5 Public Health – Water Systems Design (WS)

This PH-WS design guideline written for healthcare facilities, is a consolidated document listing out the design requirements for all new construction and major renovation healthcare projects.
In healthcare facilities, the importance of clean hygienic, and a good quality of water are critical. This has an impact on infection control parameters, equipment, staff, and patients.

The requirements outlined in these guidelines are not intended to conflict with Federal Regulations, Local Municipality Laws, Executive Orders, or the needs of the end users.
This document is intended for the Architect/Engineer (A/E) and others engaged in the design and renovation of health facilities. Where direction described in applicable codes are in conflict, the A/E shall comply with the more stringent requirement. The A/E is required to make themselves aware of all applicable codes.
The document should be read in conjunction with other parts of the Health Facility Guidelines (Part A to Part F) & the typical room data sheets and typical room layout sheets.

Aim & Objectives

The Aim of this section of the guidelines is to promote the correct design of water systems for healthcare facilities.

The scope of the Water Systems design will include the following:

- Potable Cold-Water System
- Potable Cooled-Cold Water Systems
- Water Treatment System
- Hot Water Systems
- Healthcare Sanitary Fittings
- Irrigation Systems
- Grey-Water Systems
- Steam Systems

General

- The design, installation and commissioning of the potable water systems is very critical for healthcare facilities. Many systems and operations in healthcare facilities are dependent upon clean, treated water being provided for patient and staff as well as for the use of medical equipment.
- Reliability and resiliency of water system is also crucial. Thus, it is important to ensure that disruption in water supply from the network or via main storage tanks is eliminated or reduced to the lowest risk possible. The engineer needs to ensure that the requirement of additional water storage does not lead to stagnation of water in the tanks.

Design Codes & Standards

The water system will be designed in accordance with the latest edition and requirements of the relevant standards, codes and guidelines issued by Authorities having jurisdiction and internationally recognized institutions including but not limited to the entities listed below.

Code Reference	Description
	International Standards
BS EN 805	Water Supply System
BS 6700	Design, Installation, testing and maintenance of services

	supplying water for domestic use within buildings.
BS EN 12201	Polyethylene Specification for Water Systems
BS EN 1057	Copper Specification
HTM 04-01	Safe water in healthcare premises. (Part A, B, C & D)
HTM 07-04	Water Management & Water Efficiency Best Practice for Healthcare Sector
HBN-13	Sterile Services Department (SSD or CSSD)
HBN-07-01 & 02	Satellite Dialysis Unit & Main Renal Unit
IoP	Institute of Plumbing – Plumbing Engineering Services Design Guide
IPC	International Plumbing Code
UPC	Uniform Plumbing Code
ASPE	American Society of Plumbing Engineers
CIBSE Guide G	Charted Institute of Building Services Engineers Guide - Public Health & Plumbing Engineering Guide
ASHRAE Applications	American Society of Heating & Refrigeration Air Conditioning Engineers Applications, Chapter 50
HSE – L8	The control of legionella bacteria in water systems.
WSR – 1999	Water Supply Regulations (Water Fittings) 1999 (U.K)
Laboratory Safety Guidance – OSHA	Laboratory Safety Guidance – OSHA
NRC	Nuclear Regulatory Commission (NRC)

WHO-1	WHO - Guidelines for Drinking Water Quality
WHO-2	WHO - Guidelines for Safe Recreational- Water Environments Vol 2 - Chapter 5 - Managing Water & Air Quality
EU Regulations 528	European Union Biocides Regulation 528 (2012),

Glossary & Abbreviations

Above Ground Installation – System installations that are not buried, i.e. within the basement space and floors above.

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

Biofilm – 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.

COSHH – Control of Substances Hazardous to Health [Regulations]

CQC – Care Quality Commission

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.

DWI – Drinking Water Inspectorate

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 Operator: organizations that provide or intend to provide healthcare services.

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

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.

***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.

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

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

WRAS – Water Regulations Advisory Scheme

Design Criteria

- The system components will need to comply with water regulating bodies such as WRAS, AWWA and LOCAL AUTHORITY requirements. Where there is a clash the international recognized requirements and local standards, the local standards shall take precedence.
- One of the most important factors regarding water quality is the concern of legionnaires disease. The control and elimination of legionella is very crucial, and measure must be provided. The United Kingdom's Health and Safety Executive (HSE)274 & L8, provides one of the best Approved Code of Practice and guidance on regulations 'Legionnaires' disease: The control of legionella bacteria in water systems. This guideline or the guideline from ASHRAE should be utilized for the projects.
- Metals in contact with water will also influence the quality of potable wholesome water. Therefore, for any material that is contact with water used for wholesome purposes shall all conform to BS 6920: 2000 Part 1 & 2 and Part 3 (Hot Water Service) for non-metallic materials or equivalent international standards i.e. WRAS approved fitting.
- The healthcare facility owner is obligated to preserve the quality of water according to the outline highlighted within these guidelines.
- It is recommended that plumbing installation contractors and companies have the appropriate qualifications and the industry knowledge and competence of installing the correct system suitable for healthcare facilities.

Source of Water Supply

- Depending on the water source the incoming TDS/PPM can vary from 2000 PPM to 80PPM. Water must be treated to reach water quality levels of 0 – 150PPM.
- The following water sources are acceptable for healthcare facilities:

  Connection from the Potable Water Network Supplier

Service Connection for Potable Water Trucks

Underground Water Wells

Bore Hole

- Healthcare facilities shall ensure that they have secondary water supply to the facility, from one of the sources mentioned above.
- The Incoming water supply from the sources mentioned above must be checked via a water quality report.
- The Water report is to be used to provide the correct water quality design to the healthcare facility.
- The water sources to the healthcare facility must be spilt into two systems for resiliency, redundancy and to avoid having a concern of inadequate water supply to the system. One supply will be an emergency supply to the system.
- Both the main incoming supply as well as the emergency water supply will need to have components to protect the healthcare facility from infection. This is provided through backflow prevention valves or Double Check Valves. The valve detail below provides an example of one of the acceptable configurations.

