storage

7.16 For general information on water storage, see Chapter 8 in HTM 04-01 Part A.

7.17 The Water Supply (Water Fittings) Regulations 1999 and relevant parts of BS EN 806 and BS 8558 specify minimum standards for cold water storage cisterns to ensure that the stored water is retained at a wholesome standard suitable for domestic use. It is necessary to minimise stagnation and stratification of the stored water. A nominal 12 hours' total on-site storage capacity is recommended. The quantity of the water stored should be carefully assessed in relation to the daily requirement so that a reasonable rate of turnover is achieved. The storage capacity should be reduced where it is known or established that it is excessive and where it is practicable to do so.

7.18 All cold water storage cisterns and cold feed cisterns should be examined at least annually or more frequently if the risk assessment dictates, paying particular attention to the presence of foreign objects, biological material and excessive corrosion. On completion of the examinations, the cisterns should be cleaned, if required, and any remedial work carried out. Before the cisterns and system are put back into use, they should be disinfected in accordance with the procedure detailed in chapter 2 of HSG274 Part 2. Where consideration is being given to the removal of a storage cistern, a full assessment of the downstream system is needed to ensure any consequential impacts are properly understood. These may include, but not be limited to, changes in pressure for pipes or equipment and any backflow prevention protection the cistern may have been providing.

7.19 Any chemicals or biocidal products used in the cleaning or maintenance of cisterns should be flushed from the cistern before it is put back into use. See Chapter 4 in HTM 04-01 Part A.

7.20 Cistern insulation should be checked to ensure that it is adequately positioned and in good condition.

7.21 Float-operated valves should be checked to ensure that they are securely fixed and set to achieve a correct water level in accordance with the Water Supply (Water Fittings) Regulations 1999.

7.22 Overflow/warning pipes should be checked to ensure that they maintain a steady fall (which ensures they will drain freely) and that they are clear and correctly routed to give an obvious visual alarm of an overflow condition. A weatherproof label fixed adjacent to the warning pipe identifying the tank and its location, together with the person/department to be contacted in the event of a discharge, will contribute to a quick and accurate defect report which could then be acted upon, so minimising water wastage (consideration to the provision of high- and low-level alarms linked to the BMS should also be given – see Chapter 8 in HTM 04-01 Part A). When connected to drain, they should comply with BS EN 1717.

7.23 A schematic drawing illustrating typical piping and valve arrangements for dual-cistern installations is shown in Figure 3 of HTM 04-01 Part A.

Pressurisation/supply pumps

7.24 Where two or more pumps are installed for pressurising systems, automatic control should be provided to prevent stagnation. The automatic control should also ensure all pumps are brought into operation at a regular frequency (for example, weekly) as determined by the risk assessment.

7.25 The maintenance carried out on this type of equipment should be in accordance with the manufacturer's recommendations.

Cold water distribution system

7.26 The design and installation of the cold water distribution system should comply with the Water Supply (Water Fittings) Regulations 1999 and relevant parts of BS EN 806-2 and BS 8558 (see Chapter 9 of HTM 04-01 Part A for further information).

7.27 The control of water temperature in the cold water service will essentially rely on good insulation and water turnover. Maintaining regular movement of cold water in sections prone to stagnation and guarding against excessive heat gain are effective control measures for *Legionella* and other waterborne pathogens. Special attention should be given to the maintenance and monitoring of these systems.

Notes

1. For the control of *Legionella* and other waterborne pathogens, 20°C is the quoted upper value above which multiplication of *Legionella* in particular begins to take place (see Chapter 4). It should be noted that during extremes of weather, environmental factors can influence the incoming water temperatures, particularly where water is provided from surface-water sources.

2. Where automatic flushing of urinals is used, their careful location and connection to the water system can be effectively used to assist in water turnover. When used, devices having a duty cycle should be set to flush as deemed necessary by the WSG. Information from water quality programs could be used to determine appropriate timeframes. Note that automatic flushing devices should not be located in accommodation used by patients who may become distressed by the noise.

7.28 Schematic diagrams (or as-built drawings) of the system with numbered and labelled valves reduce confusion and save time in trying to identify appropriate isolating valves and other system components.

7.29 Checks and actions should be carried out to show that:

a. the system components show no sign of leakage or corrosion or limescale;

b. the system insulation is in good condition;

c. the system filters have been changed and/or cleaned in accordance with manufacturers' recommendations. Regularly check and clean strainers;

d. all isolating valves have periodically been worked through their full range of travel;

e. every water outlet complies with the backflow protection requirements of the Water Supply (Water Fittings) Regulations 1999.

Drinking water

7.30 If separate drinking water supplies are provided, reference should be made to paragraphs 9.11–9.13 in HTM 04-01 Part A, and subject to a risk assessment consideration should be given to their removal.

Notes

1. Current guidance does not draw a distinction between drinking and general cold water services, and separate systems are no longer recommended. The installation of separate drinking water supplies has been standard policy. But in many cases where such systems have been installed, the quality of drinking water (particularly at infrequently used draw-offs, for example wash-rooms) has generally been inferior to that of the general cold water supply.

2. Softeners using salt-regenerated ion-exchange resins increase the sodium content of the water during softening, and this may be undesirable for children and infants (including the making up of babies' bottles) and anyone on strict salt-restricted diets.

Hot water storage and distribution

7.31 Hot water services should be designed and installed in accordance with the Water Supply (Water Fittings) Regulations 1999 and relevant parts of BS EN 806-2 and BS 8558. The hot water system may be of either the vented or the unvented type (see Chapter 10 of HTM 04-01 Part A for further information).

7.32 To control possible colonisation by waterborne pathogens including *Legionella*, it is essential to maintain the temperature within the hot water circulating system. To some extent, if properly maintained, the calorifier/water heater will provide a form of barrier to microbial growth. The minimum flow temperature of water leaving the calorifier/water heater should be 60°C.

7.33 The minimum water temperature at the connection of the return to the calorifier/water heater should be 50°C. To achieve the required circulating temperatures, it will be necessary to maintain the balance of flows to individual pipe branches and draw-off points.

7.34 Calorifiers should be subjected to regular procedures that include the following:

- Inspection, cleaning and maintenance at least annually, or as indicated by the rate of fouling.
- Quarterly drain flushing to minimise the accumulation of sludge. This may be extended to annual draining if, during inspection, it is found that there is little accumulation of debris.
- Whenever dismantled for statutory inspection, or every year in the case of indirect calorifiers, calorifiers should be thoroughly cleaned to remove sludge, loose debris and scale.
- Whenever a calorifier is taken out of service, it should be refilled, drained, refilled again and the entire contents brought up to, and held at, the nominal operating temperature of 60°C for at least an hour.
- The calorifier should remain isolated until the procedure is completed. When bringing calorifiers back on line, it is important that service valves are opened slowly to avoid any disturbance of sediment debris. Calorifiers that are to be taken out of service for more than a few days should be drained and should not be refilled until ready to return to service. The drain valve should be left open while the calorifier is out of use.
- Where it is known or established that gross over-capacity exists in a calorifier, and where it is practicable to do so, it should be replaced by a calorifier of the appropriate size.

Note

Full-flow (spherical/ball-type) isolating valves should be specified to avoid clogging. The drain from the gully should be of sufficient size to take the flow from the calorifier drain.

7.35 Hot water circulating pumps should be of adequate performance to ensure a minimum available temperature at draw-off points of 55°C and an absolute minimum of 50°C at the return connection to the calorifier. It is undesirable to have standby pumps owing to stagnation risks. If, however, an existing installation includes a standby pump and it is impracticable to remove it from service, it should be automatically controlled so that each is regularly brought into operation as determined by the risk assessment.

7.36 It is not permissible to shut down the pumped circulation. To do so will lead to the loss of the required system temperatures.

7.37 Electrical trace-heating is not recommended except for very small systems and those existing systems that would be difficult to rectify. Where it has been retained, it should be checked routinely (at least monthly) to ensure that it maintains the water temperature above 55°C. Care should be taken to ensure there are no cool spots. Consideration should be given to monitoring the temperatures by means of a BMS (sensors should be located at the most distal points).

Note

Dead-leg lengths should be as short as practicable; that is, the trace-heating should be taken up to the draw-off or mixing device. The continuity of the trace-heating should be monitored to avoid localised failure.

Instantaneous water heaters for single or multi-point outlets

7.38 These devices usually serve one draw-off only and are either electrically or gas-heated. In essence:

a. the flow rate is limited and is dependent on the heater's hot water power rating;

b. where restricted rates of delivery are acceptable, the heater can deliver continuous hot water without requiring time to reheat;

c. they are susceptible to scale formation in hard water areas where they will probably require frequent maintenance;

d. this form of hot water heating should only be considered for smaller premises or where it is not economically viable to run hot water distribution to a remote outlet;

e. they should be monitored to ensure they operate above 55°C (see Table 1).

Pressure and expansion vessels

7.39 Pressure and expansion vessels should be subject to routine inspection and maintenance as recommended by the manufacturer. Where practicable, these should be flushed through with wholesome water and purged to drain. If replaceable, bladders or diaphragms should be changed according to the manufacturer's guidelines or as indicated by the risk assessment.

Safe hot water delivery devices

7.40 Thermostatic mixing devices should only be installed where a risk assessment indicates their need. For guidance on applications and for a list of the types of mixing devices used, see Table 2 in HTM 04-01 Part A.

7.41 It is essential to check the temperature settings and operation of water mixing devices regularly (see manufacturers' instructions, the checklist at paragraph 7.53, and Chapter 11 in HTM 04-01: Supplement – 'Performance specification D 08: thermostatic mixing valves (healthcare premises)'). Other maintenance, where required, should be strictly in accordance with the manufacturer's instructions. Local water quality will influence the maintenance frequency for any installation.

7.42 All pipework supplying existing thermostatic mixing taps should be inspected to ensure that there is no preceding TMV supplying water to the hot port of the tap (see Figure D3 in Appendix D).

Notes

1. In existing installations, it may be necessary to install inline strainers. See the checklist at paragraph 7.53 for maintenance checks.

2. When bathing, or assisting patients, healthcare staff must always check the water temperature with a thermometer.

Showers

7.43 Disinfection of showerheads and angle-valve strainers has only a short-lived effect on microbial colonisation and growth. Manual cleaning to remove scale and other deposits or replacement of disposable showers should be carried out as based on the risk assessment. Traditionally this has been a quarterly task but the water quality and evidence base will influence the risk assessor's decision of the actual frequency implemented. Regular flushing of showers reduces microbial growth, but counts can significantly increase if regular flushing should cease. The most effective management of showers will be achieved by the removal of unnecessary ones and the regular use of others. Where showers are removed, it is important to cut back and remove all associated pipework (see paragraph 7.50 on the removal of redundant pipework).

7.44 It is important to note the distinction between self-purging and self-draining showers. Self-purging showers can be an effective Legionella control procedure, while self-draining showers can support the proliferation of *Legionella*.

> **Note**
>
> Adjustable showerheads are not recommended in healthcare facilities. See paragraph 10.61 in HTM 04-01 Part A.

Point-of-use filtration

7.45 Point-of-use (POU) filtration should be considered and agreed by the WSG only as an interim safeguard where control measures have been ineffective, prior to and during engineering remedial works, during periods of plumbing refurbishments and maintenance works, and where additional protection is required for vulnerable patients. Continuous long-term use of POU filters is not recommended, except where there is no effective alternative. The WSG should review their continued use and ensure an action plan is created and enacted to make certain they are changed at the intervals specified by the manufacturer.

