



Queensland Government



Preliminary Guidelines for Managing Microbial Water Quality in Health Facilities

23 September 2013



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Use of This Document

These preliminary guidelines are to be interpreted as recommendations for practices to be implemented by Queensland Health within Hospital and Health Care (Healthcare) facilities. These practices address the management of health risks associated with potable water supplied to and within Healthcare infrastructure.

It is the intent of these guidelines to reinforce the need for Healthcare managers to proactively manage all potable water infrastructure. This management includes identifying, assessing, monitoring, and responding to microbial risks in order to minimise waterborne threats to Healthcare staff and patient health and safety.

As a preliminary document, these Guidelines may not contain full detail which may be found in a more formalised document. In that regard, it is expected that their application by Healthcare infrastructure managers will be focused on the goal of implementing best practices to manage human health risks associated with microbial content in potable water. To meet due diligence in development of these preliminary guidelines, the document has been concurrently placed in peer review both internally and externally to Queensland Health. Peer review inputs will be considered for future revisions to these guidelines.

All questions and concerns about these guidelines contained within this document should be forwarded to the Building Services Director, Health Infrastructure Branch, System Support Services, Department of Health. Questions may also be emailed to: waterquality@health.qld.gov.au.



Background

Following two instances of potable water-supply acquired Legionnaires disease that have been documented in a private hospital in Brisbane in 2013, Queensland Health requested public and private hospital and health care (Healthcare) facilities across Queensland to undertake 'snapshot' testing of their water supply systems. A significant number of these facilities tested positive for Legionella contamination to varying degrees.

Queensland Health issued additional guidelines to health facilities to assist with understanding the nature of the problem, extent of risk and the response required to problems through a series of protocols:

- An Interim Guideline was released in June 2013 in order to assist public hospitals conduct the snapshot testing program as well as respond to the results they obtained from that testing
- An Amended Interim Guideline was released on 30th July 2013 to clarify discrepancies that were contained in the May release and further assist public hospitals complete their snapshot testing.

The resulting guidelines presented in this document were developed by building upon the above interim and amended interim guidelines as well as information from other State guidelines, standards and studies ^[1-8] as well as international guidelines, standards, and recommendations ^[9-18]. These guidelines provide helpful information in how to identify and respond to unacceptable water quality results obtained during routine monitoring and management of hot, warm, and cold potable water infrastructure. The rationale for this guideline is described herein; the guideline is necessary because of the realisation of a 'gap' existing between the management of Healthcare infrastructure and the management of drinking water supplies.

In general, the recommended process of risk management described in these guidelines is illustrated in **Figure 1**, below. These guidelines help to fill this gap with practical tools that can be implemented by Healthcare infrastructure managers. Specifically, the guidance and response tools provided surround the monitoring, identification, and response to unacceptable microbial-related risks associated with potable water infrastructure. This document contains several sections that include background information and practical instructions. The risk identification and mitigation procedures provided in these guidelines may be changed according to subsequent revisions published by Queensland Health.

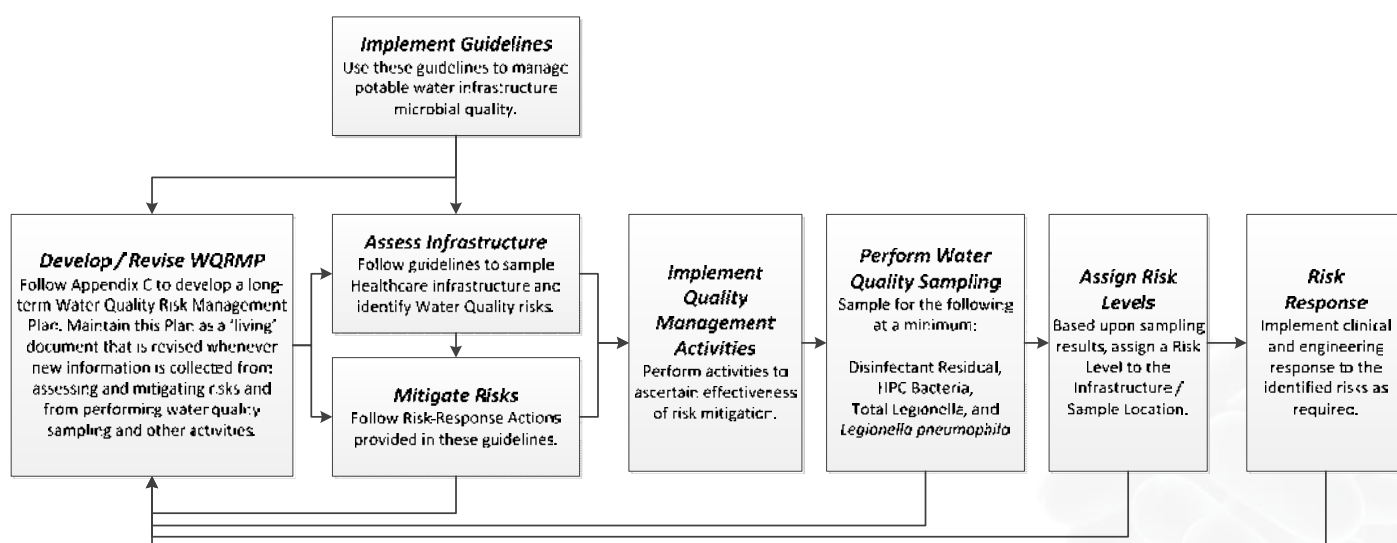


Figure 1
Process flow diagram for the implementation and use of these guidelines

Purpose of this Document

This document replaces the Amended Interim Guideline V2.5 2013 and provides further guidance. It largely follows the same approach as that taken in the previous document as well as an older guidance document which was released by North Queensland Tropical Public Health Unit in 1997^[83]. The purpose of this document is as follows:

- Summarise the Support of the Snapshot Sampling Program - A key objective in previous documentation was to provide relevant information to health care facilities within a short time frame. There is now an opportunity to provide additional background information and provide greater clarity on objectives and procedures, as well as identify technical issues which should be developed in more detail into any future amendments of this document.
- Improve upon the Initially Released Documents - Where necessary, procedures have been improved based on information and knowledge gained since the previous document was issued, including available outcomes from the peer review process and specific queries raised by HHS staff in the initial document.
- Identify Important Technical Areas where Future Guidelines Need Development – A new area of focus where these Guidelines have focused (as compared to Guidelines from other International or State Guidelines for legionella control) is in the identification that Australian potable water quality offers an additional challenge in Queensland. Therefore, where the previous documents had a narrower focus on what to do once Legionella was detected, this resulting document requires additional objectives of providing an understanding of the quality of water provided to the health facility and guidance to managing water quality within the facility to manage the risk of Legionella infections occurring.

What does the future hold?

The requirements for future guidelines on managing water quality and legionella risk in water systems of buildings/facilities is currently under consideration. It could be a revision of this document and be released in the form of one or a combination of the following:

- A Queensland Guideline
- A National Guideline
- Amendments/additions to AS3666 (Air Handling and Water Systems of Buildings)
- Amendments/additions to AS3500 (National Plumbing and Drainage Code)

Extensive input from specialists and key stakeholder organisations will be required, and it is envisaged that 6 to 12 months for final Queensland guidelines and 18 to 24 months may be required before final national documentation would be available. Until such time, these preliminary guidelines will apply.



Infrastructure Water Quality Risks

The purpose of this section is to provide information on the water quality that the health facility is likely to receive from its city/town water supply system in Queensland and of potential risks.

Australian Drinking Water Guidelines

The supply of safe drinking water involves the use of multiple treatment barriers to pathogens, which if well operated, will reduce the risk of pathogens leaving the water treatment plant to a very low level. The Australian Drinking Water Guidelines (ADWG) ^[8] adopts a risk-based approach to managing water supplies, sets limits for a wide range of parameters, but does not guarantee water quality throughout the entire system. ADWG offers recommendations for water utilities in monitoring specific parameters which may either be health or aesthetic based values. Aesthetic values are generally based on public perceptions and good practice, and set higher standards than health values. The guidelines encourage low microbial content but do not yet prescribe legionella or levels for total microbial control. Risk factors and parameters of interest are mentioned later in this section.

Healthcare infrastructure managers must realise that water utilities and ADWG guidelines **do not**:

- Guarantee microbial-free water,
- Provide sterilised water,
- Circumvent the need for Healthcare managers to develop, implement, and actively manage a detailed, robust Water Quality Risk Management Plan (WQRMP) as described in Appendix C.

Water Supplies

Potable (or drinking) water supplied by the water utility is not sterilised, but merely treated and disinfected with a range of conventional processes in order to meet the health needs for human consumption. Key issues of risk which Healthcare facilities should recognise in Queensland are as follows:

- **Residual Disinfection is Not Guaranteed** ^[19]. A disinfectant residual in the water, generally in the form of chlorine, is necessary to continue protection against microbial regrowth. A residual should not be expected or guaranteed to be present upon delivery to the user's meter from the local water utility.
- **Bacteria Will Regrow in Water Systems** ^[20-25, 65, 82, 84]. The risk of microbial colonisation of potable water increases with increasing water storage time and decreasing disinfectant residual. This is important since most Healthcare facilities have water storage.
- **Bacteria Bring Health Risk** ^[24, 26-50]. There are several bacterial organisms which can grow to significant levels when there is low or absent disinfectant residuals in potable water, potentially posing a significant health risk within Healthcare facilities.
- **There is No Single Solution** ^[51]. Not all treatment devices or strategies offered to building owners to control bacterial growth are appropriate for Healthcare facilities to implement.

It is important that Healthcare managers understand that potable water can degrade and become a health risk inside of buildings. Due to this, it is important that all Healthcare facilities contact their local potable water suppliers and understand the water quality which is provided to their facilities.

Healthcare infrastructure risk factors

There are certain factors which present themselves in Healthcare facilities which compound risks as follows:

- Increased retention time of water within the facility due to storage of potable water in tanks;
- Low-water-use locations further extending water retention and possible stagnation and biofilm development;
- Introduction of bacteria due to construction/renovation practices without proper hygienic controls ^[52], and
- High populations of immunocompromised or immunosuppressed persons unable to normally resist infection.