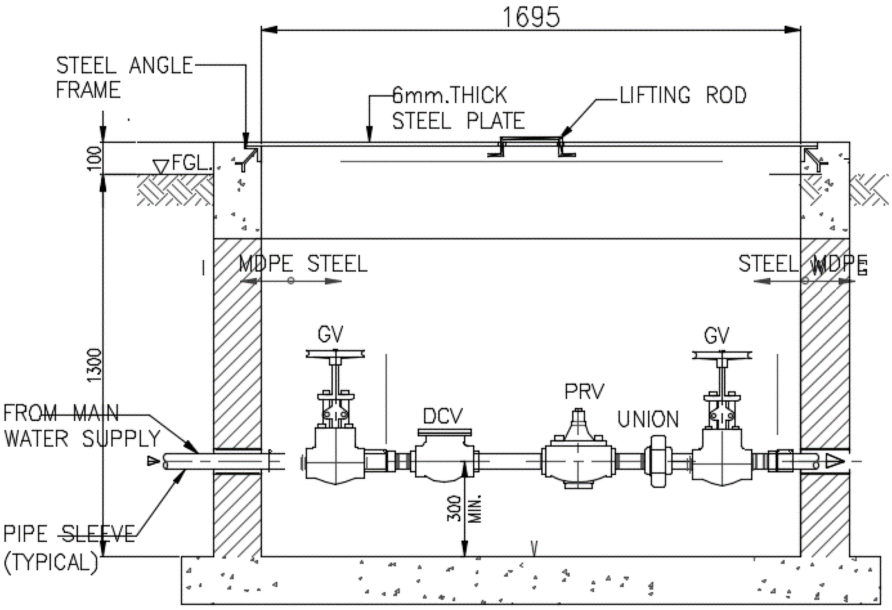

Diagram 5.1A – Incoming Mains Water Valve Detail Buried at the Ground Floor

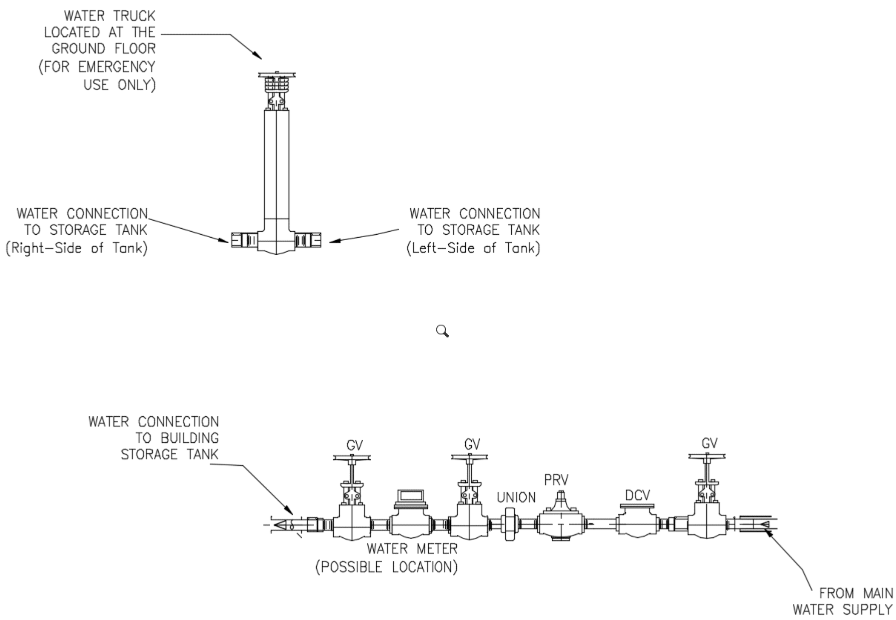

Diagram 5.1B– Incoming Mains Water Valve Detail at High Level Ground Floor or Basement (Water Meter Shown)

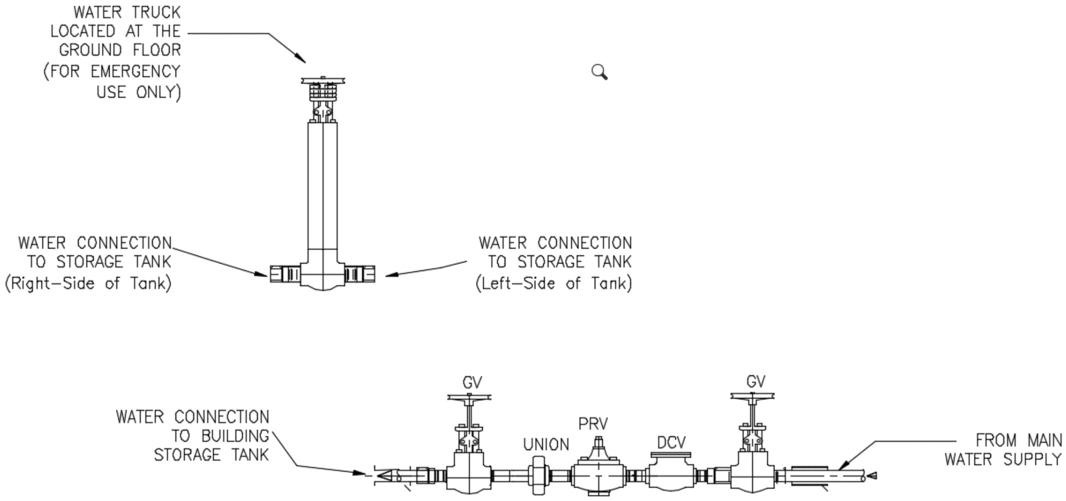

Diagram 5.1C– Incoming Mains Water Valve Detail at High Level Ground Floor or Basement (Without Water Meter Shown)

- Diagrams 5.1A, 5.1B and 5.1C show an emergency water truck connection allowance as a redundancy measure in situations where the main water network will fail or in areas where the water network has not been established or a provision from the network has not been provided by the local authority.
- To provide the most efficient water quality with the correct water treatment system installed, the following information must be known from the incoming water quality report:

  Details of the elements and organisms in the source water supply such as the amount of metals, micro-biological etc.