7.46 Where POU filters are installed as a temporary measure while appropriate remedial work is carried out, they should be changed in accordance with the manufacturers' recommendations, typically at least once a month. Once removed for whatever reason, a replacement filter should be fitted. When changing filters, it is recommended that sampling of water quality takes place at outlets identified as sentinel points before refitting a replacement filter. It is essential to ensure that – where filters are to be used – they are constructed of the appropriate materials (see paragraph 3.1 in HTM 04-01 Part A).

7.47 Where POU filters are to be used, the backflow protection requirements need to be maintained in accordance with the Water Supply (Water Fittings) Regulations 1999. This may require additional backflow protection or modification of the system. In addition, sufficient activity space should be maintained to enable the outlet to be used without contaminating the filter.

7.48 Where filters are in place, follow manufacturers' instructions for cleaning, or they should be wiped clean as part of the basin/sink cleaning protocol as agreed by the WSG.

7.49 Where point-of-use filters are no longer required, the outlet connection should be flushed, cleaned and disinfected to remove any accumulated biofilm.

Removal of redundant pipework and services

7.50 In existing systems or during refurbishments, water systems should be inspected to identify redundant pipework (often referred to as blind ends) or services. In such cases, pipework should be cut back to the connection point including replacing the branch T with a straight coupling to ensure all redundant pipework is removed and to eliminate any opportunity for stagnation to occur.

Cleaning and disinfection

7.51 At some stage during the occupancy and use of a building, it is possible that the hot and cold water systems could become contaminated with waterborne pathogens. Should this be the case, the WSG may wish to consider cleaning and disinfection of part of the, or the entire, system. Advice may be found in HSG274 Part 2 and BSI's PD855468. See also Chapter 4 in HTM 04-01 Part A for guidance on the impact of treated water on materials and components.

> **Note**
>
> Whenever disinfection is planned, liaison with specialist departments (such as renal units and neonatal units) should take place.

Summary checklist for hot and cold system water systems

7.52 A summary checklist for hot and cold water systems is shown on the following pages (adapted from HSG274 Part 2 by kind permission of the HSE). For every operation that is undertaken, a method statement needs to be prepared and followed to ensure the stages are completed safely and effectively.

7.53 In Table 1 the suggested frequencies of inspecting and monitoring the hot and cold water systems will depend on their complexity and the susceptibility of those likely to use the water, and are for guidance only. The risk assessment should define the frequency of inspection and monitoring depending on the type of use and user and particularly where there are adjustments made by the assessor to take account of local needs. The water quality and evidence base will influence the risk assessor's decision.

Table 1 Checklist for hot and cold water systems (adapted from HSG274 Part 2)

Service	Action to take	Frequency (see paragraph 7.53)
Calorifiers	Inspect calorifier internally by removing the inspection hatch or using a borescope, and clean by draining the vessel. The frequency of inspection and cleaning should be subject to the findings and be increased or decreased based on conditions recorded	Annually, or as indicated by the rate of fouling
	Where there is no inspection hatch, purge any debris in the base of the calorifier to a suitable drain Collect the initial flush from the base of hot water heaters to inspect clarity, quantity of debris and temperature	Annually, but may be more frequent as indicated by the risk assessment or result of inspection findings
	Check calorifier flow temperatures (thermostat settings should modulate as close to 60°C as practicable without going below 60°C) Check calorifier return temperatures (not below 50°C).	Monthly
Hot water services	For non-circulating systems: take temperatures at sentinel points (nearest outlet, furthest outlet and long branches to outlets) to confirm they are at a minimum of 55°C within one minute	Monthly
	For circulating systems: take temperatures at return legs of principal loops (sentinel points) to confirm they are at a minimum of 55°C. Temperature measurements may be taken on the surface of metallic pipework	Monthly
	For circulating systems: take temperatures at return legs of subordinate loops; temperature measurements can be taken on the surface of pipes, but where this is not practicable, the temperature of water from the last outlet on each loop may be measured, and this should be greater than 55°C within one minute of running. If the temperature rise is slow, it should be confirmed that the outlet is on a long leg and not that the flow and return has failed in that local area	Quarterly (ideally on a rolling monthly rota)
	All HWS systems: take temperatures at a representative selection of other points (intermediate outlets of single pipe systems and tertiary loops in circulating systems) to confirm they are at a minimum of 55°C to create a temperature profile of the whole system over a defined time period	Representative selection of other sentinel outlets considered on a rotational basis to ensure the whole system is reaching satisfactory temperatures for *Legionella* control
POU water heaters (no greater than 15 litres)	Check water temperatures to confirm the heater operates at 55°C, or check the installation has a high turnover	Monthly–six monthly, or as indicated by the risk assessment
Combination water heaters	Inspect the integral cold water header tanks as part of the cold water storage tank inspection regime; clean and disinfect as necessary. If evidence shows that the unit regularly overflows hot water into the integral cold water header tank, instigate a temperature-monitoring regime to determine the frequency, and take precautionary measures as determined by the findings of this monitoring regime	Annually
	Check water temperatures at an outlet to confirm the heater operates at 55°C	Monthly

Service	Action to take	Frequency (see paragraph 7.53)
Cold water storage cisterns	Inspect cold water storage cisterns and carry out remedial work where necessary	Annually
	Check the cistern's water temperature remote from the ball valve and the incoming mains temperature. Record the maximum temperatures of the stored and supply water recorded by fixed maximum/minimum thermometers where fitted	Annually (summer) or as indicated by the temperature profiling
Cold water services	Check temperatures at sentinel taps (typically those nearest to and furthest from the cold cistern, but may also include other key locations on long branches to zones or floor levels). These outlets should be below 20°C within two minutes of running the cold tap. To identify any local heat gain, which might not be apparent after one minute, observe the thermometer reading during flushing	Monthly
	Take temperatures at a representative selection of other points to confirm they are below 20°C to create a temperature profile of the whole system over a defined time period. Peak temperatures or any temperatures that are slow to fall should be an indicator of a localised problem	Representative selection of other sentinel outlets considered on a rotational basis to ensure the whole system is reaching satisfactory temperatures for *Legionella* control
	Check thermal insulation to ensure it is intact, and consider weatherproofing where components are exposed to the outdoor environment	Annually
Showers and spray taps	Dismantle, clean, descale and disinfect removable parts, heads, inserts and hoses where fitted	Quarterly or as indicated by the rate of fouling or other risk factors, e.g. areas with high-risk patients
POU filters	Record the service start date and lifespan or end date and replace filters as recommended by the manufacturer (bacterial-retention filters should be used primarily as a temporary control measure while a permanent solution is developed, although long-term use of such filters may be needed in some healthcare applications)	According to manufacturer's guidelines
Base exchange softeners	Visually check the salt levels and top up salt, if required. Undertake a hardness check to confirm operation of the softener	Weekly, but depends on the size of the vessel and the rate of salt consumption
	Service and disinfect	Annually, or according to manufacturer's guidelines
Multiple-use filters	Backwash and regenerate as specified by the manufacturer	According to manufacturer's guidelines

Service	Action to take	Frequency (see paragraph 7.53)
Infrequently used outlets	Consideration should be given to removing infrequently used showers, taps and any associated equipment that uses water. If removed, any redundant supply pipework should be cut back as far as possible to a common supply (e.g. to the recirculating pipework or the pipework supplying a more frequently used upstream fitting) but preferably by removing the feeding 'T' Infrequently used equipment within a water system (i.e. not used for a period equal to or greater than seven days) should be included on the flushing regime Flush the outlets until the temperature at the outlet stabilises and is comparable to supply water and purge to drain Regularly use the outlets to minimise the risk from microbial growth in the peripheral parts of the water system, sustain and log this procedure once started	Weekly, or as indicated by the risk assessment
TMVs	Where integral, inspect, clean, descale and disinfect any strainers or filters associated with TMVs. To maintain protection against scald risk, TMVs require regular routine maintenance carried out by competent persons in accordance with the manufacturer's instructions. There is further information in paragraphs 2.152–2.168 of HSG274 Part 2.	Annually or on a frequency defined by the risk assessment, taking account of any manufacturer's recommendations
Inline strainers	Where fitted, inspect, clean, descale and disinfect any strainers or filters associated with TMVs or other sensitive equipment.	Annually or on a frequency defined by the risk assessment, taking account of any manufacturer's recommendations
Pressurisation and expansion vessels	Where practical, flush through and purge to drain. Where removable, bladders or diaphragms should be changed according to the manufacturer's guidelines or as indicated by the risk assessment	Monthly–six monthly, as indicated by the risk assessment
Biocidal treatment systems	Check the dosing and control system operation including alarms	Weekly
	Measure the treatment parameters to establish the required values are being achieved at representative outlets including sentinel outlets	Weekly
	Note: Consider 24-hour automatic monitoring for biocidal treatment on large or complex systems	Validation and calibration of the automatic monitoring system should be carried out at the frequencies recommended by the manufacturer

8 Other operational considerations

8.1 The WSG need to identify other waterborne hazards (the list below is not exhaustive but provides examples).

8.2 Waterborne pathogens including *Legionella* may colonise other areas where droplets of contaminated water of a size suitable for deep inhalation are generated. Such aerosol-generating plant and equipment should not be installed next to patient accommodation or air inlets. Some patients may be particularly susceptible to infection (see also HSG274 Part 3).

Vending, chilled-water and ice-making machines

8.3 See paragraphs 9.24–9.27 in HTM 04-01 Part A for guidance on installation of this equipment.

8.4 Where equipment is hand-filled, there should be clear instructions on the water used; it should be hygienically collected and decanted into the equipment from a clean vessel.

8.5 Chilled-water drinking fountains normally include a reservoir to assist in the cooling cycle; if machines are turned off, water quality can deteriorate. Provision of bottle dispensers should be approved only by the WSG. Where carbon filters and/or UV are fitted, these should be maintained as per the manufacturer's instructions. Additional cleaning to ensure adequate hygiene of nozzles etc should be put in place as recommended by the WSG.

Note

Proprietary water containers for water dispensing machines should be returned to the supplier.

8.6 Ice machines should not be placed in augmented care units. Where ice is needed for treatment purposes, it should be made using water obtained through a microbiological POU filter or boiled water in sterile ice trays or ice bags.

8.7 Ice should not be allowed to stagnate in an ice-making machine's storage bin, but should be changed frequently. Appropriate cleaning and hygienic procedures, agreed by the WSG, including the cleaning and disinfection of scoops etc should be put in place. For guidance on infection-control precautions with regard to ice-making machines, see HBN 00-09 – 'Infection control in the built environment'.

8.8 Maintenance for ice-making machines should be carried out in accordance with the manufacturer's recommendations. Care should be taken to ensure that the water supply to the ice-making machine is not subjected to heat gain.

Portable/room humidifiers

8.9 Designs should not include the use of "portable" or "room" self-contained humidifiers (having a water supply that is sprayed/atomised into the room space). In clinical/patient areas the decision to use this type of humidifier should rest with the IPC team. See also Safety

Notice NHSE SN(96)06 – 'Evaporative type cooling fan'.