Microorganisms of concern

Potential waterborne disease causing organisms (pathogens) include viruses, bacteria, and protozoa. As mentioned above, a significant reduction in the number of waterborne pathogens will generally occur at the water utility's treatment facility. Risk of Healthcare infrastructure pathogen colonisation increases with increasing water storage time and decreasing disinfectant residual. When residual is absent, opportunistic pathogens (particularly certain bacteria) are free to replicate if conditions are favourable. Some bacteria of concern include those described here:

- ***Acanthamoeba spp.*** ^[30, 43, 53-56]. There have been *Acanthamoeba* species detected in many water-based environments including drinking water, showers, dental units, and cooling water. *Acanthamoeba* and other free-living amoeba (FLA) are organisms which offer protection to *L.pneumophila* and therefore have been argued to be of greater health risk concern than the pathogens themselves as they are hosts which amplify, provide protection to, and increase the virulence and dissemination of pathogens in a water environment.
- ***Escherichia coli (E.coli)*** ^[22, 25]. A gram-negative, aerobic coliform bacterium which naturally occurs as an enteric (intestinal) mammalian parasite. Most strains are harmless, but some serotypes are highly infectious and have contaminated food and water via sewage or animal entry to water storages. Pathogenic serotypes include *E. coli* O157:H7, O104:H4 & H21, O121, O26, O103, O111, and O145 and cause enteric infections with severe diarrhoea and dehydration and possible organ failure at very low infectious doses of <100 cfu.
- ***Legionella pneumophila (L.pneumophila)*** ^[38, 52, 57-59]. A gram-negative, thermophilic, aerobic bacterium which replicates inside amoebae (an amoeba-resisting microorganism [ARM]) and simple algae in the aquatic and/or wet terrestrial environment. Human disease is caused when viable bacteria and/or spores are inhaled (as water droplets or aerosol) or aspirated. *Legionella* can enter into a water system with dirt or dust in mains or storage tanks (during construction or repair) and they can survive in water where there is low disinfectant residual. Legionellosis can occur in two forms: Legionnaire's Disease (bacterial pneumonia with high mortality) and Pontiac Fever (a self-limiting flu-like illness). Immunocompromised and immunosuppressed persons are more at risk to infection.
- ***Mycobacterium avium Complex (MAC)*** ^[36, 44, 45]. A nontuberculous Mycobacteria (NTM), relatively resistant to disinfectants, and causes pulmonary and extrapulmonary infection. NTM disease incidence has been estimated to range from 15 to 30 per 100,000 population. Generally older age is associated with higher prevalence of respiratory disease, but susceptibility is poorly characterised. NTM has been associated with drinking water at point-of-use within buildings – both private and public. It is of particular concern in Healthcare infrastructure due to risk of exposure to immunocompromised and immunosuppressed patients. Hypersensitivity pneumonitis is associated with exposure to water aerosols as the route of exposure. MAC is only one of several NTM of pathogenic concerns to public health. Increased incidence of NTM pulmonary disease in recent decades may parallel increased usage of showers instead of baths for personal hygiene.
- ***Pseudomonas aeruginosa (P.aeruginosa)*** ^[37, 39, 59-64]. This gram-negative, rod-shaped bacterium requires very little nutritional inputs and therefore can survive in nearly any environment. In hospital studies it has been recovered from 50-60% of hospitalised patients. Non-hospital, community acquired infections in normal, healthy individuals are primarily related to eye, ear, and skin exposure in recreational waters. Primary infections have been ascertained by the United States' Centers for Disease Control (CDC) and others to occur where there has been a failure to maintain a sufficient level of residual disinfectant. The most common infection occurs in settings where *P.aeruginosa* is allowed to grow in plumbing and exposure is through bathing or showering. Typical infection of folliculitis or skin rash may include low-grade fever and other systemic symptoms and could present as lesions on hands and feet (hot hands or hot foot syndrome). Persons with diabetes who are afflicted by *P.aeruginosa* infections can suffer severe and potentially life-threatening complications if untreated. There is increased risk of *P.aeruginosa* pulmonary disease for patients in intensive care with modes of transmission including skin contact with water, aerosols, aspiration, and indirect transfer from moist surfaces with solutions to reducing risk including point-of-use filters and increasing disinfectant residual concentrations.
- ***Naegleria fowleri (N.fowleri)*** ^[66, 67]. Typically it is found in warm water, soil, and drinking water as free-swimming thermophilic amoeba – and harsher environments within a protective cyst form. Human disease is caused when it enters through nerves in the nasal epithelium and infects the host (even those with healthy immune systems) with primary amoebic meningoencephalitis (PAM) which is nearly always fatal. Typical exposure is from swimming or bathing in water containing the organism, but it may also enter via inhalation



or aspiration, or ulcerated or broken skin. In these cases, persons with suppressed or compromised immune systems are at risk of contracting granulomatous amoebic encephalitis.

This document does not specifically consider risk from protozoa such as *Cryptosporidium* and *Giardia*, which are highly chlorine-resistant and cause gastro-intestinal illness^[68]. The risk of infection from these sources within well operated treatment and supply systems is generally very low, but it should be noted that non-potable systems are not expected to be free of these protozoa. Furthermore, drinking water requirements in Australia do not require disinfection of these protozoa^[8]. The only known practical disinfection system that works for all protozoa is ultraviolet (UV) light^[68-75]. Use of UV light to disinfect incoming Healthcare potable water is highly recommended in order to provide a barrier to these organisms, but UV will not provide a disinfectant residual through pipework infrastructure to prevent bacterial regrowth^[22, 25, 29] and is therefore not a focus of this document.

Water Quality supplied to Healthcare facilities

As part of the initial Healthcare facility's WQRMP, the parameters shown in **Table 1** should routinely be monitored at the supply point from the water utility and at distal locations throughout Healthcare facilities.

Table 1

Water quality parameters of interest to Healthcare facility managers

Parameter	Potential Desired Value at Supply Point	Impact if Not Managed	Comment
Chlorine* or chloramines* Residual	≥2 mg/l	Degradation to non-detectable levels	In order to maintain chlorine throughout a all supply locations in a facility, this residual will likely need to be boosted (to ≥2 mg/l) so that a residual of ≥0.5 mg/l can be achieved at all water outlets. Note that water in Queensland has varying levels of dissolved organic matter which may consume chlorine at varying rates throughout the year. Due to this varying demand and decay of chlorine or chloramines residual ^[77-81, 84] , the actual residual in a healthcare setting may change dramatically and must be actively managed.
Turbidity	< 0.1 NTU	No change	A measure of turbidity or "cloudiness" is specified by ADWG to remain <5 NTU. It must be <1 NTU to ensure effectiveness of any applied disinfectants, and <0.2 NTU downstream of filters at a water treatment facility to ensure acceptable reduction in the number of protozoa such as <i>Cryptosporidium</i> and <i>Giardia</i> . Note that the level of turbidity in potable water may increase during extreme storm events.
<i>Acanthamoeba spp.</i> , <i>E.coli</i> , <i>MAC</i> , <i>N.fowleri</i> , <i>L.pneumophila</i> , & <i>P.aeruginosa</i>	Not Detected	Potential increase	Multiplication can occur in pipework that does not contain a disinfectant residual.
Heterotrophic plate count (HPC) bacteria	< 500 cfu/ml	Potential increase	HPCs are an indicator of background bacteriological colonisation of pipework. HPC does not indicate the presence of pathogenic bacteria, but population of all aerobic bacteria. ADWG recommends that drinking water have <500 cfu/ml. The number of HPC will decrease in the presence of a disinfectant residual. It is recommended that Healthcare facility infrastructure be managed such that HPC bacteria remain <500 cfu/ml, and increasing numbers should be interpreted as an indication of deteriorating water quality.
pH	6.5 to 8.5	No change	At low levels (<6.5), water may be corrosive. At high levels (>8.5), precipitation of minerals into pipe infrastructure may occur.

* Note that chlorine residual is significantly different than chloramines residual. The local water purveyor may supply water to the Healthcare facility with either a chlorine or chloramines residual and each of these residuals require different methods of measurement to determine their concentration. If chloramines are present in the water and it is tested for the presence of chlorine, a likely result will be '0 mg/l' when a measurable chloramines residual may actually be present.

Specification, sampling methodology and interpretation of test requirements should be done in consultation with the water utility, Health Department - Water Quality Division, or a water quality specialist.

Free chlorine, pH and turbidity can be conducted on site with appropriate field test equipment and now total microbial levels can be conducted on-site by rapid microbial detection assays. HPC and *Legionella* should be conducted at NATA accredited laboratories with appropriate sampling methods.

Engaging with the Drinking Water Supplier

The drinking water supplier will have a number of points within their network where water quality is monitored. Through discussions with the supplier, it may be possible to have a point at or close to the health facility included as a monitoring point, or even to have the residual chlorine level increased in the entire network. The supplier may also be able to provide alerts in the event of possible water quality problems in the supply.



Identifying Water Quality Risks

Overview

The purpose of this section is to assist managers of health facilities in understanding practices to follow for minimising hazards and risks of their water supply systems within the facility.

With respect to management of water quality, the following documents are relevant:

- Queensland Health (Communicable Diseases Unit) released a document titled “Guide to the Development of a Drinking Water Services Plan (DWSP) for Public Health Care Facilities” in November 2002. This document was intended to apply to all public hospitals and required to be implemented.
- Under the Water Supply (Safety and Reliability) Act 2008, all drinking water service providers (of which, Healthcare facilities may or may not be categorised) are required to develop and implement a Drinking Water Quality Management Plan (DWQMP) and submit these plans to the Department of Energy and Water Supply (DEWS).

The requirement for Healthcare managers to develop a DWSP appears not to have been generally adopted throughout Queensland at the time of completing this document. Queensland Health will seek to obtain clarification from DEWS on the determination of whether Healthcare facilities should be deemed drinking water services providers and then required to submit and obtain approval of a DWQMP. A facility such as a major hospital will have storage, treatment and distribution of water over a large area with end-users. These identifiable characteristics may be the triggers which require a DEWS-approved DWQMP.

There are several risk factors that have been identified in Queensland Healthcare potable water systems. It is recommended that a combination of the above two documents (Queensland Health’s DWSP and the DEWS DWQMP) establish the basis for development of a Water Quality Risk Management Plan (WQRMP) that Healthcare facilities should develop, implement, and actively manage. Some of the key elements that would form the basis of a WQRMP are included in this section. **Appendix C** contains a preliminary framework for a WQRMP. It should also be noted that, if a WQRMP is properly developed following the guidance in **Appendix C**, it would more than likely also be acceptable by DEWS as a DWQMP.

Understanding Facility Risk Factors

For the average healthy person, there is a very low risk of illness due to the presence of expected, background levels of waterborne pathogens in drinking water in Queensland. However, for the immunocompromised and immunosuppressed population, one should interpret health risks from potable water in a different manner. As such, Healthcare facilities face unique risks if microbial water quality remains unchecked. These risks come from the combination of vulnerable patients, complex water supply and reticulation systems, varying operational regimes, and ever-changing occupancy of various buildings, wings, wards, and rooms of any given facility. These facilities can routinely experience a lack of flow at various scales (whole-facility or room-by-room) and resulting microbial colonisation of water lines.