  The process or method of water purification used by the network provider chemical, a Reverse Osmosis treatment etc.
- The design must take into consideration the maximum foreseeable water consumption and average flows as well as peak loads and pressure required from the LOCAL AUTHORITY water network.
- During the stages of design, the design engineer must inform LOCAL AUTHORITY of the hospital

water consumption as outlined in Part A of these guidelines.

- The water design for the healthcare facility must obtain approval from LOCAL AUTHORITY before any installation is carried out. The engineer must ensure that the following information is submitted:

  Service Connection Details

  Access to Valve Assemblies and Water Meters

  Flushing By-Pass

  Provisions for Fire & Rescue Service (If applicable)

Quality of Water Supply

- In certain situations, there may be times in the year when the water supply from the network supplying the healthcare facility is interrupted and the network provider may provide the water supply from a different source to maintain the supply for the required demand. The change in water supply will most likely have different quality of water such as water hardness, metallurgy etc. This change in water supply may cause issues such as scaling. Water hardness may increase by almost 50% when the services changes.
- The design engineer will need to provide a strategy to ensure that water treatment is provided from the point of supply up until its use. Below is a table that consists of internationally recognized levels of potable water requirements.
- ***Please note:*** For renal dialysis areas, certain elements such as copper & silver need to be controlled. Also, chemical water treatment has to be avoided.

Factor	Standard	Factor	Standard
Temperature	20℃	Calcium	250 mg/l
pH	5.5-9.5	Potassium	12mg/l
Colour	20 Hazen Units	Sodium	150 mg/l
Turbidity	4 Formazin Units	Copper	3000 μg/l
Qualitative Odor	All Odor Investigations	Zinc	5000 μg/l
Qualitative Taste	All Taste Investigations	Lead	50 μg/l
Dilution Odor & Dilution Taste	Dilution No. 3 at 20℃	Silver	10 μg/l
Conductivity	1500 μs/cm at 20℃	Antimony	10 μg/l
Total Hardness – Alkalinity	Applies Only if Water is Softened	Barium	1000 μg/l
Free Chlorine & Total Chlorine	Comparison Against Average	Boron	2000 μg/l
Fecal Coliforms	0 / 100 ml	Cyanide	50 μg/l
Clostridia	1 / 20 ml	Cadmium	5 μg/g
Fecal Streptococci	0 / 100 ml	Chromium	50 μg/l
Total Coliforms	0 / 100 ml (95%)	Mercury	1 μg/l
Colony Count: 2-Day & Colony Count: 3-Day	Comparison Against Average	Nickel	50 μg/l
Oxidisability	5 mg/l	Selenium	10 μg/l
Ammonia	0.5 mg/l	Total Organic Carbon	Comparisons
Nitrite	0.1 mg/l	Trihalomethanes	100 μg/l
Nitrate	50 mg/l	Tetrachloromethane	3 μg/l
Chloride	400 mg/l	Trichloroethene	30 μg/l
Fluoride	1500 μg/l	Tetrachloroethene	10 μg/l

Phosphorus	2200 $\mu g/l$	Fluoranthene 3, 4-Benzofluoranthene 11, 12-Benzofluoranthene 1, 12-Benzoperylene Indeno (1, 2, 3-cd) Pyrene	Individual Testing of these Substances to Provide Total
Sulphate	250 mg/l	Total Polycyclic Aromatic Hydrocarbons (PAHS)	0.2 $\mu g/l$
Magnesium	50 mg/l	Anionic Detergents	200 $\mu g/l$
Aluminum	200 $\mu g/l$	Pesticides and Compounds	5 $\mu g/l$ total

Table 5.1 – Water Quality Table

- The design engineer should consider the type of water treatment used by the water network supplier to ascertain what type of water treatment should be used. In some supplies, the water may have residual chemical treatment used during extreme hot climates and cool weather at different times of the year. This will affect certain immunodeficient patients in the healthcare facility.
- The design of the healthcare facility must also consider any possible concerns that will affect the quality of water in the facility such as "dead leg" or "stagnate water areas". The design must eliminate these areas.

Potable Cold-Water (Cooled-Water) System

- Incoming water as well as the water stored can go up to 40°C or higher in extremely hot climates. This then becomes an area for bacterial growth, water contamination becomes a high risk. Many of the most dangerous types of bacteria such as pseudonymous legionella thrives in such an environment. Therefore, potable water cooling must be provided if incoming water temperature cannot be ensured.
- The design should ensure that water temperature is between 15-20Deg C. This should be done via plate heat exchanger arranged in an N+1 provision.
- Cooled water is to be used for wash hand basins, sinks, baths, showers, and hand-held bidet.

Normal Temperature Potable Cold-Water System

- Water that shall not be cooled, shall still be treated to ensure water quality & legionella protection.
- Potable normal temperature water service shall only be used in the following:

  WC flushing System.

  Maintenance areas, Work Shops, Back of house areas for services areas.

  Cleaners Sinks

  Bib Tap Points

  Cooling Tower Makeup Water

Water Storage

- The purpose of water storage is to act as a safety net for when the main incoming water supply is interrupted , ensuring continuous supply.
- Many healthcare guidelines limit the amount of water storage to be kept at 12 hours storage. This will

ensure that the prevention of bacterial contamination is kept at a minimum via continuous emptying and top up of water within the tank.

- For Healthcare Facilities, the following strategy is preferable:

  3 days of Potable Water Storage

  Out of the 3 days, 2 Days are actual Raw Water Storage.

  The remaining 1 day shall be divided in 2 No. tanks.