Non-wholesome water storage

8.10 Non-wholesome water is sometimes stored for emergency use (for example for fire-fighting purposes). These systems should have an appropriate backflow prevention device in accordance with the Water Supply (Water Fittings) Regulations 1999. They should be considered by the risk assessment and the WSG.

Deluge showers

8.11 Deluge showers (sometimes called emergency showers) are intended for use in an emergency where a staff member or a patient has suffered external chemical contamination. Similarly, there may be other special outlets used for personal emergencies, for example eyebaths. These should not be installed on the end of lines. They should be dismantled, descaled and disinfected regularly in accordance with the risk assessment, and should be flushed in accordance with the recommendations in HSG274 Part 3.

Trolley wash procedures

8.12 High-pressure hoses will generate aerosols and have been associated with causing cases and outbreaks of Legionnaires' disease. The contamination of the aerosol can be reduced if the water supply is taken from a wholesome water system via a suitable air gap giving fluid category 5 protection – typically an air gap of Type AA or AB, which requires a break tank and booster pump to provide adequate pressure to the washing equipment. Procedures should be put in place to flush to drain before use, and to disinfect them if they have been out of use for a prolonged period.

Lawn sprinklers and garden (or similar) hoses

8.13 In certain conditions, lawn sprinklers may retain stagnant water in the pipework/hose supplying the sprinkler head; they may also produce an aerosol spray. The pipework may be installed underground or via a flexible hose over ground. In either case it is very unlikely that they can be completely drained down after use or when not required; at certain times in the year the retained water may be at temperatures suitable for the colonisation by, and multiplication of, *Legionella* and *P. aeruginosa*. There is evidence linking cases of Legionnaires' disease with permanently installed systems that use underground supply plumbing. Irrigation systems and hoses for these purposes should be supplied via backflow prevention devices giving fluid category 5 protection – typically an air gap of Type AA or AB, which requires a break tank and booster pump to provide adequate pressure to the irrigation nozzle or hose outlet. A risk assessment should be undertaken prior to use to minimise the risk by implementing suitable control measures.

8.14 Hoses used for filling of remote equipment or mobile units should be of materials suitable for use with wholesome water systems and should be drained, capped between uses and kept in cool conditions. They should be disinfected (by immersing in hypochlorite) before use.

Vehicle-washing plant

8.15 Vehicle washing is carried out either using a hand-held pressure spray or by a frame wash that consists of a bay containing a rectangular pipework frame fitted with several high-pressure sprays. In the latter case, this equipment should be flushed regularly. Pressure washers and frame washers should be supplied via backflow prevention devices giving fluid category 5 protection – typically an air gap of Type AA or AB, which requires a break tank and booster pump to provide adequate pressure to the outlets. See the

Water Management Society's 'Managing the risk of legionnaires' disease in vehicle-washing systems W046-5'.

8.16 Permanent hard-standing areas for vehicle-washing purposes should have an even surface to avoid ponding and have a slope or dish to a suitable drain.

Decorative internal and external water features

8.17 Internal ornamental water features (for example a water cascade in the main entrance hall) are susceptible to airborne contamination and are not recommended.

External water features

8.18 Ornamental fountains have been implicated in cases of legionellosis. External water features should not be situated under trees where fallen leaves or bird droppings may contaminate the water. Exposure to high winds should be avoided as they can disperse spray beyond the immediate confines of the basin/pond. The apex of the water column/jet should not exceed the distance to the nearest edge of the basin/pond for the same reason. An overflow/outlet to a suitable drain should be provided for easy emptying and cleaning. Where possible, a permanently installed freshwater supply pipe with topping-up device should be provided. Their provision should be subject to a risk assessment and approval by the WSG, and appropriate action is required to minimise the risk. Any top-up supply from a wholesome water supply should be supplied via backflow prevention devices giving fluid category 5 protection – typically an air gap of Type AA or AB.

8.19 A risk assessment should be undertaken prior to use to minimise the risk by implementing suitable control measures.

Wet fire and automatic sprinkler systems

8.20 Wet fire protection systems have been implicated in outbreaks of legionellosis. All hose reels, sprinkler systems and wet risers should be isolated from the potable water supply by a method permitted by the Water Supply (Water Fittings) Regulations 1999. Many fire authorities are not in favour of local fire-fighting, preferring early professional intervention. It may, therefore, be possible to remove hose reels, thus avoiding their hazards. (Any redundant pipework should be cut back to the connection point including replacing the branch 'T' with a straight coupling.)

8.21 Fire-fighting systems should be included within risk assessments. See FPA Technical Briefing Note – '*Legionella* and firefighting systems' for further guidance.

Patient contact equipment (for example respiratory nebulisers, humidifiers)

8.22 Patient contact equipment (such as respiratory nebulisers and humidifiers) should be used, drained, cleaned, rinsed, and dried strictly in accordance with the manufacturer's recommendations and agreed by the WSG. They should always be allowed to dry thoroughly before use. See also Chapter 3 in HTM 04-01 Part C, which should be applied to all healthcare settings.

Heater cooler units used in cardiac surgery

8.23 Heater coolers units (HCU) are used in cardiopulmonary bypass operations and for extracorporeal membrane oxygenation or extracorporeal life support, and their function is to regulate the temperature of the blood perfusing the patient using water in the HCU tanks to indirectly raise or lower the patient's body temperature. There have been a number of outbreaks and fatalities due to the presence of *Mycobacterium chimaera* in the HCUs that has resulted in endocarditis, surgical site infection and disseminated infection possibly via the aerosol route. HCUs should be operated and decontaminated according to the manufacturer's instructions, and their use should be subject to a risk assessment that should be approved by the WSG.

Flowers and plants

8.24 Consideration should be given to providing specific facilities for regularly disposing of wastewater and compost outside in-patient accommodation. This should not be provided in dirty utilities.

Buried pipelines

8.25 Pipelines made of plastics are susceptible to hydrocarbons such as fuels and oils. These chemicals can permeate through plastic pipes if they are nearby and contaminate the water supply, and it may take days, weeks or even months before a noticeable taste can be detected in the water supply. Whenever spills are reported, an assessment of services within the area should be undertaken. See also paragraphs 12.8–12.16 in HTM 04-01 Part A.

8.26 Where there is a risk of hydrocarbon contamination of the supply, barrier pipe can be used instead. This is a double-layer plastic pipe with a barrier layer (usually aluminium) in between.

Other risk systems

8.27 Further guidance on other risk systems is given in Appendix 3.1 of HSG274 Part 3.

9 Microbiological monitoring

9.1 Where there are taste or odour problems, microbiological monitoring for total viable counts (TVCs) may be considered necessary. However, routine microbiological monitoring for TVCs is not recommended as there is no direct association with TVCs and the presence of waterborne pathogens.

9.2 If performed, TVCs may be used to analyse trends. Counts taken before and after disinfection (samples at least 48 hours post-disinfection) can give an indication of the efficacy of a disinfection procedure.

9.3 All microbiological measurements should be by approved methods and/or be carried out by United Kingdom Accreditation Service (UKAS)-accredited laboratories for the method being used. Dip slides are not acceptable on hot and cold water systems.

> See also the Standing Committee of Analysts' 'Microbiology of drinking water – Part 7' for methods suitable for TVCs.

10 Testing for *Legionella*

10.1 *Legionella* monitoring should be carried out where there is doubt about the efficacy of the control regime or where the recommended temperatures, disinfectant concentrations or other precautions are not consistently achieved throughout the system. The WSG should use risk assessments to determine when and where to test, which may include the following circumstances:

a. When storage and distribution temperatures do not achieve those recommended and systems are treated with a biocide regime, testing should be carried out monthly, although that frequency may be altered depending on the results obtained.

b. In systems where the temperature or biocidal control regimes are not consistently achieved, weekly checks are recommended until the system is brought under control, after which the frequency of monitoring can be reviewed.

c. When a nosocomial outbreak is suspected or has been identified.

d. Where there are at-risk patients with increased susceptibility.

Legionella bacteria (cfu/L)	Action required
Not detected or up to 100	The primary concern is protecting susceptible patients, so any detection of *Legionella* should be investigated and, if necessary, the system resampled to aid interpretation of the results in line with the monitoring strategy and risk assessment.
>100 and up to 1000	Either: If the minority of samples are positive, the system should be resampled. If similar results are found again, a review of control measures and a risk assessment should be carried out to identify any remedial action necessary, or If the majority of samples are positive, the system may be colonised, albeit at a low level. An immediate review of control measures and a risk assessment should be carried out to identify any other remedial action required. Disinfection of the system should be considered.
>1000	The system should be resampled and an immediate review of the control measures and a risk assessment should be carried out to identify any remedial actions, including possible disinfection of the system. Retesting should take place three days following systemic chemical or thermal disinfection and at frequent intervals thereafter until a satisfactory level of control is achieved as agreed by the WSG.

10.2 As a minimum, samples should be taken as follows:

- from the cold water storage and the furthermost outlet from the tank;
- from the calorifier flow, or the closest tap to the calorifier, and the furthermost tap on the hot water service circulating system;
- additional samples should be taken from the base of the calorifier where drain valves have been fitted;
- additional random pre- and post-flush samples may also be considered appropriate where systems are known to be susceptible to colonisation in line with BS 7592 guidance;
- methods should be in accordance with BS 7592.

10.3 Analysis of water samples for *Legionella* should be performed in UKAS-accredited laboratories with the current ISO standard methods for the detection and enumeration of *Legionella* included within the scope of accreditation. These laboratories should take part in a water microbiology proficiency testing scheme (such as that run by PHE or an equivalent scheme accredited to BS EN ISO 17043). Alternative quantitative testing methods may be used as long as they have been validated using BS EN ISO 17994 and meet the required sensitivity and specificity. The laboratory should also apply a minimum theoretical mathematical detection limit of ≤100 *Legionella* bacteria/litre sample.

10.4 Action following *Legionella* sampling in hot and cold water systems is given in the following flowcharts (see Figures 4–6).