Risk increases due to the higher than normal potential for Healthcare facilities (when compared to smaller buildings or residences) to experience colonisation and multiplication of opportunistic pathogens in their potable water systems. Opportunistic, bacteriological pathogens can colonise and multiply within water tanks, pipelines, plumbing hardware, and inside point-of-use (POU) devices such as sink faucet filters. Colonisation by these organisms is very hard to detect and likely will not cause infection in the short-term. However, if left alone and given the proper environmental conditions (such as warm water (between 20 and 50 °C) with low levels of chlorine residual (<0.5 mg/L) and near-neutral pH (6.5 < pH < 8.5), colonisation can increase to a level which can facilitate biofilm sloughing from pipe and resulting transport of high numbers of pathogens to points of exit from the potable water system.

With regards to the above, Healthcare facilities should implement a WQRMP which may include the following practices in order to better understand their risk factors:

- Employ and/or obtain the assistance of suitably qualified persons who specialise in identifying water quality and building health risk. This is likely to include specialist engineers, scientists or occupational hygienists.
- Develop an understanding of the water quality that the facility receives.



- Institute appropriate and regular water quality monitoring and management.
- Obtain all relevant layout drawings and develop a detailed understanding of the characteristics of the Healthcare facility and its water supply systems. This would include knowledge of the following areas:
 - Determination of supply water quality and if it contains chlorine residual or chloramines residual.
 - How to properly measure chlorine or chloramines residual – depending on which is present at the location sampled – and an understanding of the water chemistry in order to properly add an alternative disinfectant (if desired) or change the residual disinfectant from chloramines to chlorine or otherwise.
 - How to properly inject a chemical disinfectant into Healthcare infrastructure with the capability of avoiding corrosion to areas immediately nearby the chemical injection location (*note there is a high risk of corrosion to copper and steel pipe work nearby an injection point for chlorine if the proper precautions are not taken*).
 - Water infrastructure which remains unused and/or with low flow for 5 (five) days or longer.
 - Water storage that increases retention time and therefore increases microbial risk.
 - How to properly locate, operate, maintain, and monitor (e.g., know that the equipment is working as desired) any water conveyance or quality adjusting equipment such as chemical disinfectant dosing systems, non-chemical disinfectants, screens, filters, backflow prevention devices (such as RPZ/non-return valves), pressure regulating valves (PRVs), thermal mixing valves (TMVs), and others,
 - Defined boundaries of Healthcare facility infrastructure, its major components and where isolating valves are placed. Where possible, secondary connections should be eliminated so that component areas are supplied from a single connection to make it easier to isolate when needed.
 - Pipe systems in areas such as roof spaces or other uncontrolled environments where ambient temperatures may exist that exacerbate microbial growth.
 - Prior to any new or maintenance work being undertaken, identify areas that may be impacted and what measures may be required to protect occupants.
 - Location of key supply-point items such as basins, drinking fountains, showers, baths, spigots, and other outlets.
 - Location of all facility pipeline dead legs (e.g., stub pipe which is longer than twice the pipe diameter and experiences low flow and/or stagnant conditions).
 - Understand where plumbing age is reaching or has surpassed its useful life.
 - Identify vulnerable locations through the Healthcare facilities where patients may have compromised immune systems and may also come into contact with water in various forms (risk depends on the patient exposure, patient immunity, and method of exposure such as by aerosol, ingestion, or by touch).

Routine Preventative Maintenance

Routine preventative maintenance must be included in the WQRMP and is critical to controlling accumulation of microbial contamination in critical parts of the plumbing system, such as, shower heads and basin taps. Key preventative maintenance requirements and factors are listed below:

- Maintain an adequate disinfection residual throughout the facility
- Regularly flush low use areas to prevent stagnation and to increase disinfectant residual
- Use periodic pasteurisation where appropriate.
- Regularly inspect and sanitise RPZs, PRVs, TMVs, shower heads, taps and other critical fittings
- Regular review of sampling results and maintenance schedules
- Apply risk management guidelines in this document
- Perform annual reviews and tests of emergency response processes and procedures
- Actively manage the Healthcare infrastructure with a WQRMP.



Sampling and Testing Requirements

Healthcare facilities must establish routine sampling and testing of specific locations throughout the facility, which will represent the various levels of identified risk. A sampling plan will be a key element of the WQRMP, and will be customised to the nature, characteristics and identified risk areas of each particular Healthcare facility. The WQRMP shall also contain guidance on required actions should any of the parameters fall outside the acceptable limits. **Appendix D** provides more information in recommended methods for sampling planning.

To inform proper development of a WQRMP, the following guidance is provided:

- A robust testing program shall be implemented and repeated at regular intervals (see **Appendix D**).
- Sampling shall occur at strategic representative locations within each building, wing, floor, ward, and room as well as locations that correspond with the facility's risk to house immune-compromised and/or other patients which may be at risk to waterborne pathogens.
- Sampling at locations that are both frequently, and not frequently used,
- Microbial and chlorine residual samples should be sampled from the same taps/locations,
- It is recommended that samples are collected in triplicate methods as much as is possible. This 'triplicate' is meant to include (1) a warm water first flush sample, (2) after 15 seconds of running of the cold water, and (3) after 15 seconds of running warm water (all sampled under normal infrastructure operating conditions and not with any added chemical or physical treatment which is not normally applied). First flush means holding the container under the water outlet and filling it with the first water discharged.



Responding to Water Quality Risks

The charts presented in this section allow the Healthcare manager to assess results from routine monitoring of “High” and “Low” clinical risk areas of the hospital. Results must be collected from hot, warm, and cold water systems in these areas to determine if the system is operating as intended, or if there is a low, medium, high, or very-high microbial risk compromising the system. The process of interpreting results from the Risk and Action charts for either clinical area is similar, and leads to the implementation of responses as outlined. A functional description of the risk levels is provided here:

System Normal	Controls effective
Low	Controls mostly effective, adjust as necessary
Medium	Controls may be failing – investigate and respond
High	Controls are failing and must be adjusted following appropriate investigation and response
Very High	Controls in place have failed and/or are severely inadequate

Methods for the proper use of the following charts include:

1. Identify a location sampled as either a High or Low Clinical Risk Location (depending on patient and staff exposure within that area),
2. Enter the appropriate chart on the following pages in this section of the guidelines and determine (based on the sample results) the microbial risk level at that sampled location,
3. Follow the actions flowchart figures on the pages following each of the two charts in order to properly respond to the microbial risk level that has been identified.

The following information must also be considered when using the below charts:

- Disinfectant residual sampled within the Healthcare facility could be chlorine, chloramines, chlorine dioxide, or a similar type of disinfectant. These disinfectants must be sampled properly, and applied properly. Note that these chemicals should be applied such that downstream residual levels do not exceed the following levels (also see **Appendix B**):
 - Chlorine: 5 mg/l (note this can be dosed above this level)
 - Chloramines: 4.1 mg/l (note this can be dosed above this level)
 - Chlorine dioxide: 0.8 mg/l
- Chlorine residual is different than chloramines residual. The local water purveyor may supply water to the Healthcare facility with either chlorine or chloramines residual and each requires a different method of measurement to determine its concentration. Furthermore, if chloramines are present in the water and the water is tested for the presence of chlorine, a likely result will be ‘0 mg/l chlorine’ while there still may be a measurable chloramines residual present.
- If chloramines are present entering the Healthcare facility and it is desired to change this residual to a chlorine residual, there is a complex understanding of water chemistry required (specifically, with regard to breakpoint chlorination) in order to achieve a proper outcome. A water treatment and/or quality specialist should be consulted to properly achieve breakpoint chlorination.
- The addition of chlorine will corrode copper and steel pipe in the immediate area where it is injected, but is easily mitigated by installation of non-corroding materials near the injection location. A water treatment and/or quality specialist should be consulted to develop methods that will properly protect pipe near chlorine injection sites.

NOTE: Print out the following two pages on A3-sized paper

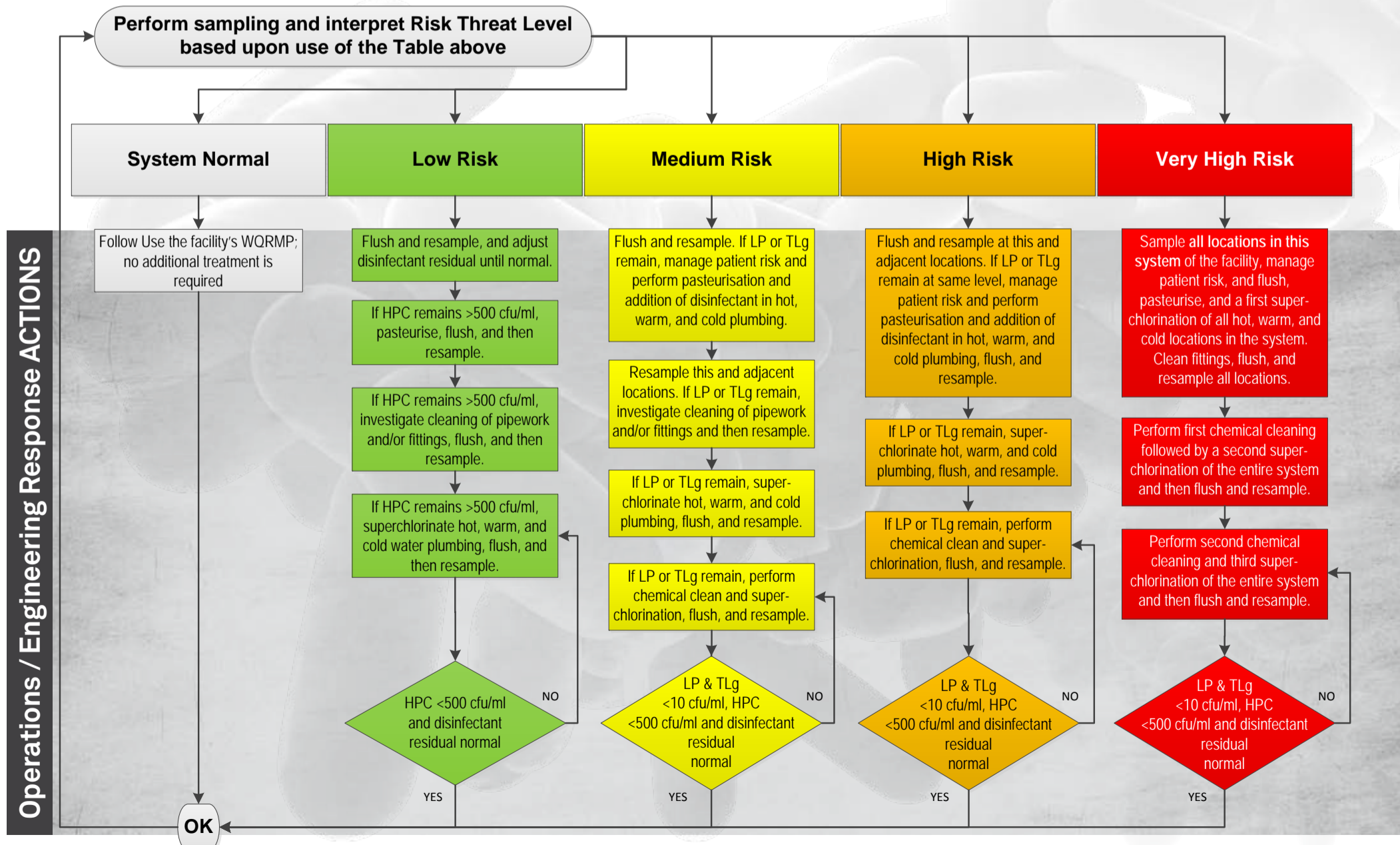


LOW Clinical Risk Locations



Sampling should be performed according to frequencies discussed in Appendix D. The table at the top of this page helps determine risk ratings for your facility's water system (hot, warm, and cold) LOW clinical risk locations. Samples collected in order to properly use this table include disinfectant residual, HPC bacteria, and Legionella. First, find the box at the left of the table which best reflects the results obtained. Next, assign that location with the Risk Threat Level from the next box to the right and follow the clinical response indicated, and note the Operations / Engineering Response at the far right. The flowchart at the bottom of this page can be used by moving vertically downward the appropriate 'Response' path and performing the actions described.