  1 No. Tank will be treated cold-water (cooled)

  1 No. Tank will be treated Cold water serve non-clinical areas
- The main 2-day storage tank shall be concrete, buried or GRP tank(s). The treated water storage tanks must be insulated GRP tanks. Treated water tanks water quality shall be as per Table 5.1. Diagram 5.2 flow diagram shows a more detailed design provision of the water system but provides the design strategy behind the water storage.
- Potable water supply to the network, must be after the valve assembly shown in Figure 6.1. In some facilities, the valve assembly may be part of an existing building or include a water meter requirement.
- To avoid the risk of deterioration of water quality, Low level chemical treatment as well as circulation pumps must be provided.
- Water storage calculation should be based on the peak demand and the rate of water supply make up from the main external water source.
- For potable water sizing, water demand or loading units are used for calculations. These contain an inherent diversity factor.
- There is no diversity factor to be considered for special departments such as SSU's, Laboratories, Renal Dialysis etc. This will be sized with full provision.

  As mentioned in Part A of these guidelines, there are many different types of healthcare facilities using the RDL 1-6 designation. Tables 5.2 (below) provides the water demand based on a KPU (bed numbers) for hospitals as benchmark requirement, this is only to be used in the early stages of design calculations

General Hospital – RDL 4-5 (Acute Healthcare Facilities)	
Number of Beds	Average Water Consumption (Liters Per Day Per Bed)
0-50	299
51-100	398
101-200	490
201-400	590
401-600	599
Over 600	978

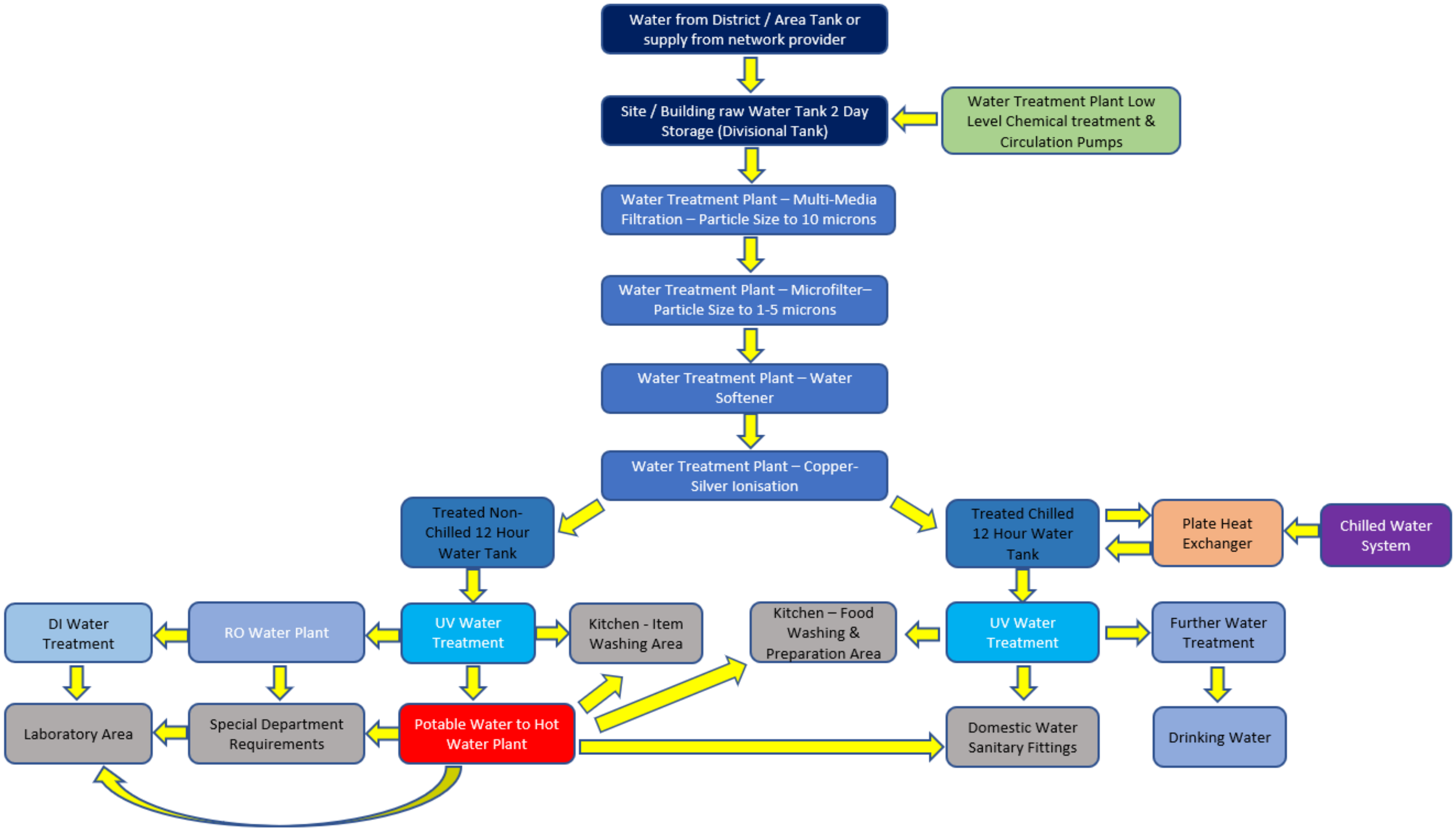

Diagram 5.2 – Water System for Healthcare Facilities

Centre of Excellence – RDL 5-6 (Specialist Acute Healthcare Facility)	
Number of Beds	Average Water Consumption (Liters Per Day Per Bed)
0-25	319
26-50	347
51-100	362
101-200	479
Over 199	530

LTC – (Long Term Care)	
Number of Beds	Average Water Consumption (Liters Per Day Per Bed)
0-50	180
51-100	269
101-200	247
201-300	217
Over 300	306

Recovery and Convalescent Facilities	
Number of Beds	Average Water Consumption (Liters Per Day Per Bed)
0-25	216
26-50	206
51-100	185
Over 100	181

Geriatric & Chronic illness Facilities	
Number of Beds	Average Water Consumption (Liters Per Day Per Bed)

0-50	246
51-100	203
101-200	164
Over 200	127

Psychiatric Facilities	
Number of Beds	Average Water Consumption (Liters Per Day Per Bed)
0-100	180
101-200	269
201-400	247
Over 400	350

Teaching Facilities	
Number of Beds	Average Water Consumption (Liters Per Day Per Bed)
0-100	680
101-200	866
201-300	830
301-500	904
Over 500	1228

Table 5.2 – Water Consumption Data for Healthcare Facility types in relation to number of beds

- A number of healthcare facilities may include residences for doctors and nurses being served from the main hospital potable water system. The designer is to take the data based on the healthcare definitions mentioned in Table 5.2.
- The water consumption figures provided in Table 5.2, are overall figures which consider special departments. In later stages of design, detailed calculations should be conducted for accurately sizing the storage requirements.