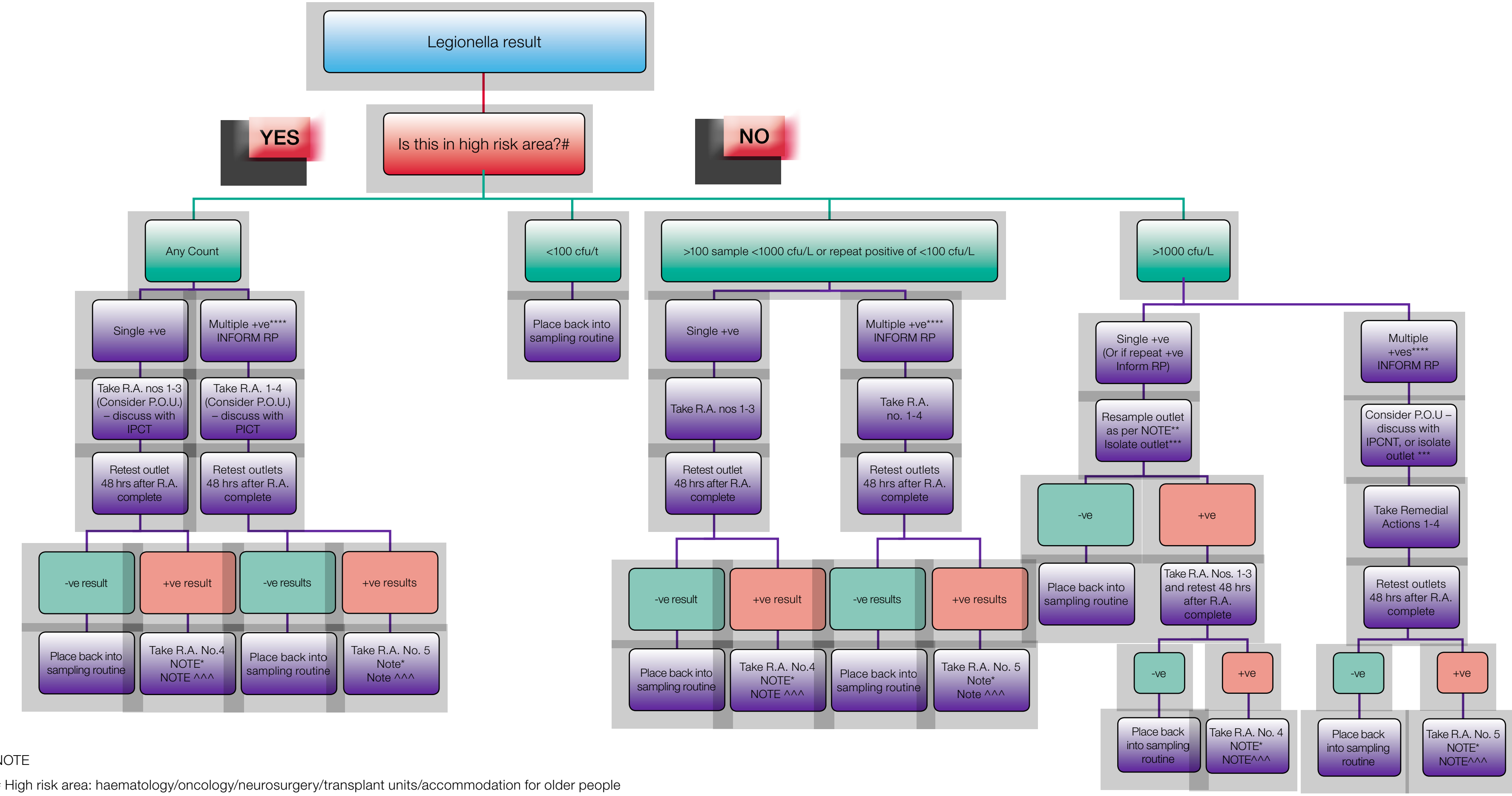
Note

Figures 4–6 are given as examples of a range of various methods that may be used. Individual conditions will dictate which procedure is appropriate and therefore the charts can be adapted accordingly.

<table>
<tr><th rowspan="2">Legionella bacteria (cfu/l)</th><th>Results from Pre-flush samples</th><th>Systemic results (Post-flush samples)</th></tr>
<tr><td>Pre-flush samples tend to be an indicator of local conditions and if detected will often require Post-flush samples in order to determine that the contamination is local and not systemic.</td><td>Post-flush samples (or multiple positive samples) may be an indication that the whole water systems is contaminated and that controls are not effective.</td></tr>
<tr><td>Legionella not detected</td><td colspan="2">Continue with current control scheme</td></tr>
<tr><td>Legionella From detection to 100</td><td colspan="2">Action required
• The detection limit for Legionella by culture methods was historically 100cfu/L, at present laboratories may be able to report to levels of 20cfu/L or less. This can cause confusion over what level should bring about corrective actions. The primary concern is protecting susceptible patients, so any detection of legionella should be investigated and, if necessary, the system resampled to aid interpretation of the results in line with the monitoring strategy and risk assessment.</td></tr>
<tr><td>100- less than 1000</td><td>Action required
• Identify remedial actions, Investigate:–
o Usage frequency
o Outlet for corrosion and scale
o local heat gain,
o Local Dead ends
o Cross flow between hot and cold and vice versa,
o Localised failure of the HWS return
• It may be appropriate to immediately resample to indicate if initial remedial actions have been effective. The locations should then be resampled after 3 to 6 months to confirm any actions taken have remained effective.
In addition to the above, and if the outlet is served by a TMV:
• Review the need for the TMV taking into account the relative risks of scalding. Remove the TMV if considered appropriate
• If the TMV is to remain, clean and disinfect the TMV, the outlet and the strainers on both cold and hot feeds.
• Identify any flexible hoses (particularly after the TMV) and consider replacement, avoiding the use of flexible hoses where practicable.</td><td>Action required
Whilst low numbers are unlikely to pose a risk to the general population,
• Review immediately the system control measures and risk assessment
• Identify remedial actions, Investigate: -
o Check for any hot water backflow via the calorifier cold feed pipes
o Calorifier discharge via open vents to the cold tank.
o Failure of HWS to operate at target temperatures
o Over capacity or under usage
• Cleaning & Disinfection of the entire system should be considered
• It may be appropriate to confirm effective disinfection, any required microbiological samples should be taken between two and seven days after the system is treated. (Samples taken immediately after a disinfection process might give false negative results).
• The water system should then be resampled regularly to confirm any actions taken have remained effective.</td></tr>
<tr><td>1000-10,000</td><td>Action required
• In addition to the above
• Review immediately the local control measures and risk assessment to identify any required remedial action (dead ends etc)
• Cleaning and Disinfection of the outlet should be undertaken – (especially showers and spray taps)
• If a shower (spray outlet) cannot be taken out of use, consider installing point of use microbiological filters on all affected showers.
• It is likely to be appropriate to resample, between two and seven days after, to indicate if initial remedial actions have been effective.
• The locations should then be resampled (e.g. 1 to 3 months) to confirm any actions taken have remained effective.</td><td>Action required
• In addition to the above
• Cleaning & Disinfection of the entire system is likely to be required.
• To confirm effective disinfection microbiological samples should be taken between two and seven days after the system is treated. (Samples taken immediately after a disinfection process might give false negative results).</td></tr>
</table>

Legionella bacteria (cfu/l)	Results from Pre-flush samples Pre-flush samples tend to be an indicator of local conditions and if detected will often require Post-flush samples in order to determine that the contamination is local and not systemic.	Systemic results (Post-flush samples) Post-flush samples (or multiple positive samples) may be an indication that the whole water systems is contaminated and that controls are not effective.
>10,000	Action required • In addition to the above. • Take immediate measures to prevent exposure from this outlet until remedial measures are taken and shown to be effective. • If the outlet cannot be taken out of use, install a point of use microbiological filter on all affected outlets. • Resample, between two and seven days after, to indicate if initial remedial actions have been effective. • The locations should then be regularly resampled to confirm any actions taken have remained effective.	Action required • In addition to the above. • Take immediate measures to prevent exposure from all outlets fed by the system until remedial measures are taken. • Clean & Disinfect the entire system as soon as possible.

Figure 4 Action levels following *Legionella* sampling in hot and cold water systems. Example 1



NOTE

High risk area: haematology/oncology/neurosurgery/transplant units/accommodation for older people

* If all remedial actions are exhausted and there is no improvement in results, then take remedial action No. 6.

** Take additional samples pre and post from adjacent areas on same loop based on worst case scenario (Low usage outlets).

*** Remedial Action should occur 48 hours after isolation.

**** More than one positive on same loop in the system.

^^^ More frequent sampling is required

- Remedial Actions (R.A.)
  1. Review control measures e.g. temperatures flow and return and local, CLO_2 levels, investigate if outlets are being used and/or flushing regime in place
  2. Consider changing outlet i.e. shower head and hose or tap as appropriate
  3. WHB – TMV change/consider removal
  4. Full investigation of the plumbing system including dead leg invesitgation, flexible connections, has there been remedial works in the area, has anything changed
  5. Consider Installation of standalone CIO_2 Unit
  6. Consultation/inform WSG

RP = Responsible person

Figure 5 Action levels following *Legionella* sampling in hot and cold water systems. Example 2

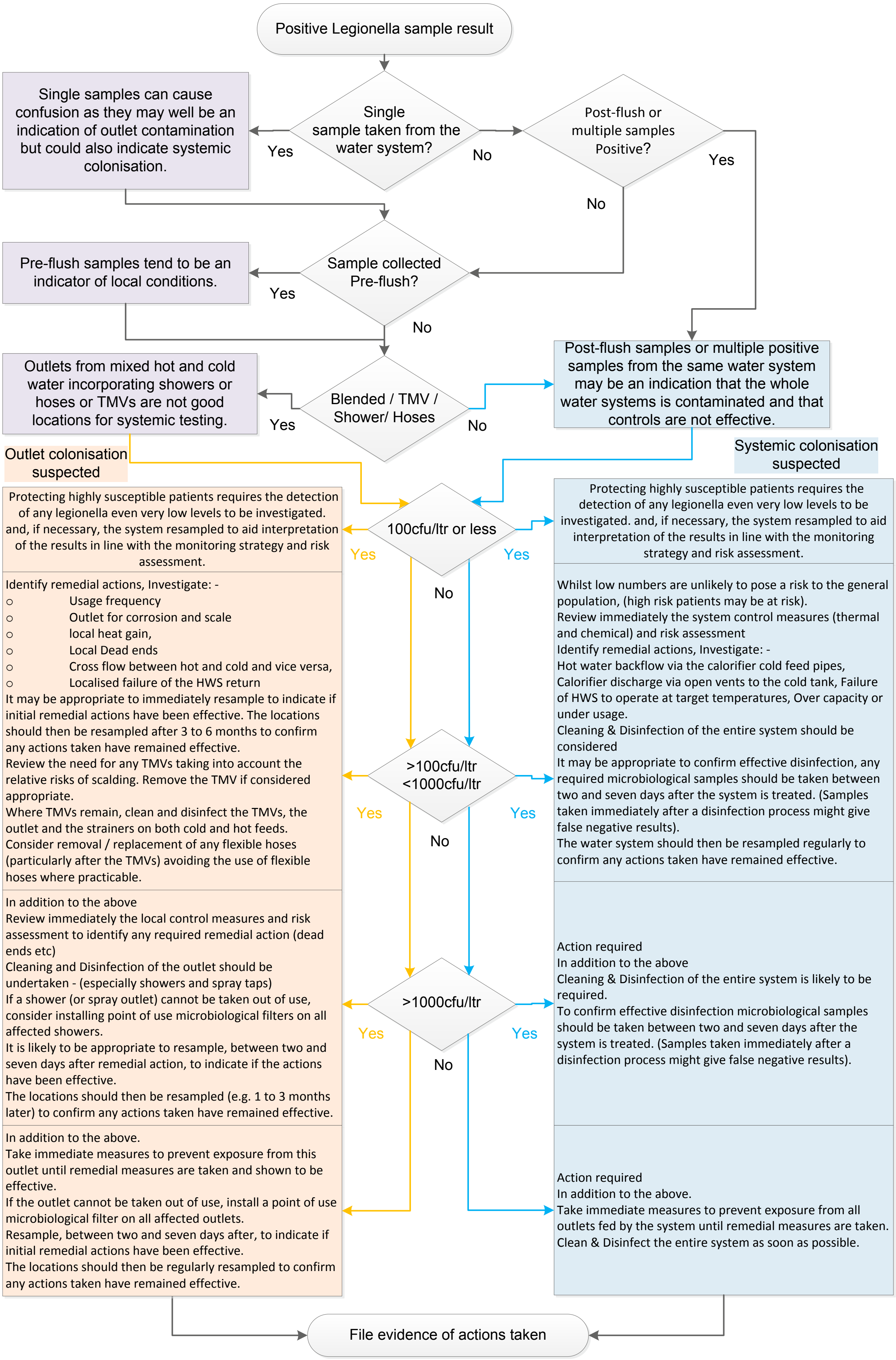


Figure 6 Action levels following positive result

Appendix A Examples of the use of water within a healthcare facility and water quality types

A1. All water and water systems in healthcare facilities should be risk-assessed according to their intended use and patient immune status taking into account any identified inherent hazards within the facility and the quality of the water supply to the systems being assessed. The assessment of risk should take account of the most vulnerable population likely to be exposed to each potential source.