Sampling Results	Risk Threat Level	Clinical Response	Operations / Engineering Response
<p>Cl₂ Cold Water ≥ 0.5 mg/l or Hot Water ≥ 0.2 mg/l AND</p> <p>HPC ≤ 500 cfu/ml AND</p> <p>LP TLg No positive samples</p>	SYSTEM NORMAL	None	Refer to System Normal Actions Flowchart below
<p>Cl₂ Cold Water < 0.5 mg/l or Hot Water < 0.2 mg/l AND</p> <p>HPC > 500 cfu/ml AND</p> <p>LP TLg No positive samples</p>	LOW RISK	None	Refer to Low Risk Actions Flowchart below
<p>TLg ≤ 50 cfu/ml AND</p> <p>LP ≤ 50 cfu/ml</p>	MEDIUM RISK	Yes. Advise local Public health unit or Private Health Regulation Team, as appropriate. Refer to Appendix H.	Refer to Medium Risk Actions Flowchart below
<p>TLg > 50 cfu/ml and ≤ 100 cfu/ml AND</p> <p>LP > 50 cfu/ml</p>	HIGH RISK	Yes. Advise local Public health unit or Private Health Regulation Team, as appropriate. Refer to Appendix H.	Refer to High Risk Actions Flowchart below
<p>TLg > 100 cfu/ml AND</p> <p>LP > 50 cfu/ml</p>	VERY HIGH RISK	Yes. Advise local Public health unit or Private Health Regulation Team, as appropriate. Refer to Appendix H.	Refer to Very High Risk Actions Flowchart below



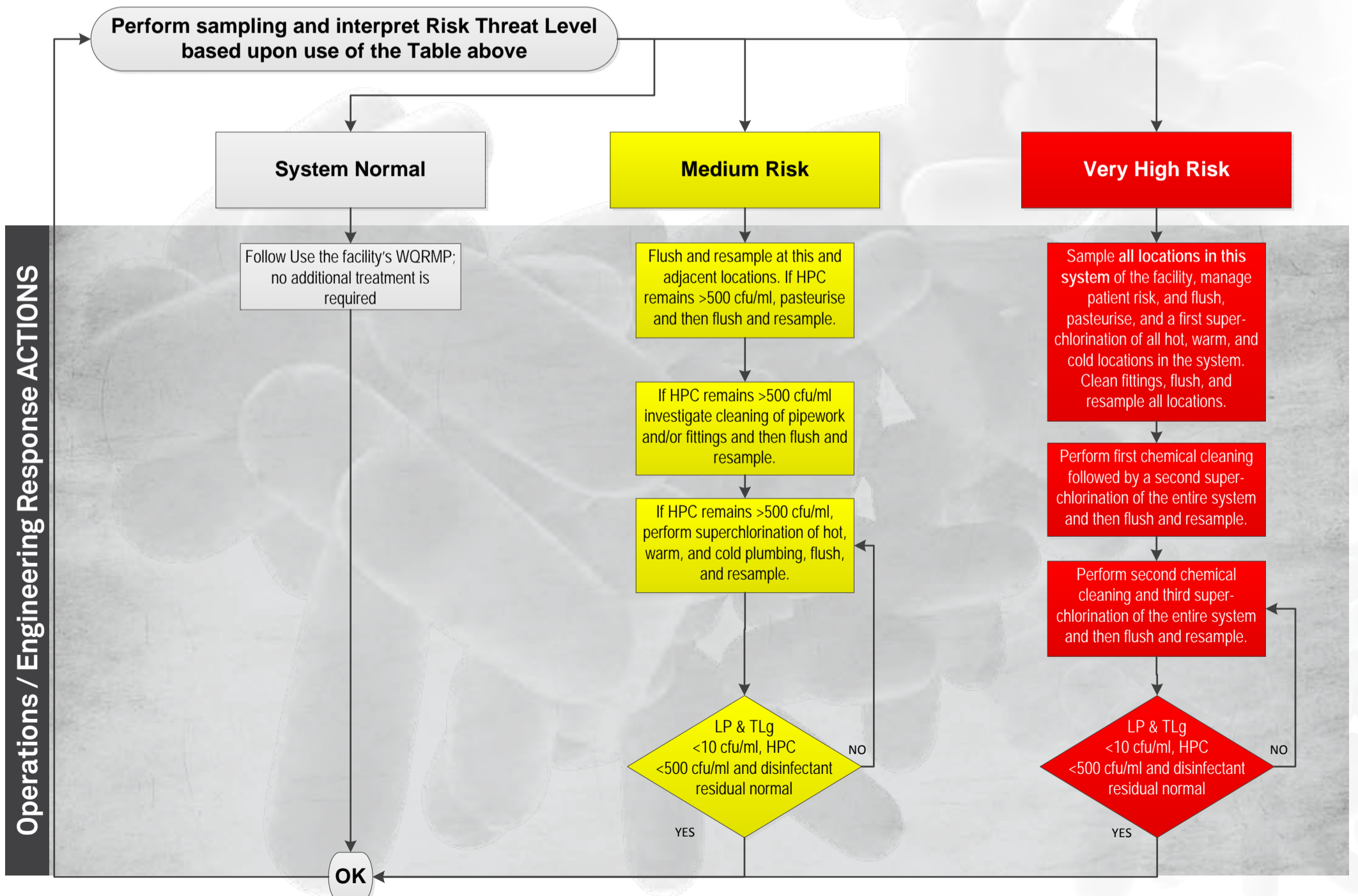
Managing Microbial Quality

HIGH Clinical Risk Locations



Sampling should be performed according to frequencies discussed in Appendix D. The table at the top of this page helps determine risk ratings for your facility's water system (hot, warm, and cold) HIGH clinical risk locations. Samples collected in order to properly use this table include disinfectant residual, HPC bacteria, and Legionella. First, find the box at the left of the table which best reflects the results obtained. Next, assign that location with the Risk Threat Level from the next box to the right and follow the clinical response indicated, and note the Operations / Engineering Response at the far right. The flowchart at the bottom of this page can be used by moving vertically downward the appropriate 'Response' path and performing the actions described.

Sampling Results	Risk Threat Level	Clinical Response	Operations / Engineering Response
<ul style="list-style-type: none"> Cl₂ Cold Water ≥ 0.5 mg/l or Hot Water ≥ 0.2 mg/l AND HPC ≤ 500 cfu/ml AND TLg LP No positive samples 	SYSTEM NORMAL	None	Refer to System Normal Actions Flowchart below
<ul style="list-style-type: none"> Cl₂ Cold Water < 0.5 mg/l or Hot Water < 0.2 mg/l AND HPC > 500 cfu/ml AND TLg LP No positive samples 	MEDIUM RISK	Yes. Advise local Public health unit or Private Health Regulation Team, as appropriate. Refer to Appendix H.	Refer to Medium Risk Actions Flowchart below
<ul style="list-style-type: none"> TLg Any Positive Sample Result OR LP Any Positive Sample Result 	VERY HIGH RISK	Yes. Advise local Public health unit or Private Health Regulation Team, as appropriate. Refer to Appendix H.	Refer to Very High Risk Actions Flowchart below



Glossary

ADWG	Australian Drinking Water Guidelines (2011)
Amoeba	Organisms that can harbour and protect <i>Legionella</i> , allowing them to replicate
ARM	Amoeba-resisting microorganisms
AS	Australian Standard
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
Biofilm	Organic material in pipelines that harbours/protects waterborne pathogens
Bacteria	Organisms that may replicate in the environment or in amoeba
Breakpoint chlorination	Oxidising ammonia to convert combined chlorine residual to free chlorine residual
CCPs	Critical control points (part of the WQRMP)
Chloramines	Chlorine combined with ammonia in which chemical effectiveness is based on pH
Chlorine	Also known as free available chlorine (most effective at lower [<8.5] pH values)
Cl ₂	Chlorine, see free available chlorine
clinical risk	Risk determined on clinical / patient exposure
Combined chlorine	Chlorine that is combined with ammonia to form chloramines
cfu	Colony forming units
Cold water	Water that is received from the public water supply prior to heating
Dead leg	A length of pipe more than twice its diameter with low or stagnant flow conditions
DEWS	Department of Energy and Water Supply
distal	A location at a far-reaching end of the Healthcare facility
DPD	N, N-diethyl-p-phenylenediamine sulfate reagent for chlorine measure
DWQMP	Drinking Water Quality Management Plan (for DEWS requirements)
DWSP	Drinking water services plan
FAQ	Frequently asked question (see Appendix A)
FLA	Free living amoeba
Free available chlorine	Chlorine that is not combined with ammonia and exists in water in residual form
HAAs	Haloacetic acids
HACCP	Hazard Analysis Critical Control Point
HAZOP	Hazard and Operability
HEALTHCARE	Hospital and health care
HHS	Hospital and Health Service
Hot water	Water that is kept above 60 °C
HPC	Heterotrophic plate count
Legionella	Aerobic bacterium which will multiply in number in warm water
Legionellosis	Any illness caused by exposure to legionella
<i>L.pneumophila</i>	Causative <i>Legionella</i> species for Legionnaires' disease