Water Storage Tank Locations

- The strategy in the past was to provide two sets of potable water storage tanks (not including fire). 1 No. tank at the incoming main (basement or ground floor) and 1 No. at the roof of the healthcare facility. This strategy may continue to be used for healthcare facilities due to the site space restrictions, flood risks which could contaminate the potable water source for the facility.
- A flood risk assessment must be carried out to determine the best location of the potable water tanks.

- If there is a risk of flooding the potable water tanks must not be placed in areas of flooding risk such as the basement, ground floor etc.
- If there is no risk of flooding. Its preferable to locate portable water tank at the lower levels of any healthcare facility (basement, ground floor etc.).
- To ensure resiliency in the system and not to solely depend on gravity roof water tank approach, the booster pumps will need to be connected to emergency power. This ensures that the potable water supply will be available to all sanitary fittings within the facility.
- The risk assessment must consider the following concerns for possible potable water contamination:

  Location in relation foul & wastewater drainage

  Ingress of insects, rodents, dust, sand, debris etc.

  Danger of oil or fuel seepage (if installed below a car park or other fuel vessels)
- Tanks should be installed with a watertight bund allowing sufficient space all around and beneath the storage vessel to permit inspection and maintenance. For buried underground tanks the construction may not allow for risk elimination of the tank being contaminated.
- The tank chamber should include provision for a sump to collect drainage water and any piping necessary to pump out tanks to the site drainage
- During the healthcare design process, the healthcare facility may be required to constructed in phases. Phases may last months, years and sometimes maybe decades. The design engineer shall ensure that the actual size of the water tank is to be designed for the completed facility. The reason for this is for the following:

  Risk of cross water contamination of providing multiple sources and risk to patient, visitor, and operational staff safety.

  Space planning restrictions

  Equipment costs of providing separate systems

Future Water Considerations

- Many healthcare operators expand their services. This expansion of services will require extra system capacity to be provided. The design engineer must provide a 15% spare water capacity to the system to allow for future expansion of the facility. This means that 15% must be added when submitting requirements to the utility company for water demand approval (Please note that this 15% is on top of the water consumption requirements provide in Table 6.2A & 5.2B).

Material Tank Construction

- As per international standards, the construction of the water of the tanks shall be Glass-reinforced plastic (GRP) as per BS EN 13280 if above ground. Tanks must be in a conditioned space in hot climates.
- There shall 1m provision around all sides of the GRP tanks for equipment maintenance.
- Raw Water Tanks can be concrete tanks buried or within a conditioned space.

Divisional Tanks

- Buildings operate in a very extreme climate and thus critical equipment such as the healthcare facilities water tanks need to be maintained even during operating hours.
- The water tanks support with the tank must not retain water within the supports as this increases the risk for water stagnation.
- The water storage tanks must always be divided into two compartments. These parts should be the total tank capacity divided into two (50/50 configuration).
- This type of arrangement allows for one part of the tank to be cleaned, disinfected, serviced, repaired, inspected etc. while the other is in operation.
- To ensure that the water flow is provided when required and that each tank is provided with equal volume of flow a water meter should be installed as well as a solenoid valve linked to the ball float or chain valve.
- In each section of the divisional tank the following needs to be provided:

  An Isolation Valve at the inlet and outlet of the tank division.

A Valve Strainer at the outlet of each tank division.

Drain Connection at the bottom of each tank. The invert of the drain should be located to fully drain that division of the tank.

Overflow pipe from each division of the tank. Overflow connection to be connected directly to drainage

Overflow warning pipe with insect protection screen (0.65mm mesh – design needs to ensure that the screen area will pass the same amount of water as the overflow or warning pipe)

An External and Internal Access ladder of the tank division.

A vent pipe with an air inlet corrosion resistant mesh.

- In certain circumstances, it may be difficult to install an overflow or a warning pipe directly to a drain line. In this instance, the design must include an audible warning alarm to inform the facility team of overflow scenario.
- A Sectional GRP Tank should not be installed directly on a concrete plinth that is protected by an asphalt membrane. This is because irregular settlement into the asphalt may lead the tank leak.

Pressure Vessels

- Pressure (Expansion) vessels are designed to deal with the thermal (natural, not heated) expansion of the system.
- The most recognized certificate is the KTW (Germany & Netherlands/Holland) approved certificate. KTW provides guidelines for organic materials in contact with water. KTW also provides the concentration of substances that are permitted. The installed pressure vessels must have certification and should be installed as per manufactures specifications. This ensures that they are operated in a manner that prevents the accumulation of debris, water stagnation and increase of water temperature within the vessel.
- The design of the pressure vessel must have water entering the vessel at low level and exiting at high level. Some manufactures use special valves which encourage water flow or pressure movement within the pressure vessels, this is an acceptable alternative.
- For general pressure vessels for medium to large systems, there must be drain connections for flushing at the top and bottom of the vessel. If a diaphragm/bladder type expansion vessel is used, then a connection only at the bottom of the vessel is sufficient.
- Pressure vessels must be provided on the cold potable water side of the system and the pipes to the vessel should be insulated to minimize heat gain.