A2. Examples of different categories of water for differing uses are shown in Table A1.

Note

The hazards and their occurrence will depend on the quality of source water. Therefore the associated risks should be calculated taking into account local conditions.

Table A1 Examples of water quality parameters for different applications in healthcare

Healthcare area	Application	Physical, chemical or microbial quality indicators	Water quality parameters given in:	Particular hazards (based on an assessment for each system)	See also
All settings	Wholesome water for drinking, cooking, food preparation and washing	Physical: Odour, colour, taste Chemical: Heavy metals, nitrates, orthophosphates, pesticides, surfactants Biological: Coliform bacteria, *E. coli, enterococci*	Water Supply (Water Quality) Regulations http://www.dwi.gov.uk/stakeholders/legislation/wqregs2007cons.pdf tables A and B. Where private water supplies are also used, see The Private Water Supplies Regulations 2009 http://www.dwi.gov.uk/stakeholders/legislation/pwsregs2009.pdf		DWI guidance and codes of practice Details of recommended sampling procedures are given in the Microbiology of Drinking Water https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/316769/MoDW-2-232.pdf and BS EN ISO 19458.
All settings	Circulated hot water systems and cold water systems	*Legionella* spp.: colony counts per litre *Pseudomonas aeruginosa* colony counts per 100 mL	HTM 04-01 Parts A, B and C BS 7592 Sampling for Legionella bacteria in water systems. Code of practice	*Legionella* spp., *Pseudomonas aeruginosa* and other waterborne pathogens	For *Legionella*, see Health and Safety Executive (2014). *Legionnaires' disease HSG 274 Part 2. The control of Legionella bacteria in hot and cold water systems.*
Flexible endoscope reprocessing units	Initial flush	Hardness	HTM 01-06 Decontamination of flexible endoscopes Part B – Design and installation HTM 01-06 Decontamination of flexible endoscopes Part E – Testing methods		
	Intermediate flush	Hardness			
	Water for diluting disinfectants and detergents	Hardness			
	Final rinse-water	• Hardness • Total organic carbon • Electrical conductivity • Appearance • pH • Total viable count • *P. aeruginosa* • Environmental mycobacteria			

Healthcare area	Application	Physical, chemical or microbial quality indicators	Water quality parameters given in:	Particular hazards (based on an assessment for each system)	See also
Renal units and satellite dialysis units	**Water for haemodialysis**	**Total viable counts and endotoxin concentrations**	• BS ISO 13959: Water for haemodialysis and related therapies. • BS ISO 11663: Quality of dialysis fluid for haemodialysis and related therapies. • BS ISO 13958: Concentrates for haemodialysis and related therapies.		• HBN 07-01 Satellite dialysis units • HBN 07-02 Main renal units
Augmented care units		**Pseudomonas aeruginosa: Colony counts per 100 mL**	HTM 04-01 Part B and Part C: *Pseudomonas aeruginosa* – advice for augmented care units		
Aquatic therapy pools		pH, free residual halogen, total and combined halogen and other treatment parameters. Coliforms, *E.coli*, *Pseudomonas aeruginosa* and TVCs			• See the PWTAG's 'Swimming pool water: treatment and quality standards for pools and spas';
Spa pools and whirlpools		pH, free residual halogen and other treatment parameters			• See HSE/PHE's 'Management of spa pools: controlling the risks of infection'; **Note** This document is currently being revised and will become HSG274 Part 4 – 'The control of Legionella and other infectious agents in spa pool systems'.

Healthcare area	Application	Physical, chemical or microbial quality indicators	Water quality parameters given in:	Particular hazards (based on an assessment for each system)	See also
Sterile services departments	Final rinse	Appearance:	HTM 01-01 Part D Washer disinfectors		
		• pH • Conductivity at 25°C • Total dissolved solids • Total hardness • Chloride, Cl • Heavy metals, determined as Lead, Pb • Iron, Fe • Phosphate, P_2O_5 • Silicate, SiO_2 • Total viable count at 22°C • Total viable count at 37°C • Bacterial endotoxins			
	Other stages	• Total hardness • Chloride, Cl • Silicate, SiO_2			
Laundries	Final rinse	Hardness (total Ca^{2+}/Mg^{2+})	HTM 01-04 Decontamination of linen for health and social care: engineering, equipment and validation	*Clostridium difficile* *Bacillus cereus*	Textile Services Association's (2008) "Target specification for recycled water to meet final rinse quality".
		• pH • Turbidity • Colour • Iron • Manganese • Copper • Surfactant • Bioburden (TVC)			
Dental facilities	Dental unit water lines and water systems	*Legionella* spp.: colony counts per litre *Pseudomonas aeruginosa* colony counts per 100 mL	Chapter 19 in HTM 01-05 Decontamination in primary care dental facilities https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/170689/HTM_01-05_2013.pdf	*Legionella* spp. *Pseudomonas aeruginosa* and other waterborne pathogens	

Appendix B Action in the event of an outbreak of legionellosis

B1. In England and Wales, Legionnaires' disease is notifiable under the Health Protection (Notification) Regulations 2010. Under these regulations, registered medical practitioners must report cases of Legionnaires' disease to the Proper Officer. These regulations also require human diagnostic laboratories to notify PHE of cases of Legionnaires' disease identified by laboratory testing.

B2. An outbreak is defined as two or more cases where the onset of illness is closely linked in time (weeks rather than months) and location and where there is epidemiological evidence of a common source of infection, with or without microbiological evidence. An outbreak control team should always be convened to investigate outbreaks. It is the responsibility of the Proper Officer to declare an outbreak. The Proper Officer, appointed by the local authority, is often a consultant in communicable disease control (CCDC) within the local PHE centre health protection team.

B3. The local PHE centre health protection team has established incident plans to investigate major outbreaks of infectious diseases including legionellosis.

B4. The HSE or local environmental health officers (EHOs) may be involved in the investigation of outbreaks, their aim being to pursue compliance with health and safety legislation. The local authority, Proper Officer or EHO acting on their behalf will make a site visit to carry out a public health risk assessment, often with the relevant officer from the enforcing authorities (the HSE or the local authority) for health and safety reasons. Any infringements of relevant legislation may be subject to a formal investigation by the appropriate enforcing authority.

B5. There are published guidelines on the PHE website for the investigation and management of incidents, clusters and outbreaks of Legionnaires' disease.

B6. If the hot and cold water system is implicated in an outbreak of Legionnaires' disease, the WSG may wish to consider cleaning and disinfection of part of the, or the entire, system. Advice may be found in HSG274 Part 2.

Appendix C Exemplar temperature test sheets

SERVICE VISIT REPORT - Temperature

Client ______________________ **Visit Date** ______________________

Site ______________________ **Report Ref** ______________________

Equipment type	Location	Mains	Cold	Hot	Mixed	Fail	Comment
Limits	Tanks & Cold taps	<20	<20				(Within 2 minutes)
	Calorifier Flow			57-65			
	Calorifier Return			50-60			(& HWS return loops)
	HWS			>50			(Within 1 minute)
	Thermostatic valve (TMV)	<20	<20	>50	38-46		

Comments & Recommendations

Report by ______________________ **Signature** ______________________

Site Contact ______________________ **Site Signature** ______________________

C1. A unique identification is required for each outlet/mixing device as well as identification of its type.

C2. At commissioning, hot and cold water pressures also need to be measured and recorded for each mixing device together with all the test parameters from the in-service tests in HTM 04-01: Supplement – 'Performance specification D 08: thermostatic mixing valves (healthcare premises)'. This allows supply conditions to be reassessed in the future if outlet temperatures have changed.

Appendix D Testing for *P. aeruginosa*

D1. *P. aeruginosa* may be present within the water storage, distribution and delivery systems and also in the water supplied to the healthcare facility.

D2. The sampling protocol (Appendix E) is intended to help healthcare providers establish whether the water in augmented care units is contaminated with *P. aeruginosa* and, if it is, to help locate its origin and to monitor the efficacy of remedial measures.

D3. *P. aeruginosa* contamination is generally found in the last two metres of the point of water delivery; therefore pre-flush samples should be collected to assess the highest risk to outlet users and at-risk patients.

D4. Biofilm will constantly be released as clumps or free-floating individual cells (planktonic forms).The concentration of planktonic bacteria will build up over time when the water is stagnant, but will be diluted as water is used and flows through the pipework or tap containing the biofilm.

D5. Water outlets can give very different results and may be negative if water from the tap has been used before a sample is collected.

D6. The first water to be delivered from the outlet (pre-flush sample) should be collected to assess the microbial contamination in the last two metres of pipework.

D7. To maximise the recovery of these free-floating planktonic bacteria, water samples should be taken:

a. during a period of, preferably, no use (at least two hours or preferably longer); or

b. low use.

D8. If water flows over a biofilm containing *P. aeruginosa* located in the last two metres, planktonic bacteria arising from that biofilm will be diluted and a subsequent sample will give low bacterial counts. If contamination is upstream in the system, this will not affect bacterial counts, which may actually increase.

D9. The sample obtained after allowing water to flow from an outlet is referred to as a "post-flush" sample (see paragraphs E12 and E13 in Appendix E). Comparison of counts from pre-and post-flush samples can help locate the source of the *P. aeruginosa*. If a pre-flush sample gives a high count, subsequent paired pre- and post-flush samples should be tested to help locate the source of the contamination.

D10. In order to be able to carry out the appropriate microbiological examinations on a sample and provide a meaningful interpretation of test results, it is essential that samples are collected in the correct manner using the correct equipment and that the sampling protocol in Appendix E is adhered to.

D11. Protocols for microbiological examination of samples are provided in Appendix F.

Where to sample water outlets

D12. The water outlets to be sampled should be those that supply water which:

- has direct contact with patients;
- is used to wash staff hands; or
- is used to fill or clean equipment that will have contact with patients as determined by risk assessment.

When and how to sample water outlets

D13. The outlets identified above should be sampled to provide an initial assessment of contamination levels. There is no need to sample all taps that are due to be sampled on the same occasion; samples can be taken in batches on separate occasions. It may assist the receiving laboratory if the sampling schedule is agreed beforehand (see Figure D1 and also Appendix F).

Interpretation of *P. aeruginosa* test results

D14. If test results are satisfactory (not detected), there is no need to repeat sampling for a period of six months unless there are changes in the water distribution and delivery systems components or system configuration (for example, refurbishments that could lead to the creation of dead-legs) or occupancy.

D15. However, the WSG could indicate that water sampling is required within six months if there are clinical evidence-based suspicions that the water may be a source of patient colonisation or infection (that is, with *P. aeruginosa* or another potentially waterborne pathogen).