MAC	Mycobacterium avium Complex
mg/l	Milligrams per litre
µg/l	Micrograms per litre
LP	<i>Legionella pneumophila</i>
ml	Millilitre
NATA	National Association of Testing Authorities
NH ₂ Cl	Monochloramines (chlorine combined with ammonia), see combined chlorine
NTM	Nontuberculous Mycobacteria
NTU	Nephelometric turbidity unit
Nutrient	A food source for microorganisms
PAM	Primary amoebic meningoencephalitis
Pasteurisation	Heat treatment above 70 °C with a goal of inactivating microorganisms
PFD	Process flow diagram
Potable water	Water that is fit for the purpose of drinking and other related uses
ppm	Parts per million, which is equivalent to mg/l with respect to water
ppt	Parts per trillion, which is equivalent to µg/l
RPZ	Reduced pressure zone (non-return valve)
Snapshot sampling	A 2013 event where Queensland Healthcare facilities were sampled for legionella
THMs	Trihalomethanes
TLg	Total legionella
TMV	Thermal mixing valve
Total chlorine	The combined measurement of free and combined chlorine
UV	Ultraviolet (as in UV light disinfection)
Warm water	Water which is artificially heated up to 60 °C
Waterborne	Originating or related to water
WQMP	Water Quality Management Plan (for water purveyors), similar to DWQMP
WQRMP	Water Quality Risk Management Plan for Healthcare managers (see Appendix C)



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Appendix A

Practical Application of Guideline and Frequently Asked Questions

Practical Application of Guidelines And Frequently Asked Questions

Question	Response and/or Section Discussed
What is Legionella?	See page 5.
How do I establish whether I have a problem	Develop a WQRMP (Appendix C) and follow 'response' recommendations in the section titled "Responding to water quality risks."
What do I do if my water system tests positive?	Follow section titled "Responding to water quality risks."
What are my treatment options?	Information provided in section 5, and Appendices B,E, F, and G.
How effective is pasteurisation?	It is not as effective as superchlorination or other chemical application, see Appendix E.
I receive water from a recognised water authority. Does that mean that that I do not have a problem?	No. Water purveyors do not guarantee water quality and are not required to deliver water that is free of microbial contaminants. You are responsible for monitoring and maintaining your infrastructure water quality.
I know about Legionella in air-handling systems. Is this different?	In terms of transmission of Legionella – yes. This document describes management of risk due to potable water systems.
I have been offered a disinfectant – Can I go ahead and install it?	Not all disinfectants will work in all locations, and it is likely that each facility will require variations in design requirements for disinfectants so that they can be used in the most effective manner. You are encouraged to engage with an experienced disinfection system design specialist to assist with implementing the appropriate disinfection type and design.
I have been offered device which I am told either prevents growth of, or kills Legionella – Should I go ahead and install it?	Some assistance is offered in Appendix B. There are many devices which work well in cooling tower and air handling systems which are not expected to work well in potable water infrastructure. It is advised that you engage with independent disinfection specialists in order to gain proper advice.
Is this a final document? The title suggests that it is an interim guideline. How far from a final document is it considered to be?	This document was initially developed is for interim use only to respond to the snapshot program. It has been revised into a preliminary guideline which is expected to be improved in subsequent versions. The expected subsequent versions will build upon the information provided in this version.
Why does this document include discussions on organisms and monitoring parameters other than <i>Legionella</i> ?	Due to concerns over water quality, the approach listed in the guidelines was to both provide further information as well as identify other potential microbial risk in potable water at hospital. The intended overall approach is to provide guidance toward a proper level of care for potable water infrastructure. The rationale for variance from other guidelines is partially because water quality in Queensland is both significantly different than that in other regions where legionella regulations exist (such as in NZ, UK, Canada, and US) and there is variable seasonal water quality throughout the State which may cause elevated microbial risk in Healthcare water infrastructure. In order to understand and be assisted with managing this risk, these guidelines are significantly different than many other existing, contemporary guidelines.



<p>Do I need to shut-down my water system to implement recommendations in these guidelines?</p>	<p>Regarding impacts on service disruption, it is the intent of these guidelines that they can be implemented with minimal disruption to service. Such practices as pasteurisation, cleaning, and superchlorination would need to be conducted with adequate isolation of the system. However, this should be able to be conducted during low-use periods (e.g., at night) while maintenance-level residual disinfection can be conducted regularly during normal use of the system.</p>
<p>Is there a typical procedure for developing the total number of samples that a facility should collect?</p>	<p>Each 'building' should be considered a 'water system' and each 'water system' should have multiple locations within it which are sampled for these various water quality parameters. The samples are therefore water samples, and they would be collected from various locations such as shower heads, hand wash basin faucets, sink faucets, and other areas both within patient rooms and elsewhere. The total number of samples would vary from one facility to another, with the number of samples a reflection of the complexity of the Healthcare campus (number of buildings, rooms, sample locations, and high risk areas).</p>
<p>Does this guideline apply only to hot water systems?</p>	<p>No, this guideline applies to all potable water systems – which include hot (>60 °C), warm (after TMV and <60 °C), and cold.</p>





Appendix B

Available Technologies and Treatment Methodologies

Available Technologies and Treatment Methodologies

The following information has been expanded based upon that previously published [18, 51].

Item	Disinfection Systems							Combined Disinfection Systems		
	Super Heating ¹ and Flushing	Chlorine	Chloramines	Chlorine Dioxide	Copper-Silver Ionisation	Ozonation	UV Disinfection	UV Disinfection ² & Chlorine	UV Disinfection & Chloramines	UV Disinfection & Chlorine Dioxide
Cold Water	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hot Water	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Chemicals Used	No	Sodium hypochlorite	Sodium hypochlorite and ammonium chloride (or ammonium sulphate)	Chlorine and chlorite to form sodium chlorite	Forced corrosion of sacrificial copper and silver (metals) which are dissolved in the water supply	No. Generated on-site, no bulk chemicals to be stored.	No, generated by a mono or polychromatic UV lamp apparatus	See columns at the left	See columns at the left	See columns at the left
Chemical by-products created or expected from the product used	None	Disinfection by-products (trihalomethanes [THMs], haloacetic acids [HAAs]) and possible impurities such as chlorate, perchlorate, and bromate.	Disinfection by-products (trihalomethanes, haloacetic acids) and possible impurities such as chlorate, perchlorate, and bromate.	Disinfection by-products (chlorite and chlorate) and possible impurities such as additional chlorate, perchlorate, and bromate.	Copper and silver.	Biodegradable by-products (such as aldehydes, carboxylic acids, and aldo-keto acids) and possibly bromate	None	Disinfection by-products (trihalomethanes, haloacetic acids) and possible impurities such as chlorate, perchlorate, and bromate.	Disinfection by-products (trihalomethanes, haloacetic acids) and possible impurities such as chlorate, perchlorate, and bromate.	Disinfection by-products (chlorite and chlorate) and possible impurities such as additional chlorate, perchlorate, and bromate.
Effective pH	None	>7, <7.5	>8.5, <9	>8, <10	8	N/A ³	N/A	>7, <7.5	>8.5, <9	>8, <10
Aesthetics related issues (tastes, odour, clarity)	None	Chlorinous tastes and odours can occur when residual >3 mg/l.	Chlorinous tastes and odours can occur when residual >3 mg/l.	Must remain below 0.8 mg/l or cat-urine type tastes and odours may occur.	Potential for black-water clarity problems.	The decomposition of dissolved ozone, if not properly removed, will cause odour problems downstream.	N/A	Chlorinous tastes and odours can occur when residual >3 mg/L	Chlorinous tastes and odours can occur when residual >3 mg/L	Must remain below 0.8 mg/l or cat-urine type tastes and odours may occur.

¹ Similar to pasteurisation

² UV disinfection systems may destroy residual chlorine, chloramines, or chlorine dioxide therefore UV disinfection must be placed upstream of the addition of these chemicals.

³ N/A = Not applicable

Item	Disinfection Systems							Combined Disinfection Systems		
	Super Heating ¹ and Flushing	Chlorine	Chloramines	Chlorine Dioxide	Copper-Silver Ionisation	Ozonation	UV Disinfection	UV Disinfection ² & Chlorine	UV Disinfection & Chloramines	UV Disinfection & Chlorine Dioxide
Potential for Impact to Equipment and Systems	Low (as long as risk prevention to burns from heated water is properly managed).	Moderate (localised corrosion, increased rate of changeout for activated carbon [GAC] filters upstream of dialysis and other sensitive equipment).	Moderate (localised corrosion, increased rate of changeout for GAC filters upstream of dialysis and other sensitive equipment).	Moderate (localised corrosion, increased rate of changeout for GAC filters upstream of dialysis and other sensitive equipment).	Unknown to Moderate (potential deposition of copper on steel pipe with localised corrosion).	Moderate to High (A residual ozone will rapidly corrode all metals except for 316-stainless steel).	Low to Moderate Some high-intensity UV lamps can generate a dissolved residual of ozone in water (see ozonation column).	Moderate (dissolved ozone from high-intensity UV lamps, localised corrosion, increased rate of changeout for GAC filters upstream of dialysis and other sensitive equipment).	Moderate (dissolved ozone from high-intensity UV lamps, localised corrosion, increased rate of changeout for GAC filters upstream of dialysis and other sensitive equipment).	Moderate (dissolved ozone from high-intensity UV lamps, localised corrosion, increased rate of changeout for GAC filters upstream of dialysis and other sensitive equipment).
Issues related to the Impact on Dialysis Equipment	Heated water must not be passed through treatment equipment upstream of dialysis units.	Residual must be kept below 4 mg/l and the RO equipment must be operated to effectively remove chlorine by-products.	None, as long as residual is kept below 2 mg/l and GAC filters upstream of dialysis are designed to reduce chloramines residuals.	None, as long as residual is kept below 0.8 mg/l and GAC filters are properly designed to remove it and GAC/RO can remove all by-products as well.	Unknown	None, as long as ozone residual is not carried through HEALTHCARE infrastructure (note this requires a separate, upstream ozone contactor system).	None	Residual must be kept below 4 mg/l and the RO equipment must be operated to effectively remove chlorine by-products.	None, as long as residual is kept below 2 mg/l and GAC filters upstream of dialysis are designed to reduce chloramines residuals.	None, as long as residual is kept below 0.8 mg/l and GAC filters are properly designed to remove it and GAC/RO can remove all by-products as well.
Effects and Challenges for Human Health and Environment	Heated water has potential to burn users of the system.	While high levels are used for off-line cleaning, any unanticipated exposures could result in moderate to severe irritation to skin and mucus membranes. Long-term residual maintenance would cause exposure to THMs and HAAs similar to or exceeding acceptable drinking water levels.	High levels would not be used as chloramines at high levels are not stable. Use of long-term residual maintenance would cause exposure to THMs and HAAs which are similar or exceed levels in drinking water.	High levels would not be used as chlorine dioxide at high levels is not stable. Use of long-term residual maintenance would cause exposure to chlorite and chlorate which may be similar or exceed levels in drinking water.	Long-term use may promote continuous elevated levels of copper, which may be toxic at levels as low as 50 ppb, which may inhibit the practical use of such a system in a potable water environment.	Residual maintenance is required (as above) and long-term exposure to bromate may be similar to or exceeding acceptable drinking water levels.	None	While high levels are used for off-line cleaning, any unanticipated exposures could result in moderate to severe irritation to skin and mucus membranes. Long-term residual maintenance would cause exposure to THMs and HAAs similar to or exceeding acceptable drinking water levels.	High levels would not be used as chloramines at high levels are not stable. Use of long-term residual maintenance would cause exposure to THMs and HAAs which are similar or exceed levels in drinking water.	High levels would not be used as chlorine dioxide at high levels is not stable. Use of long-term residual maintenance would cause exposure to chlorite and chlorate which may be similar or exceed levels in drinking water.