Water Treatment Systems

- In healthcare facilities the treatment of water and the control of microbiological safety of water is an important functionality to ensure a safe, hygienic clean water provision.
- The extent of water treatment will vary for each application depending on water quality, intended usage etc. But the source of water supply is also important to identify the type of water treatment to be used. Source of water supplies such as Wells, Reservoirs, Rivers and Lakes may contain organic matter, higher TDS/PPM and will require water treatment prior to active facility use.
- Generally, to control microbiological growth within water systems, temperature, chemical and mechanical control methods will be enforced to reduce the risk of water contamination. The methods that can be used are the following:

Pasteurization

Chemical Treatment (Biocides, Chlorine etc.)

Silver-Copper Ionization

Filtration

- Depending on the type of healthcare facility the water treatment strategy needs to be considered for current hospital design and possible future expansion. For example, of hemodialysis department, a separate mains water supply must be considered so that other areas of the healthcare facility may be dosed without affecting the RO plants.

Pasteurization Treatment

- Pasteurization or water heat treatment flashing of the system is a method used in some healthcare facilities by raising the water temperature of the hot water system to 70-75℃ for at least 60mins and running each sanitary fitting within the facility for 5mins. A well-insulated system is required so that heat is maintained to all sanitary fixtures. This is a temporary solution and does not prevent re-infection of the system. This method must not be used for new facilities.
- Existing facilities may only use this method as a temporary solution but will need to install a permanent water treatment method. This method is costly and huge waste of electricity and water as well as it will require complete shutdown of all sanitary fixtures for 5mins, which will be very difficult for medium to large for facilities, but for smaller facilities it may be possible.
- In relation with this method and biocide water treatment, the effectiveness of biocides concentration is difficult to achieve in hot water systems due to gassing off.

Biocidal treatment

- Biocide treatment concentration should be as per international requirements for healthcare facilities. UK COSHH regulations 2002 , provide a good reference.
- Since Legionella and other water contamination organisms play a huge part of water quality, there are occasions where biocide water treatment will be used to maintain the water quality.
- It is important that biocides system must not be drawn for bathing, food preparation or drinking until the treatment chemical has been completely flushed from the system. The hospital operator must ensure that that measures are taken to protect vulnerable patients such as those in renal dialysis units.
- As per international standards, biocides used for water treatment must have the following:

  Contain an active substance approved for that use

  Be suitable for drinking-water use.
- For effective biocide water treatment, there must be an implementation of a very rigorous water monitoring regime with a fail-safe system to ensure the safety of the system as well as ensure the correct dosing of biocide concentration is applied which reduces risk of water contamination.
- Local monitoring will still be required by healthcare operational staff.
- The equipment supplying biocide water treatment shall be provided with a leak detection system.
- As described by the European Union Biocides Regulation 528 (2012), biocides are used to control harmful unwanted organisms within water systems. The regulations also require supplies of biocide to be registered.

Chlorine dioxide

- Chlorine dioxide water treatment is an oxidizing biocide that is capable of reacting with a wide range of organic substances within the water. As per BS EN 12671, the treatment method has been shown to be effective to control organisms within the water. Chlorine-dioxide water treatment equipment is a dispersive water treatment method and the equipment needs to generate a product efficacy greater than 90% to provide the optimum performance. Hence, since it is a dispersive treatment method, bacteria in the water continue to be killed.
- As per international legionella control requirements, Chlorine Dioxide is an approved method of control for legionella bacteria in water systems for PPM values greater than 0.1 and for DWI requirements of less than 0.5 PPM for total oxidants. But as mentioned for biocide treatment, it will require rigorous control and monitoring.
- Chlorine Dioxide is also a very powerful disinfectant that kills both planktonic and sessile organisms. This is important as the majority of organisms live in sessile bacteria.

Chloramine Water Treatment

- Healthcare operators and healthcare engineering designers must take note that municipality distribution company may have introduced chloramine as a disinfecting agent in potable water supply network as alternative to chlorine. This is because chloramine is able to provide a more stable approach of providing a residual antibacterial activity with lower chlorine levels. In systems, where free chlorine is rapidly lost, such as typical hot and cold-water service systems, chloramines can remain for much longer, which is of grave concern for dialysis patients.
- Chloramines and to a lesser extent chlorine in dialysis water can cause hemolysis – a condition

whereby red blood cells are ruptured. In addition, all renal patients suffer from anemia to some extent because they are lacking in erythropoietin. This natural hormone, which stimulates bone marrow to produce red blood cells, is not available in sufficient quantities in patients with damaged or diseased kidneys. Synthetic erythropoietin is administered to dialysis patients but, apart from its high cost, can have unpleasant side-effects. Where chlorine or chloramines are present, the need for erythropoietin escalates, and therefore it is imperative to eliminate chlorine and chloramines from water supplies to dialysis equipment to minimize the dosage of erythropoietin. Dialysis requires a water supply that has the minimum of chemical and bacterial impurities. Hence, special water treatment is required, such as reverse osmosis (RO), which removes chloramines or chlorine from the water.

- For Water Supply using Chloramines a Reverse Osmosis water treatment will need to be used, along with non-chemical water treatment (Copper-Silver Ionization and Ultraviolet Water Treatment).
- The use of deionization should not be used for a water treatment method for the entire facility or as the sole water treatment method. This is because of the following:

  There is some reduction of chloramines (not all)

  The quality of water degrades at a fast rate.

  The water quality shall be as detailed in table 5.5 below.

Water Softener

- Water Softening is used in areas where the quality of water is not suitable for its intended use. For example, hard water areas where the Calcium and Magnesium salts in the water are high, means that scale deposits in the systems equipment and pipework become a concern as they reduce the flow of the system, efficiency and increase the surface area of biofilm.
- In healthcare facilities water softening is used in water to serve the following equipment within a facility:

  Copper-Silver Ionization Water Treatment

  Steam Boilers

  Laundry Area

  Hot Water Systems

- International Studies have shown some concern with cardiovascular disease tends to be higher in areas with soft water supplies than in areas with hard water supplies. The association is clearest where the soft water supplies contain hardness below about 150 mg/L (as $CaCO_3$). Therefore, the correct water softening regime is necessary to remove any risk to patient within those healthcare facilities, especially in areas where the water supply will be used for drinking water (including LDR Nurseries for baby bottle feeding) and kitchen washing facilities.