D16. If tests show counts of 1 to 10 cfu/100 mL, the WSG should risk-assess the use of water while simultaneously retesting the water outlet (see Figure D1 and Note below).

D17. If test results are not satisfactory (>10 cfu/100 mL), further sampling along with an engineering survey of the water system could be used to identify problem areas and modifications that may be implemented to improve water quality.

D18. After such interventions, the water should be resampled (see Figure D1 for suggested frequencies).

Note

Figure D1 gives an example of sampling frequencies. Sampling may be undertaken more frequently according to the risk assessment. It is important that samples are taken as described in Appendix E to avoid false negative results.

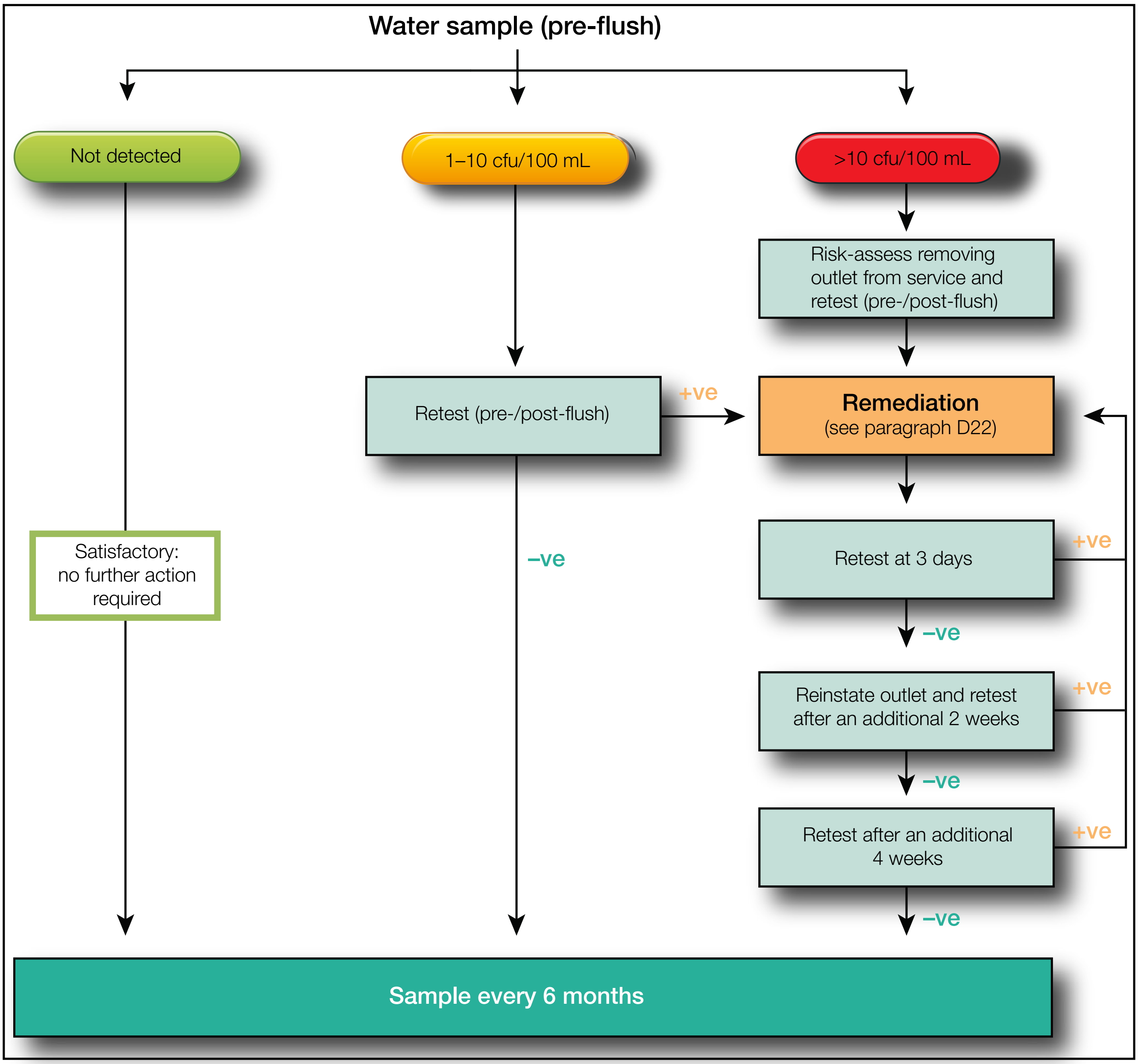


Figure D1 Summary of suggested water sampling and testing frequencies

Interpretation of pre- and post-flush counts

D19. High counts in pre-flush samples but with low counts or none detected at post-flush could indicate that areas/fittings at or near the outlets are the source of contamination (see Table D1).

- A few positive outlets, where the majority of outlets are negative, would also indicate that the source of contamination is at or close to the outlet.
- If both pre- and post-flush samples from a particular outlet are >100 cfu/100 mL and other nearby outlets have no or low counts, this shows that the single outlet is heavily contaminated, despite the high post-flush count. This could be explored by testing dilutions of pre- and post-flush water samples from this outlet or by using an extended flush such as for five minutes prior to post-flush sampling or by taking a post-flush sample after disinfection of the outlet as occurs with *Legionella* post-flush sampling.

Table D1 Interpretation of pre- and post-flush counts

High *P. aeruginosa* pre-flush count (>10 cfu/100 mL) and low post-flush count (<10 cfu/100 mL)	Suggestive of a local water outlet problem
High *P. aeruginosa* pre-flush count (>10 cfu/100 mL) and high post-flush count (>10 cfu/100 mL)	Suggestive of a problem not related to a local water outlet but to a wider problem within the water supply system

Note

Overlaying sample results onto schematic drawings of the system may help to identify the source of contamination and locations for additional sampling.

D20. If the sampling indicates that the water services are the problem, then most outlets would possibly be positive and other points in the water system could then be sampled to assess the extent of the problem (see Table D1).

D21. Figure D2 provides a summary of the sampling procedure and interpretation of results for *P. aeruginosa*.

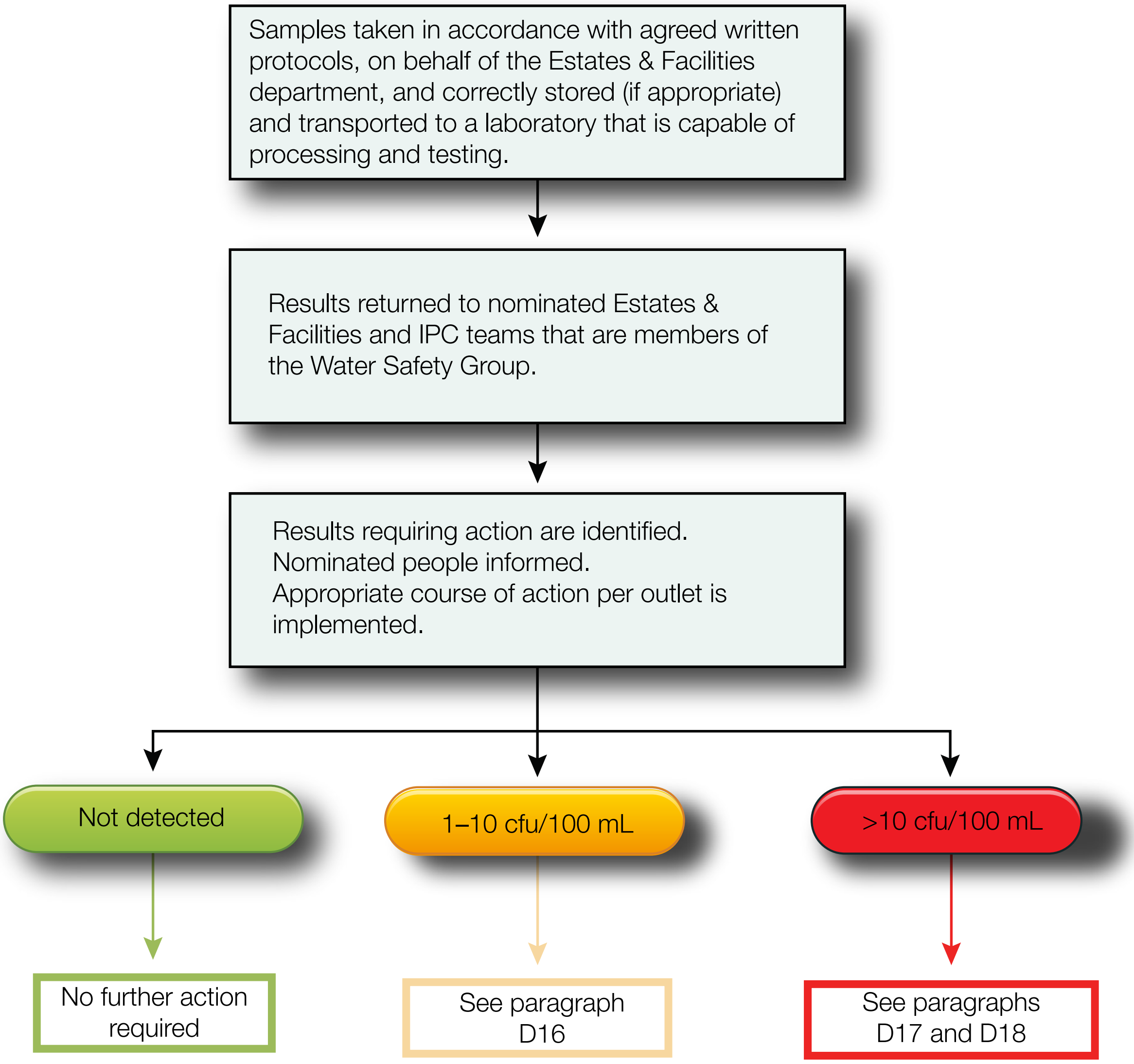


Figure D2 Summary of sampling procedure and interpretation of results for *P. aeruginosa*

What to do if a contamination problem is identified

D22. Should risk assessment or water testing identify contamination with *P. aeruginosa*, the following risk reduction and preventive measures should be considered.

a. Inform the WSG and hold a focused incident control meeting (for example, IPC team, estates and clinical staff) to ensure patient safety is prioritised and to formulate an action plan.

b. If a water outlet has been taken out of service because of contamination with *P. aeruginosa*, continue daily flushing while the outlet is out of normal use to prevent water stagnation and exacerbation of the contamination.

c. Where practical, consider removal of flow straighteners. However, the removal of flow straighteners may result in splashing and therefore additional remedial action may need to be taken. If they are seen to be needed, periodically remove them and either clean/disinfect or replace them. Replacement frequency should be verified by sampling/swabbing.

d. Splashing can promote dissemination of organisms, resulting in basin outlets becoming heavily contaminated. If splashing is found to be a problem, investigate the causes. Example causes include:

    i. the tap's designed flow profile is incompatible with the basin;

    ii. the tap discharges directly into the waste aperture;

    iii. incorrect height between tap outlet and surface of the basin;

    iv. excess water pressure;

    v. a blocked or malfunctioning flow straightener.

e. Hand-washing should be supplemented with the use of an antimicrobial hand-rub.

f. To prevent water stagnation, check for infrequently used outlets – assess frequency of usage and if necessary remove infrequently used outlet(s). For example, the provision of showers in areas where patients are predominantly confined to bed, and the resultant lack of use, could lead to stagnation.

g. Check connections to mixing taps to ensure that the supply to the hot connection is not supplied from an upstream TMV. In a hot water service, a dead-leg will exist between the circulating pipework and hot connection of a fitting such as a mixing tap. In the case of cold water services, sometimes there will be no draw-off from any part of the system and the entire service is in effect a dead-leg. To minimise the stagnation of water in a cold water system, it can be beneficial to arrange the pipework run so that it ends at a frequently used outlet. A dead-leg may also exist when a TMV is installed upstream of a mixing tap (see Figure D3). Depending on the activities of the room in which the tap is located, cold water may never be drawn through the pipe between the cold water connections of the mixing valve and mixing tap.

h. Risk-assess the water system for redundant pipework and dead-legs (for example, where water is supplied to both the cold water outlet and a TMV supplying an adjacent blended water outlet, as such cold water outlets in augmented care units may be infrequently used). When removing outlets, the branch hot and cold water pipes should also be cut back to the main distribution pipework in order to eliminate redundant pipework.