Item	Disinfection Systems							Combined Disinfection Systems		
	Super Heating ¹ and Flushing	Chlorine	Chloramines	Chlorine Dioxide	Copper-Silver Ionisation	Ozonation	UV Disinfection	UV Disinfection ² & Chlorine	UV Disinfection & Chloramines	UV Disinfection & Chlorine Dioxide
ADWG- Approved Disinfectant	No	Yes (below 5 mg/l)	Yes (below 4.1 mg/l)	Yes (below 0.8 mg/l)	No	No	No	Yes (below 5 mg/l)	Yes (below 4.1 mg/l)	Yes (below 0.8 mg/l)
Use as One- Time High- Dose for Reducing Biofilm (System Not Operating)	May reduce biofilm, but likely will not remove all biofilm.	Works well if applied at a range of 20 to 50 mg/l for a duration of hours.	Cannot be applied at high levels.	Cannot be applied at high levels.	Does not work at high levels. ¹⁷⁶¹	Cannot be applied throughout an entire pipeline system at high levels.	No	Works well if applied at a range of 20 to 50 mg/l for a duration of hours.	Cannot be applied at high levels.	Cannot be applied at high levels.
Use as a Residual Maintenance Chemical to Prevent Biofilm Growth	No	Yes	Yes	Yes	Possibly for short lengths of pipe. ¹⁷⁶¹	No	No	Yes	Yes	Yes





Appendix C

Water Quality Risk Management Planning

Water Quality Risk Management Planning

Methodology for Minimising Waterborne Microbial Risk in Water Systems

Background

Effective prevention and control of waterborne pathogenic risk can be achieved in Healthcare building water systems via a systematic approach to the anticipation, recognition, assessment, evaluation and control of these risks. That is, to adopt a preventative management approach that covers all stages of the Healthcare potable water infrastructure. An approach commonly applied to managing water quality in different industries is to develop and implement a framework for risk management. This regularly takes the form of a WQRMP which provides a risk-based approach to the identification and management of public health risks for the water supply system. WQRMPs provide a robust, transparent and defensible process that facilitates a comprehensive assessment of the supply system, ensuring that water quality risks are well understood and prevented or mitigated.

Risk Management Drivers

There are a range of approaches and standards that relate to the development of the risk management plan; however the fundamental drivers are consistent. These frameworks generally contain the following core elements:

- Commitment to drinking water quality management
- System risk analysis and management
- Supporting requirements
- Implementation and review.

These frameworks guide a structured and systematic approach for the management of water quality and allow for water system managers to adapt the requirements to suit their specific context. It is important that application of such frameworks does indeed consider the context of the water supply system and should be tailored to the appropriate scope and draw on the relevant resources. As such there is no 'universal solution' but rather these frameworks provide the user with an approach to develop a WQRMP that specifically addresses the scope, needs and operating context of the water supply manager.

Water Quality Risk Management Tools

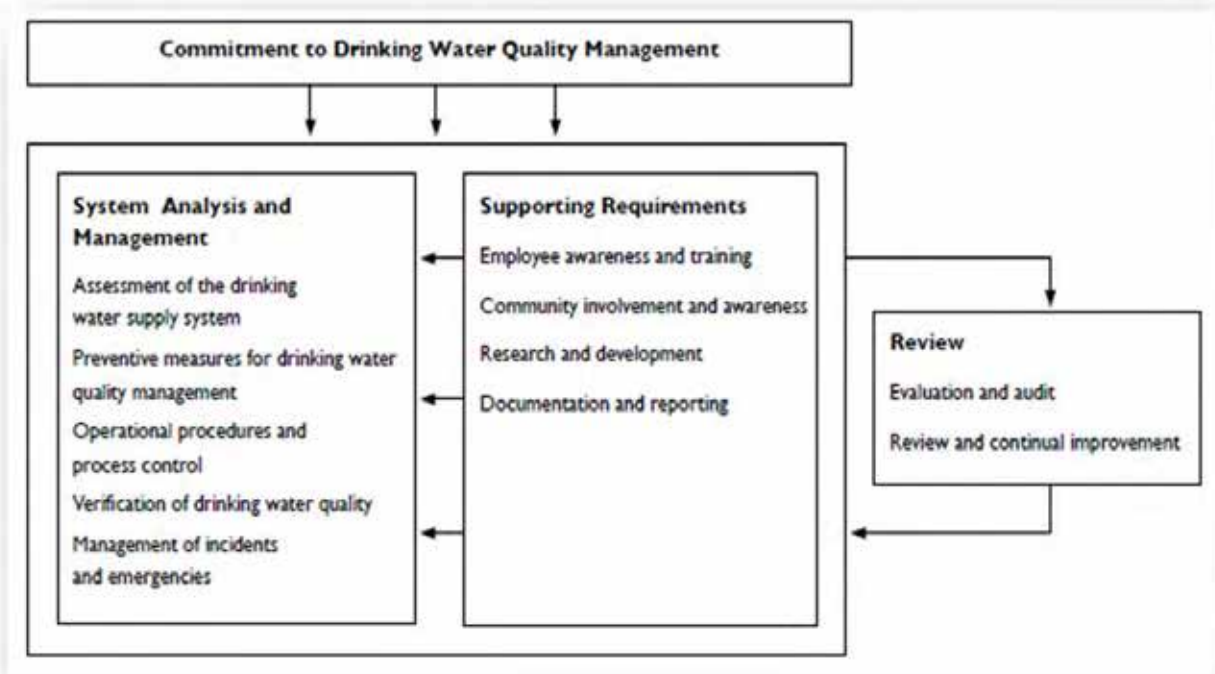
Water utilities in Australia commonly adopt (and in some states are regulated to adopt) the ADWG Framework for the means of effectively managing potable water quality. This framework has been specifically developed for the management of drinking water quality in Australia and as such provides a less generic road map than other more broad risk management frameworks. The ADWG Framework incorporates key elements of other risk management systems such as Hazard Analysis Critical Control Point (HACCP), ISO 9001 and AS/NZS risk management standards, but applies them with a drinking water supply context. A high level overview of the key elements of the ADWG Framework is presented in the diagram below.

In the context of building potable water infrastructure, there is a need for building managers to take a structured pro-active approach to risk identification and mitigation of risks to protect against microbial pathogens that may colonise potable water systems (hot, warm, and cold). This need for a comprehensive over-arching framework coupled with a site-specific implementation is reflected in the more recent / pending guidelines on *Legionella* control in building water systems from overseas sources, such as World Health Organisation (WHO) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

The most efficient method anticipated for Healthcare infrastructure managers to develop an effective and robust WQRMP is to adopt the ADWG Framework while drawing on relevant building specific guidelines internationally relating to *Legionella* control in building water systems. Examples of such international standards are the 2007 and 2011 WHO documents and the recent Draft Standard from the ASHRAE. The ASHRAE Draft Standard 188P and the WHO documents, like the ADWG Framework, apply the well-established concepts from HACCP risk analysis and management methodologies to the assessment and management of safe building water systems which can be tailored to the needs of any institution. As the ADWG Framework (and therefore the principles of HACCP) is commonly employed for risk management of drinking water supplies by water utilities, the adoption of this framework provides the added benefit of having a consistent language and approach as the water utilities that provide water supply services to the Healthcare facilities. Additionally, the ADWG Framework can be readily adapted to suit the size and scope of any Healthcare facility whether it be large, small, old, new, a hospital, or an aged care facility.



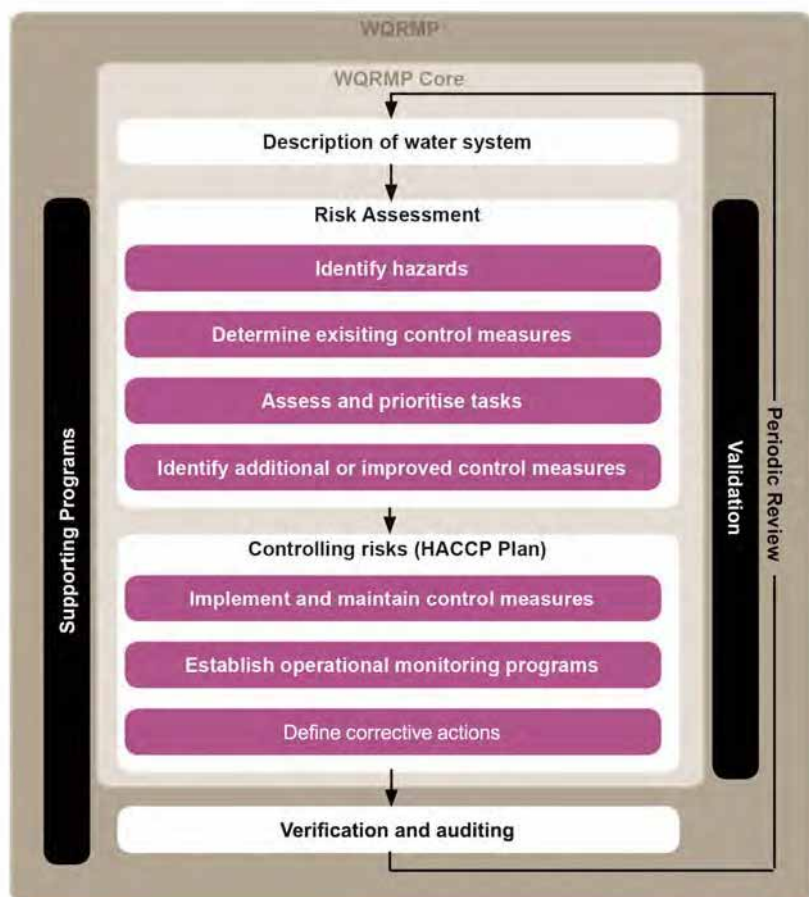
An overview of the ADWG Framework is provided in the following flowchart:



WQRMP Approach

To achieve a systematic approach for controlling microbial risks in Healthcare infrastructure, implementation of the ADWG framework incorporates a HACCP risk management approach for the development of a WQRMP. A high level approach of how Healthcare managers could develop a WQRMP suitable to manage potable water supply at their facility is provided in this section.

Effectively and proactively managing water quality risks is the key objective of developing a WQRMP. As such, Healthcare managers should initially focus efforts towards understanding and developing strategies in minimising water quality risks presented in their facilities' potable water systems. This is the core of the WQRMP and is defined in the ADWG Framework as the water quality risk assessment and HACCP Plan. The diagram to the right presents the elements of a WQRMP, focusing on the activities required to address these core elements.