  Recommendation: If it is considered essential to provide water softening to drinking water and kitchen areas, then the softening must be maintained to a minimum and the manufacturer must be informed to provide the correct disinfection regime of the water softener.

Copper-Silver ionization

- Copper-Silver Ionization is a water disinfection system used for Legionella and other organisms that exist in contaminated water supply and storage. The system works by passing a current through a copper-silver plate and thus forcing the plate to release ions of Copper-Silver. The ions are used to control planktonic and sessile bacteria and area effective against the formation of biofilm.
- The concentration of Copper-Silver ratio must be as per the table below:

Healthcare Facility Size	Copper-Silver Ratio
Small to Medium Facilities (RDL: 1-4)	10% Silver& 90% Copper
Large Facilties (RDL: 5-6)	30% Silver & 70% Copper

Table 5.4 – Copper-Silver Ratio in Relation to Healthcare Facility Size

Important Note: Ratio percentages does not mean an amalgam of the elements. It refers to the ratio of the elements to each other i.e. if 90 % of Copper is 1 kg then 10% of silver is 0.1kg etc.

Reverse Osmosis Water Treatment

- Reverse Osmosis (RO) is one of the most widely used treatment process in healthcare facilities. It is the water treatment technology that removes majority of contaminants within the water by applying pressure through a semi-permeable membrane.

- In healthcare facilities, RO water is required to be served to Renal Dialysis Units/Departments, SSU's, Dirty Utilities (for washer sterilizers) and Laboratories.
- The RO water requirements for healthcare facilities as well as the concentration of copper-silver ions in the water system must be as detailed in Table 5.1, except for dialysis units. For dialysis units, the quality of water shall be as per Table 5.5 below. The table is based on ANSI/AAMI 13959 requirements.

Contaminant	**Maximum Allowable Level (mg/l)**
Contaminants with Documented Toxcity to Hemodialysis	
Fluoride	0.2
Chloramines	0.1
Copper	0.1
Aluminium	0.01
Lead	0.005
Total Chlorine	0.1
Nitrate (as N)	2
Sulfate	100
Sulfate	100
Zinc	0.1
Total Disolved Solids	5-1000
Trace Elements	
Antimony	0.006
Arsenic	0.005
Barium	0.1
Beryllium	0.0004
Cadmium	0.001
Chlromium	0.014
Mercury	0.0002
Selenium	0.09
Silver	0.005

Thallium	0.002
Microbiological Standards	
Colony Forming Units	<100 CFU/mL (Standards) And ≥50 CFU/ML (Action Level)
Endotoxin Units	<0.25 CFU/mL (Standards) And ≥0.125 CFU/ML (Action Level)

Table 5.5 –Water Quality Requirements for Dialysis Use

Important Note: For Microbiological Standards, the term standard refers to the acceptable microbiological level. The term Action Level refers to the testing protocol used to determine the bacteria level.

- As can be seen from Table 5.5 above the concentration level of Copper & Silver is much lower than the standard mentioned in Table 5.1.
- Copper-Silver Water treatment needs to be installed prior to the main treatment. This solution allows the treatment process to work best as well as encourage the water to remain at a high quality for a longer period.
- Copper-Silver Ionization also requires the water feeding it to be treated with softened water. This method prevents scaling.

Ultraviolet treatment

- Chemical Water Treatment methods are used mainly as a dispersive treatment method. But non-chemical water treatment methods are used a final point of water treatment in healthcare facilities.
- The function of the ultraviolet (UV) water treatment is to kill or deactivate the bacteria in the water. This is done by the UV light disrupting the natural make organic makeup of the bacteria. This technique is in sharp contrast to techniques such as high temperatures and chlorine dioxide which 'burn' the outside of the cell wall. For this technique to successfully work the correct UV wavelength must be selected. This is because different wave lengths of light are absorbed in different proportions and for this method to be successful, the UV light must be absorbed to cause the necessary disruption within the bacteria. Optimum wavelength for the destruction of biological matter occurs close to 254nm, and therefore it is important that the lamps used to provide UV light which is close to this ideal value. The process of killing bacteria, via this technique is often referred to as 'inactivation'.
- Ultraviolet (UV) disinfection will be provided at the distribution side. System shall incorporate system sensor to monitor the effectiveness of the disinfection. For typical potable water applications, the target exposure dose is 400j/m2 for a wavelength of 254nm (as mentioned above).
- Hydrotherapy pools in healthcare facilities will have an exposure target of 400 j/m2 for a wavelength of approx. 313nm.
- All biological species require different levels of UV light to inactivate/kill them. For example, legionella pneumophilla, will die at relatively low exposures and others like pseudomonas, which can also cause problems, are more robust and do require a higher dose of UV light to inactivate them.
- The UV water treatment plant shall be connected after the packaged cold-water tank and pumps. It shall incorporate a UV photo sensor to monitor the effectiveness of the disinfection. The output of every lamp will drop with time, typically lamps last between 11 months – 24 months (dependent on the lamp) for 24 hours of lamp operation.
- It should be remembered that all water borne bacteria, undesirable or benign, will enter the system via the incoming main, and despite the water suppliers care and diligence it is simply not possible to deliver water across the network in total sterility, thus the job of protecting the system starts with treatment of the incoming main. This treatment adds considerable value and security to the water handling process.

Ozone Water Treatment

- Ozone is a method of treatment that uses an unstable gas made up of 3 oxygen atoms and the active gas usually lasts only for a few milliseconds.
- Ozone Water Treatment usually provides a good disinfection effectiveness of any odor and taste from the water by reducing the concentration of elements such as iron and manganese.
- An Ozone system consists of passing dry, clean air through a high voltage electric discharge, thus creating an ozone concentration. The raw water is then passed through a venturi throat which creates a vacuum and pulls the ozone gas into the water or the air is then bubbled up through the water being treated. The following are important part of ozone water treatment:

  It rapidly reacts with the bacteria in the water and is effective on a wide range of PH values.