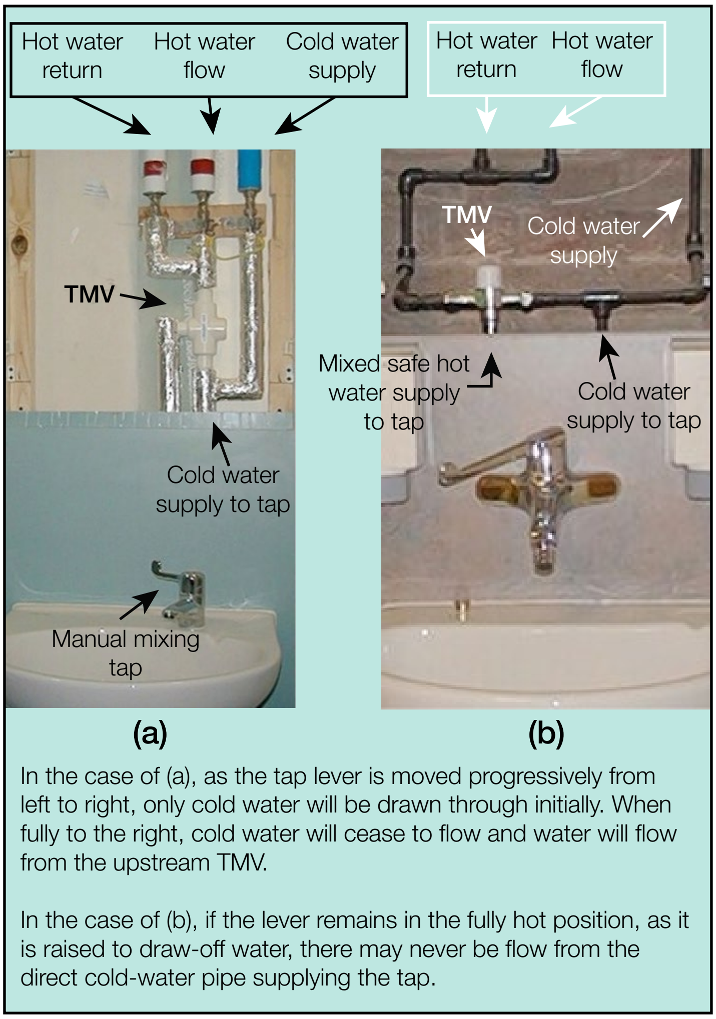


Figure D3 Dead-leg formed by the cold pipework when a TMV is installed upstream of a mixing tap

i. Assess the water distribution system for non-metallic materials that may be used in items such as inline valves, test points and flexible hoses. They should be replaced according to the guidance in safety alert DH (2010) 03 – 'Flexible water supply hoses'.

j. All materials in contact with water should have been assessed and shown they are appropriate for the intended purpose (see paragraph 1.15 in HTM 04-01 Part A) and should not leach chemicals that provide nutrients that support microbiological growth. Materials should also be compatible with the physical and chemical characteristics of water supplied to the building. Flexible pipes should only be used in exceptional circumstances (for example, where height adjustment is necessary as in installations such as rise-and-fall baths and hand-held showers).

k. POU filters, where they can be fitted, may be used to provide water free of *P. aeruginosa*. Where fitted, regard filters primarily as a temporary control measure until a permanent solution is developed, although long-term use of such filters may be required in some healthcare applications. Where POU filters are fitted to taps, follow the manufacturer's recommendations for renewal and replacement and note that the outer casing of a POU filter and the inner surface can become contaminated (see also paragraphs 7.45–7.49). There should be sufficient activity space once a POU filter has been fitted.

l. In certain circumstances, the WSG may decide it is necessary to carry out a disinfection of the hot and cold water distribution systems that supply the unit to ensure that contaminated outlets are treated. See chapter 2 of HSG274 Part 2 for guidance on how to carry out the disinfection procedure. Note that with respect to *P. aeruginosa*, hyperchlorination is not effective against established biofilms. Consider replacing contaminated taps with new taps; however, there is currently a lack of scientific evidence to suggest that this will provide a long-term solution. When replacing taps, consider fitting:

   i. removable taps;

   ii. taps that are easy to use;

   iii. taps that can be readily dismantled for cleaning and disinfection;

   iv. taps to which a filter can be attached to the spout outlet. Note: Such taps can be used for supplying water for cleaning incubators and other clinical equipment.

Note

In the event of an outbreak or incident, further advice on the management of *P. aeruginosa* contamination in water systems can be sought from PHE.

Appendix E Water sampling for *P. aeruginosa*

Note

These sampling methods will also be applicable if sampling for *Stenotrophomonas maltophilia* and *Mycobacterium* spp.

Click here for an online video showing methods for obtaining water samples.

E1. Sampling should be undertaken by staff trained in the appropriate technique for taking water samples including the use of aseptic technique to minimise extraneous contamination. The method used in this guidance may differ from the collection of water samples for other purposes (for example, for sampling *Legionella*, which should be carried out to BS 7592).

E2. Carefully label samples with the type of samples (pre- or post-flush) and outlet such that the outlet can be clearly identified; system schematics indicating each numbered outlet to be sampled can be helpful in this respect.

E3. The main strategy for sampling is to take the first sample of water (pre-flush) delivered from a tap at a time of no use (at least two hours or preferably longer) or, if that is not possible, during a time of its lowest usage. This will normally mean sampling in the early morning, although a variety of use patterns may need to be taken into account.

E4. Disinfectants in the water, such as chlorine or chlorine dioxide, will have residual activity after taking the sample and may inactivate bacteria in the sample prior to its processing and therefore the WSG should take advice from the receiving laboratory. To preserve the microbial content of the sample, neutralise oxidising biocides by dosing the sample bottle with 18 mg of sodium thiosulphate (equating to 18 mg/L in the final sample, which will neutralise up to 5 mg/L of free chlorine). It should be further noted that dosing a 1 L sample bottle with 180 mg of sodium thiosulphate (equating to 180 mg/L in the final sample) will neutralise up to 50 mg/L free chlorine or will neutralise up to at least 80 µg/L silver and 600 µg/L copper). Sterile bottles are normally purchased containing the neutraliser. However, EDTA has been found to be totally ineffective as a neutraliser for silver and therefore should not be used as such in any bacterial test including *P. aeruginosa* and *Legionella* spp. Where other disinfectants are being applied to the water system, take advice on the appropriate neutralisers to use.

E5. The tap should not be disinfected by heat or chemicals before pre-flush sampling (see paragraph E9) nor should it be deliberately cleaned or disinfected immediately before sampling.

E6. Label a sterile collection vessel (200–1000 mL volume) containing a suitable neutraliser for any biocide the water may contain. The labelling information should contain details of the tap location, sender's reference, pre- or post-flush (see paragraph E12), person sampling, date and time of sampling.

E7. If *P. aeruginosa* has been found in a preflush sample, take a second paired set of samples. The first would be a pre-flush sample as before. Run the tap for two minutes and take a second identical post-flush sample. Bacteria in this second sample (termed postflush) are more likely to originate further back in the water system. A substantially higher bacterial count in the pre-flush sample, compared with the post-flush, should direct remedial measures towards the tap and associated pipework and fittings near to that outlet. A similar bacterial count in pre-flush and post-flush samples indicates that attention should focus on the whole water supply, storage and distribution system. A more extensive sampling regime should be considered throughout the water distribution system, particularly if that result is obtained from a number of outlets.

E8. Although water sampling is the principal means of sampling, there may be occasions when water samples cannot be obtained immediately for analysis. In the event of a suspected outbreak, swabbing water outlets (as per section 5.4 of the Standing Committee of Analysts' (SCA) 'Microbiology of drinking water – Part 2: practices and procedures for sampling') to obtain strains for typing may provide a means of assessing a water outlet, but this does not replace water sampling (see paragraph E15 on swabbing).

Procedure for obtaining the samples

E9. Pre-flush sample: Aseptically (that is, without touching the screw thread, inside of the cap or inside of the collection vessel) collect at least 200 mL water in a sterile collection vessel containing neutraliser. Replace the cap and invert or shake to mix the neutraliser with the collected water.

E10. Depending on the water distribution system design and the type of water outlet, the water feed to the outlet may be provided by:

- a separate cold water supply and hot water supply to separate outlets;
- a separate cold water supply and hot water supply, which may have its final temperature controlled by the use of an integral TMV within the outlet; or
- a separate cold water and a pre-blended hot water supply that has had its temperature reduced by a TMV prior to delivery to the outlet.

Collect at least 200 mL water in a sterile collection vessel

E11. For separate hot and cold water outlets, each outlet is individually tested with its own collection vessel and outlet identifier. For blended outlets (that is, where both hot and cold water come out of the same outlet):

- sample water with the mixing tap set to the fully cold position using an individual collection vessel and outlet identifier, and note the temperature setting;
- sample the blended outlet set to the maximum available hot water temperature using an individual collection vessel and outlet identifier, and note the temperature setting.

E12. Post-flush sample: where this is required, allow the water to flow from the tap for two minutes (see above) before collecting at least 200 mL water in a sterile collection vessel with neutraliser. Replace the cap and invert or shake to mix the neutraliser with the collected water. This sample, when taken together with the pre-flush sample, will indicate whether the tap outlet and its associated components are contaminated or if the contamination is remote from the point of delivery (see Table D1 in Appendix D).

E13. If a sample from a shower is required, then place a sterile bag over the outlet. Using sterile scissors, cut a small section off the corner and collect the sample in a sampling container (see PHE's (2013) 'Guidelines for the collection, microbiological examination and interpretation of results from food, water and environmental samples taken from the healthcare environment'). Appropriate precautions should be taken to minimise aerosol production as described in BS 7592.

E14. The collected water should be processed within two hours. If that is not possible, then it should be refrigerated within two hours, kept at 2–8°C and processed within 24 hours.

E15. To take a swab sample, remove a sterile swab from its container and insert the tip into the nozzle of the tap or other designated area. Care should be taken to ensure no other surfaces come into contact with the tip of the swab. Rub the swab around – that is, move it backwards and forwards and up and down, as much as possible, on the inside surface of the tap outlet or flow straightener (see photograph). Replace the swab carefully in its container, again ensuring no other surfaces come into contact with the tip of the swab. Place the swab in a transport medium or maximum recovery diluent (MRD) and send to the laboratory.