WQRMP Core Elements

Healthcare managers should address the core elements of the WQRMP first and then progressively develop the remainder of the WQRMP around these core elements. Ultimately, the outcome of addressing these core elements would be a set of risk management priorities identified and documented in a HACCP Plan. This HACCP Plan should clearly document these risk management priorities (termed Critical Control Points, CCPs), how they will be monitored and controlled, and the planned corrective actions to be employed where there has been a loss of control.

An example of a portion of a HACCP Plan template is provided here:

CCP	Process Step	Hazardous Events	Hazard	Monitoring Unit	Control Measures	Target Criteria, Alert Limits, Critical Limits	Monitoring & Monitoring Procedures	Corrective Actions	Responsibilities & Authorities
CCP1									
CCP2									

Healthcare managers should address these core elements of the WQRMP as a priority and then progressively develop the remainder of the WQRMP around these core elements. After addressing core elements, efforts would then shift to develop the remainder of the requirements of the WQRMP.

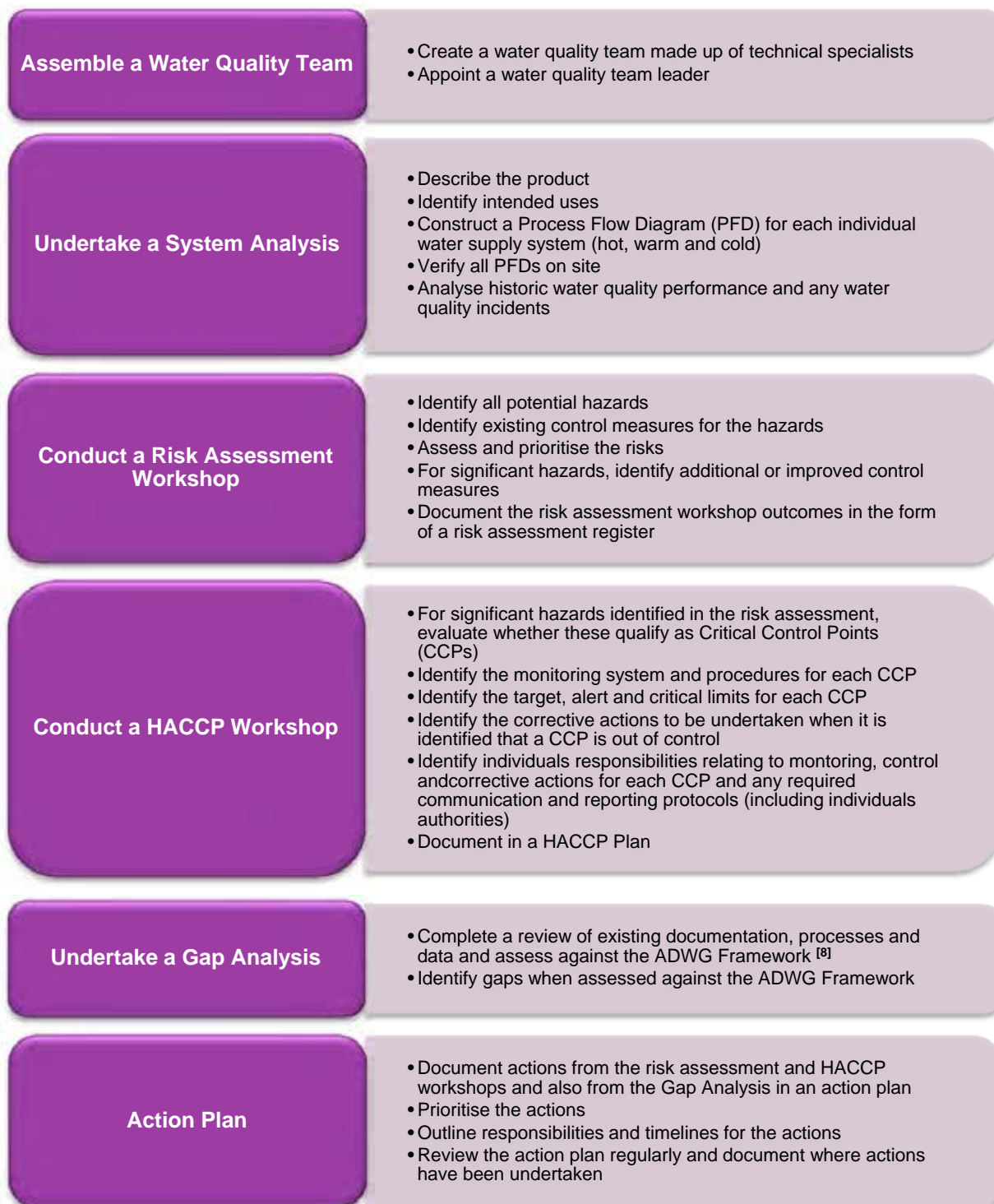
Remainder of the WQRMP

The flowchart below (on the next page) provides a high level approach that Healthcare managers should undertake to develop the whole WQRMP in a staged and prioritised manner. As mentioned above, the process firstly addresses core elements discussed above and then progressively develops the remainder of the plan around this core. The steps documented in the flow chart are sequential, with each being reliant or informed by the prior step. For example, the system analysis should bring all of the relevant information together to inform and provide the basis for the risk assessment process and the outcomes of the risk assessment process will inform CCP analysis.

In order to effectively and successfully undertake the development and implementation of the WQRMP, Healthcare managers need to firstly identify or appoint a trained, experienced, team leader who is knowledgeable in this process. This leader must be assisted by a multidisciplinary team of technical and practical specialists which include those that have knowledge of the building water system(s) being assessed as well as those that have experience in water quality management. This team would be responsible for developing, implementing and regularly reviewing the WQRMP.



WQRMP approach and staging flowchart





Appendix D

Sampling and Testing




Sampling and Testing

This Appendix should be read in conjunction with Sampling and Testing Requirements described on page 10 of this report. Water samples for disinfectant residual, HPC bacteria, *Legionella pneumophila* and total *Legionella spp.* must be collected at each representative locations throughout the Healthcare facility campus. The boxes below indicate that the following areas must be sampled:

- All known sources from local Council,
- Each water storage tank,
- Representative samples (that include high- and low-clinical risk areas) from each floor of each building.

Representative samples from each floor of each building should include patient rooms, however, a greater majority of samples should come from rooms that are considered to be high-risk clinical areas. Each room that is sampled should include hot, warm, and cold water conditions at various water taps, and each room sampled that has a shower MUST have the shower sampled. Sampling should include a majority of locations that are at far-reaching locations in each of the buildings (e.g., far downstream from where the building is supplied fresh water).

Microbial samples should be collected in approximately 250 ml sterile bottles, preserved with sodium thiosulphate, kept on ice, and shipped the same day to the laboratory. Analyses should be conducted by a NATA accredited laboratory. Free chlorine is best tested on site. It should be noted that significant time is required to obtain results (3-7 days for HPC, and 5-10 days for *Legionella*). Rapid bacterial tests (to provide information similar to HPC measurements) can also be made.

For the Healthcare Facility Campus	For Each Floor in Each Building	For Each 'Representative' Room Sampled
<ol style="list-style-type: none"> 1. All known council water sources, 2. Each water storage tank prior to entering the building(s), and 3. Collect representative samples from each floor in each building 	<ol style="list-style-type: none"> 1. A representative number of patient rooms, 2. A representative number of non-patient rooms, 3. A representative number of each hot, warm, and cold water samples from the rooms sampled, and 4. A representative number of first-flush and steady-state water samples for each of the water temperatures. 	<ol style="list-style-type: none"> 1. Collect samples from EACH shower head, and 2. Collect random samples from other locations such as wash basins, bath tubs, toilets, service taps, sinks, and other water spigots. 

A sampling 'event' at the Healthcare campus should be conducted at least as frequently as is stated here:

1. Quarterly (if conditions remain in 'System OK' Risk),
2. Fortnightly (For locations where 'Low Risk' results are obtained for microbial samples)
3. Weekly (For locations where 'Medium Risk' results are obtained for any samples)
4. Daily (For locations where 'High Risk' and 'Very High Risk' results are obtained for any samples)

It should also be noted that disinfectant residual should be monitored continually. If free or total chlorine is the disinfectant used, it must be monitored using (at minimum) DPD-based hand-held chlorine analyser equipment. It is also recommended that high-risk facilities install on-line (automated/continuous) sampling to allow continuous risk management. This automated equipment must also use DPD technology in order for disinfectant residual to be accurately and reliably monitored. It must be also understood that measurement of free and total chlorine residual requires the use of different analytical techniques. If incorrect techniques are used (such as using free chlorine residual methods when total chlorine residual is present), results will be inaccurate.





Appendix E

Pasteurisation

Pasteurisation

This is the process of heat-treating areas with the intent to kill but not remove bacteria which may be present. It is highly likely that pasteurisation will not fully eradicate bacteria which have formed attached colonies to pipelines and is only recommended if chemical disinfection is not an immediately available option to the facility management. Once pasteurisation is practiced, chemical disinfection must be used as a follow-up measure unless monthly follow-up samples from the immediate and surrounding areas show no positive detection of *L. pneumophila* or total *Legionella spp.*

Safety:

Take all necessary precautions to protect building staff, visitors and patients from the risk of exposure to hot water. Consult your facility's WQRMP. Special precautions are needed for patients with peripheral neuropathy who may not be able to feel pain or heat.

Practice:

Send hot water through all affected warm and cold water pipe. This would entail meeting the following criteria:

1. From detailed plumbing diagrams and facility manager knowledge, confirm the likely efficacy of the pasteurisation strategy.
2. Obtain a temperature of no less than 70 °C at the furthest, distal point and at the sample location, and maintain that temperature continuously and at a reasonable rate of water flow for no less than 10 (ten) minutes. This will likely require the increase of water temperature in the heated water tanks to exceed 80 °C. Ensure that the building has the hot water capacity to achieve pasteurisation.
3. All outlets are to be flushed according to No.1, above, individually. However, outlets on individual branches from main supply lines (e.g., hand basins and showers in one room) should be flushed simultaneously.
4. If 70 °C cannot be maintained per the above recommendations, it is advised that the fixtures be closed to patients and staff until chlorination and/or cleaning be conducted and any subsequent coloured water (due to the cleaning process) be completely flushed from the system.
5. Following treatment of >70 °C water as outlined above, perform verification sampling and next steps to implement cleaning (see Appendix F) as well as conducting all other related WQRMP recommendations.
6. If treatment efficacy confirmation time is critical, such as for High Clinical Risk Locations, rapid bacteriological tests may be helpful.





Appendix F

Cleaning of Pipework

Cleaning of Pipework

This is the process removing microbial coatings and accumulations in the plumbing system. The most common and effective is the use of strong alkaline detergent. Careful professional assessment of the plumbing system, fittings and associated equipment – as well as for the control and prevention of chemicals being sent to unintended locations in the plumbing system (by use of non-return valves, etc.) is required to prevent damage from corrosion and avoid unintended exposure to persons in the building. Equipment needs to be disconnected during this process and/or their warranties checked to be sure that they are not exposed to chemicals at a level which will damage them. Maximum slug doses should be circulated for 30 minutes and then run to soak in all terminal fittings for one hour. Expect discoloured water. Terminal fittings should then be flushed until reaching below pH 8 before conducting superchlorination. If possible, this process should be repeated after superchlorination up to 3 times, depending on age and contamination of the system. After repeating this process 3 times, clear water should be expected. It is recommended that the process be first conducted by specialists or suitably trained and competent personnel.

Safety:

Even though diluted into the system water, the residual alkaline detergent is corrosive and can cause serious harm if not managed properly. Do not use alkaline solutions until the chemical's material safety datasheet is reviewed, understood, and continually made available for further review where the concentrate is being stored and used. Take all reasonable and necessary precautions to protect building staff and patients from the risk of exposure to the alkaline detergent and/or any other cleaning or disinfecting chemicals that are to be used (note that this includes the installation of reverse flow protection devices and injection points in a manner such that areas of the facility can be isolated for proper, individual cleaning events). A Job Safety Analysis is required for this process.

Practice:

Develop a Job Safety Analysis. Wear appropriate PPE. Send alkaline detergent dosed in water through all affected areas. In all facilities – especially those that are > 20 years of age – plumbing should be checked by a licensed plumber to be in acceptable operating condition and free of excessive corrosion or wear. Using alkaline detergent as a cleaning treatment would entail meeting the following criteria:

1. Obtain an appropriate concentration (pH 10) at each sample location, and maintain that residual continuously for no less than 30 minutes.
2. Ensure that cleaning chemical is in both cold and hot circuits and compatible fittings.
3. Flush until pH 8 is achieved
4. Record the degree of contamination (by noting water colour and particulate matter) flushed from each fitting.
5. Superchlorinate (as per Appendix G) and repeat cleaning till there is no visible contamination (discoloration) remaining. This may take 3 cycles or require repeat cycles at convenient times.
6. Flush until achieving $6.5 < \text{pH} < 8.5$ and free chlorine $< 5 \text{ mg/l}$ are achieved.





Appendix G

Superchlorination and Residual Disinfection

Superchlorination and Residual Disinfection

This is the process of disinfecting areas with the intent to kill bacteria which may be present in suspended or recently settled form. Disinfection with chlorine (or an equivalent disinfectant) is more likely to be effective in areas that have allowed bacteria to grow if a detergent cleaning precedes application. Once chlorination (or equivalent) cleaning is completed, the system should be exposed to a constant, low-level residual of an accepted potable water disinfectant e.g. no more than 5 mg/l as indicated in the ADWG [6]. Monthly follow-up samples from the immediate and surrounding areas must be conducted and show no positive detection of *L. pneumophila* or other *Legionella spp.*

Background

It should be noted by Healthcare facility managers that if sodium hypochlorite is injected into copper or steel plumbing, the appropriate engineering precautions are necessary to protect metal at the immediate location and within the chemical mixing zone immediately downstream from injection. At these locations, the level of chlorine will be variable and high enough to corrode copper and steel. The injection location and a length of pipe following injection should be protected by either a plastic lining or replacement with plastic pipe. Downstream of this area, chlorine residuals at or less than 5 mg/l are not expected to pose an excessive corrosion burden to infrastructure. It is also important to conduct a detailed audit of the facility to determine location of all fixtures containing aluminium or zinc and sensitive equipment such as ice and coffee machines, instant heating devices, dialysis equipment and pre-treatment equipment, and clinical equipment.

Safety:

Sodium hypochlorite (used for establishing a chlorine residual) is an oxidiser and should not be placed into contact with ammonia or oxidisable material. Do not use chlorine solutions until the chemical's material safety datasheet is reviewed, understood, and continually made available for further review where the chlorine is being stored and used. Take all reasonable and necessary precautions to protect building staff and patients from the risk of exposure to chlorine and/or any other cleaning or disinfecting chemicals that are to be used (note that this includes the installation of reverse flow protection devices in a manner such that areas of the facility can be isolated for proper, individual cleaning events).

Practice:

Send chlorinated water through all affected areas. In all facilities – especially those that are >20 years of age – plumbing should be checked by a licensed plumber to be in acceptable operating condition and free of excessive corrosion or wear. Also, proper controls must be put in place to prevent chemicals being sent to unintended locations in the plumbing system (by use of non-return valves, etc.). Chlorination disinfection process that should meet the following criteria:

1. Obtain a free chlorine residual of no less than 10 mg/L at each sample location, and maintain that residual continuously and at a reasonable rate of water flow for no less than 10 (ten) minutes. Note that this may require several things:
 - a. Conducting a pre-chlorine dosing pipe cleaning by using an alkaline detergent. This will help break apart any microbial deposits in the pipe network and allow chlorine to better penetrate and disinfect any possible sediment, deposits, and heavy biofilms that may be hard to reach with chlorine alone.
 - b. Dosing of chlorine at a level much greater than 10 mg/l for a long duration until the far-reaches of buildings are able to reach a consistent, measurable residual of 10 mg/l.
 - c. Use of chlorine residual testing strips that can measure 10 mg/L and greater levels of chlorine.
2. Once the 10 mg/l is reached at the furthest point in the system and is maintained for at least 10 minutes in free-flowing water, keep this elevated level of chlorine held within the piping system for at least two hours by shutting off all taps. Following this duration of at least two hours, flush the system to remove the high chlorine solution.
3. Repeat the above chlorination (each time preceded by the detergent cleaning practice, if desired), a minimum of 2 (two) times (three total cycles of treatment are recommended).
4. All outlets are to be flushed following this practice. After completed, it is highly recommended that the facility is able to then achieve a measurable, residual level of chemical disinfectant at all water taps and showers.



This residual can either come from the water being supplied by the local water purveyor or installed within the health care facility. Acceptable drinking water disinfectants and how they are to be used to provide acceptable levels of disinfectant residual are listed in the ADWG.

5. If chlorine or chloramines are to be used as the residual disinfectant, proper equipment must be used to measure it. A colour-change type kit for measuring chlorine (such as a pool test kit, colour-wheel test kit, or colour-changing testing strip) is unreliable for residuals less than 2 mg/l. A digital colorimeter is recommended as it can provide an accurate measurement of chlorine residual. Colorimeters are manufactured by various companies and may range from \$350 to \$500 cost. These kits can offer measurement in a range of up to 5 mg/l, and measure either free chlorine (chlorine) residual or total chlorine (chloramines) residual with a reagent made of N, N-diethyl-p-phenylenediamine sulfate (abbreviated as "DPD"). Information on how to purchase this equipment as well as how it can be properly used may be available from your local water supply utility.
6. Note that facilities > 20 years old may impose a higher risk rating to superchlorination practices as outlined above. Plumbing should be checked to be in acceptable operating condition, free of excessive corrosion or wear, prior to conducting this work.
7. Perform verification sampling and next steps to conduct all other related WQMP and Risk Management Planning recommendations. Refer to ADWG for protection against microbial contamination.
8. For areas housing patients with critical infections, sample HPC daily for at least 5 days and (if desired) by using rapid microbial analyses. Also, submit 10 days of *Legionella* samples to accredited laboratories to confirm continued negative *Legionella* results.

Disinfecting Showerheads

Disassemble the fitting into its components. Inspect the components for integrity and presence of biofilm. Replace any rubber components such as seals and washers. Scrub all other components with a brush or pipe cleaner using a solution of manual dishwashing detergent, removing as much debris or growth as possible. Soak the non-rubber components in bleach for at least 1 hour then rinse thoroughly. Reconnect the fitting and flush for 2 (two) minutes.





Appendix H

Clinical Response Guidelines

Clinical Response Guidelines

These clinical guidelines were developed by the Communicable Diseases Unit, Chief Health Officer Branch in Queensland Health and may be revised at a future date.

Patient Management Response if Legionella detected in water supply Revised Interim Guidelines

20 September 2013

Guidance for Patient Management

Preamble

Legionnaires' disease is caused by Legionella bacteria inhaled by an individual from a water source. (An exception is disease caused by *L. longbeachae* where the exposure is to bacteria in soil and gardening materials). Patients at greatest risk are those who are substantially immunocompromised. There is no evidence that Legionella is spread from person to person.

All facilities should ensure that they have a sound water management plan that has been comprehensively implemented and reviewed when circumstances change. This plan should include water sampling as a quality management tool once all water management systems have been established. The following guidelines are designed to assist in the patient management response if Legionella is detected in a facility's water supply.

Investigations and antibiotics for individual patients

- An increased "index of suspicion" for Legionella when suspected hospital-acquired pneumonia occurs
- Appropriate investigations for patients with suspected hospital-acquired pneumonia may include urinary Legionella antigen testing and/or culture of lower respiratory tract specimens (e.g. broncho-alveolar lavage)
- There is no proven role for routine antibiotic prophylaxis. It may be considered by an expert incident management team if an outbreak has occurred
- Empiric use of antibiotics active against Legionella (macrolides or quinolones) may need to be considered in patients with suspected Legionnaires' disease
- Paired serum (acute and convalescent) specimens for Legionella serology should be collected when the diagnosis is suspected. The first sample should be collected within 3 weeks of onset with a further sample collected in accordance with the recommendations of the local laboratory

Care of patients

- There is no evidence of person to person spread of Legionella and there is no need for contact, droplet or airborne precautions for patients suspected of having legionellosis. Visitors may continue to be allowed.
- If a positive Legionella result is detected in the water supply, an expert incident management team should be convened to assess the situation and determine patient management strategies. This group should include at least one of the following:
 - Infectious Diseases Physician
 - Public Health Physician
 - Clinical Microbiologist
- If shower or tap water from a ward is positive for Legionella (10 or more cfu/m), the expert incident management team should consider whether to suspend showering of patients in that ward until further environmental investigations and/or corrective actions have been undertaken. This is particularly important in wards with the highest risk patients such as those who are substantially immunocompromised. Other factors to consider are the prevalence of chronic underlying disease and age profile. Recommencement of showering should be made in consultation with the expert incident management team and will depend on a number of factors including the pattern and level of the Legionella results. This decision should be made in consultation with the expert management team once the nature of changes to water management and water treatment is known



- In wards with the highest risk patients, aerosolisation from sources other than directly from showers and taps might be important. The expert incident management team may wish to consider in situations where inhalation or aspiration may occur advising patients not to drink water from affected taps in the ward – bottled water should be provided pending the outcome of any further investigation of the ward's water source. In these circumstances, staff should also not use the water in the vicinity of high risk patients. Advice should be sought from the expert incident management team before recommencing water use when these restrictions are applied.