A sterile swab should be rubbed on the inside surface of the tap outlet or flow straightener

Appendix F Microbiological examination of water samples for *P. aeruginosa*

Notes

This appendix has been developed to provide technical guidance for a range of laboratories (including NHS, PHE and commercial laboratories) that have the capability and capacity to undertake water sampling and testing.

Alternative water-testing methods other than filtration methods may be used as long as they have been validated using BS EN ISO 17994 and meet the required sensitivity and specificity such as those identified in BS EN ISO 16266.

An oxidase test alone is not sufficiently specific to identify *P. aeruginosa*.

Methods approved by the Standing Committee of Analysts and listed in the 'Microbiology of drinking water – Part 8: the isolation and enumeration of *Aeromonas* and *Pseudomonas aeruginosa*' are allowed to be used.

Definition

F1. *P. aeruginosa* are Gram-negative, oxidase-positive bacteria that, in the context of this method, grow on selective media containing cetrimide (cetyl trimethylammonium bromide), usually produce pyocyanin, fluoresce under ultraviolet light 360 ± 20 nm, and hydrolyse casein. *P. aeruginosa* needs to be identified by the following methods – identification by a positive oxidase test alone is insufficient.

Testing principle

F2. A measured volume of the sample or a dilution of the sample is filtered through a membrane filter (≤0.45 µm) to retain bacteria and the filter is then placed on a solid selective and differential medium.

F3. CN agar contains cetyl trimethylammonium bromide and nalidixic acid at concentrations that will inhibit the growth of bacteria other than *P. aeruginosa*. Other selective and differential agars are available and acceptable if validated.

F4. The membrane is incubated on a selective/differential agar and characteristic colonies are counted. Confirmatory tests are carried out where necessary (see paragraph F15) and the result is calculated as the colony count per 100 mL of water.

F5. *P. aeruginosa* usually produces characteristic blue-green or brown colonies when incubated at 37°C for up to 48 hours. Confirmation of isolates is by subculture to milk agar supplemented with cetyl trimethylammonium bromide (commercially available) to demonstrate hydrolysis of casein.

Sample preparation and dilutions

F6. Water samples should be received and handled as described in the SCAs' 'The microbiology of drinking water Part 8' (currently under review). For example, samples should be examined as soon as is practicable on the day of collection. In exceptional circumstances, if there is a delay, store at 2–8°C and do not exceed 24 hours before the commencement of analysis.

Filtration and incubation

F7. Aseptically measure and dispense 100 mL of water sample into the sterile filter-holder funnel. If the funnel is graduated to indicate volume, this can also serve to measure the volume.

F8. If high bacterial numbers are present in water samples, it may be impossible to count individual colonies accurately on the filter membrane. Therefore, if high counts are expected, a range of dilutions made in sterile diluent (water, MRD or similar) can be processed in parallel with the undiluted sample. An example of this would be a 1-in-10 and a 1-in-100 dilution processed as well as an undiluted sample. Filtration of 10 mL rather than 100 mL is an alternative to filtering 100 mL of a 1-in-10 solution.

F9. Draw the water sample through the filter.

F10. Aseptically place the membrane onto the *P. aeruginosa* selective and differential agar (see paragraph F3) and incubate aerobically at 37°C.

Counting of colonies

F11. Examine plates after 22 hours ± 4 hours and 44 hours ± 4 hours of incubation.

F12. Count all colonies that produce a green-blue (demonstrating pyocyanin production) or reddish-brown pigment and those which fluoresce under ultraviolet light (optional). Exposure of colonies to daylight for two-to-four hours enhances pigment production. When there is a moderately heavy growth of *P. aeruginosa* and other organisms on the membrane, colonies adjacent to pyocyanin-producing colonies of *P. aeruginosa* can also appear green after 44 hours ± 4 hours of incubation, making the interpretation of the count difficult. Observing the plates after 22 hours ± 4 hours assists in the interpretation in these instances.

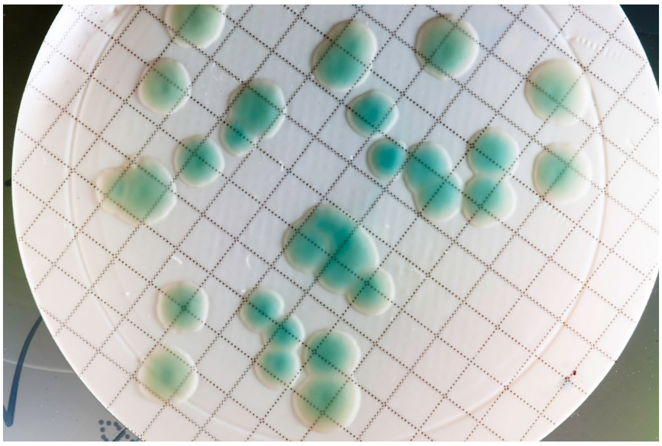


Plate showing raised counts of pyocyanin-producing colonies of *P. aeruginosa*

Processing of swabs

F13. Swabs can show presence of *P. aeruginosa* but will not provide equivalent quantitative results as water sampling. They can be used to show the presence or absence of *P. aeruginosa* at the outlet.

F14. In the laboratory, use the swab to inoculate a portion of an agar plate that is selective and differential for *P. aeruginosa* (see paragraphs F2 and F3). Streak the inoculum on the plate as for a clinical sample. Incubate as described for filter samples above. Alternatively, after sampling, place the swab in 10 mL MRD, vortex, then plate out (using serial dilution) on the appropriate media and incubate as above.

Confirmatory tests

F15. Colonies that clearly produce pyocyanin (green-blue pigmented) on the membrane are considered to be *P. aeruginosa* and require no further testing. Other colonies that fluoresce or are reddish-brown require confirmation. If more than one volume or dilution has been filtered, proceed if possible with the membrane yielding 20–80 colonies to enable optimum identification and accurate enumeration of colonies. Where there is doubt, perform additional tests to yield reliable species identification.

F16. To confirm other colonies, subculture from the membrane onto a milk cetrimide agar (MCA) plate and incubate at 37°C for 22 hours ± 4 hours. Examine the plates for growth, pigment, fluorescence and casein hydrolysis (clearing medium's opacity around the colonies). If pigment production is poor, expose the MCA to daylight at room temperature for two-to-four hours to enhance pigment production and re-examine.

F17. *P. aeruginosa* is oxidase-positive, hydrolyses casein and produces pyocyanin and/or fluorescence. Occasionally atypical non-pigmented variants of *P. aeruginosa* occur. A pyocyanin-negative, casein-hydrolysis-positive, fluorescence-positive culture should be regarded as *P. aeruginosa*. Additional tests may be necessary to differentiate non-pigmented *P. aeruginosa* from *P. fluorescens* (such as growth at 42°C or resistance to C-390, 9-chloro-9-(4-diethylaminophenyl)-10-phenylacridan or phenanthroline or more extensive biochemical tests). See Table F1.

Retention of *P. aeruginosa* isolates

F18. Where a clinical investigation is underway, inform the testing laboratory that the *P. aeruginosa* isolates and associated sampling location information should be retained for a minimum of three months as they may be required for typing at a later date.

F19. It will then be the responsibility of the testing laboratory to ensure that these isolates are supplied to the typing laboratory (for example, PHE at Colindale) when requested, and this should be written into the contract for testing.

Calculation of results

F20. Express the results as colonies of *P. aeruginosa* per 100 mL of the undiluted sample, for example:

- for 100 mL sample – the count on the membrane;
- for 10 mL of sample – the count on the membrane multiplied by 10;
- for 1 mL of sample – the count on the membrane multiplied by 100.

Reporting

F21. If *P. aeruginosa* is not detected, report as "Not detected in 100 mL".

F22. If the test organism is present, report as the number of *P. aeruginosa* per 100 mL. Reports should be specific to *P. aeruginosa*, and not generic *Pseudomonas* species.

F23. The sample reference originally submitted should be reported with each result.

Table F1

Colony on CN agar	Oxidase test	Fluorescing on MCA	Caseinolytic on MCA	Confirmed *P. aeruginosa*
Blue or green	+	NT	NT	Yes
Fluorescing and not pigmented	+	+	+	Yes
Reddish-brown non-fluorescing	+	+/–	+	Yes
NT = No testing necessary				

Microbiological typing

F24. Water and/or tap-swab isolates being sent to PHE's Antimicrobial Resistance and Healthcare Associated Infections (AMRHAI) Reference Unit for molecular analysis of *P. aeruginosa* should only be referred if the isolates have been confirmed to be *P. aeruginosa* and if there is a possible link to the outbreak strain under investigation.

F25. Referrals of *P. aeruginosa* isolates for typing should only be sent after consultation with the typing laboratory.

F26. Where many taps are positive for *P. aeruginosa*, send one colony of the *P. aeruginosa* from each water sample. Save the primary isolation plate for possible further examination once the results of typing are known and have been discussed with the typing laboratory. Analysis of results to date has consistently shown that multiple picks have been representatives of the same strain; since multiple taps are being sampled, an idea of the extent of homogeneity or otherwise will still be gained where only one colony is sent from each water sample.

F27. If only two or three taps are positive for *P. aeruginosa*, then send two separate colony picks of confirmed *P. aeruginosa* from the primary plate per water sample to AMRHAI (taking the stipulations in paragraph F25 into account). Label these clearly as being from the same water sample (so that AMRHAI can accumulate data on how common mixed strains are seen in the same tap water).

F28. It is important that the request forms have information about the links between tap water and cases as illustrated in the following examples:

a. water from tap in room "A" ref patient "X";

b. water from taps in dirty utilities;

c. tap water from room "C" with no cases.

F29. It is important to recognise that there are some types of *P. aeruginosa* that are relatively commonly found in the environment and among patient samples globally. These include the PA14 clone and clone C; a match between patient and water samples with these strains is not necessarily evidence of transmission between the two.

F30. If a contamination problem has been identified, the remediation measures in paragraph D22 of Appendix D should be followed.

Flowchart showing the processing and enumeration of *P. aeruginosa* by membrane filtration

Maintain the cold chain during transport of the sample to the laboratory

↓

Process within 2 hours. If not possible, refrigerate within 2 hours, keep at 2–8°C and process within 24 hours

↓

Make any necessary dilutions

↓

Filter

↓

Aseptically place the membrane onto the pseudomonas selective and differential agar and incubate at 37°C; examine after 22 hours ± 4 hours and 44 hours ± 4 hours

↓

Count all colonies that produce a green/blue or reddish-brown pigment and those that fluoresce under UV light (optional)

↓

Subculture non-pyocyanin-producing (green/blue) colonies to MCA and incubate at 37°C for 22 ± 4 hours

↓

Examine the plates for growth, pigment, fluorescence and casein hydrolysis. If pigment production is poor, expose the MCA to daylight at room temperature for 2–4 hours to enhance pigment production and re-examine

↓

Calculate confirmed count and report as *P. aeruginosa*

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Note

See also Appendix 2 in HTM 04-01 Part A, which gives an overview of UK water legislation.

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2904408 (Part B) Produced by Williams Lea for the Department of Health