  The Treatment process does not require to add chemicals to the water

  It is unable to prevent or inhibit bacterial growth.

  The system will require pre-treatment water plant to be installed before the unit.

  There is a potential hazard of the system being fire risk as well as toxicity issues, which may raise approval concerns with Civil Defense.
- In healthcare facilities, ozone water treatment needs to be used with a combination of other water treatment means to compliment the weaknesses in the system.
- Many designers and hospital operators in the region are not familiar with ozone water treatment for healthcare facilities, but rehabilitation clinics that use hydrotherapy pools use this approach instead of the chemical cleaning system.
- Ozone water treatment should not be used as the only source of water treatment for healthcare facilities but with a combination of other water treatment methods.
- Oxygen Gas to this type of water treatment can be from the healthcare facility medical oxygen bulk supply (VIE Tanks or PSA Generation).
- Pipe Material for this system shall be Stainless-Steel (316L).

Point-of-use filtration

- Many small clinics may use small point of use filtration systems to provide water treatment for pathogenic waterborne organisms including multi-drug-resistant strains, at a minimum.
- If small clinics wish to proceed with this approach a risk assessment strategy must be conducted for the water treatment strategy. This strategy should be made to determine the sterilizing grade of the filters installed with the filter by determining the bacteria retention and have a management strategy based upon that.

Multi-Media Filtration & Microfiltration

- Multi-Media filtration (MMF) is the most common type of filtration system used generally in healthcare facilities, they ensure particles are removed as well as odor and taste from the water system used. Whereas, microfiltration removes small particles from the water post MMF use.
- In healthcare the design of MMF should be as follows:

  Sand Filtration – Removing Particles down to 10microns (this includes turbidity/suspended solids as per WHO definitions)

  Carbon Filtration – Removing Odor & Taste from the Water
- MMF suppliers and manufactures shall provide this approach in a two-vessel system, one for Sand Filtration and one for Carbon Filtration.
- Microfiltration uses a bag & cartridge filtration method that removes particles of less than 10microns. This type of water treatment method needs to be maintained by the healthcare facility staff and bags need to be checked on a monthly basis. If the system is maintained correctly, bags should be changed between 6-12 months strategy.
- Both water treatment methods are unable to prevent or inhibit bacterial growth. Therefore, this water strategy method must be used with other water treatment methods.

Distilled Water

- Distilled water is the condensed purified water from condensed steam. Distilled water is provided for laboratory use in healthcare facilities.

- Distilled water requires a RO water connection from the plant or DI water connection (depending on the requirements of the laboratory functions.

  Due to the amount of distilled water used, this will be a local bench top unit and not a major plant or a centralized system

Drinking Water

- Some healthcare facilities may provide a separate water supply for drinking water fountains (as shown in Diagram 5.2). The quality of drinking water with Chemical treatment must be as per the requirements highlighted in Table 5.1 or as per local municipality requirements.
- The chemicals used for water treatment for drinking water need to ensure that there have no adverse effects for human consumption. Chemical products used have been provided in an approved list by the Drinking Water Inspectorate (DWI).
- To prevent the drinking water system from stagnation and from the likelihood of temperatures exceeding 20°C (thus affecting the quality of water) the drinking water will need to be provided from a central chilled water storage tank and pump made for drinking water purposes only.
- Drinking water without a storage requirement must not be installed.
- If a central drinking water system has not been provided, then a bottled water drinking water system shall be provided via a water cooler.
- Bottled water coolers shall be provided with chilled and hot water capability but shall only be supplied with a dedicated single water supply (1 No.) designated for drinking purposes only.
- In healthcare facilities pantry areas, there is a requirement for above bench or below bench hot water boiler/chiller unit (as per Part B of these Guidelines). These will be required to be supplied with a normal potable water supply (these units will have internal low-level water treatment).

Specialist Water Systems Provisions

- For healthcare facilities that are expanding their departmental services or providing new FPU's as part of the expansion, local water treatment solution shall be provided if the potable water supply is not treated. An example of this requirement is a new Dialysis unit or Endoscopy clean-up area etc.
- For locally installed water treatment system, the connect from the main supply line to the treatment plant must be provided with a valve assembly set (DCV/BFP, PRV & IV's).

Hydrotherapy Pools

- Water treatment for Hydrotherapy pools shall be a via combined water treatment system.
- The intent of the water treatment system is to control the water mineral concertation. The combined water treatment system will be a combination of MMF and chemical water treatment or Ozone water treatment.
- The treatment system shall be a backwash system that reuses the water within the pool.
- Plant equipment must be installed according to manufacturer's specifications and shall be located in close proximity to the Hydrotherapy Pool with easy access for staff to monitor and service the water treatment systems.
- The water temperature of the pool needs to range between 28 to 35℃ as per healthcare requirements. For most conditions being treated the optimum temperature is between 33-35℃ .

Cold-Water & Cooled Cold-Water Distribution System

- In healthcare facilities, the water system design relies heavily on the installation practices in any region. The installation practices determine the type of contingencies the water distribution should designed with.
- The water design and installation should be as per Water Supply (Water Fittings) Regulations 1999 and relevant parts of BS EN 806-2 and BS 8558 or as mentioned by local regulations.
- To maintain the chilled water conditions of the system for healthcare facilities and reduce the risk of heat gain, the pipework should be insulated. The installation should be a vapor seal type to avoid any condensation as per BS 5970.
- Water Hammer Arrestors or Surge Water Arrestors should be connected to discharge to waste via appropriate type AA air gap as per BS EN 1717.

Cold Water & Cooled Cold-Water Booster Pumps

- As part of the World Health Organization Infection Control Strategy high flows are essential for hygienic hand washing. Healthcare facilities depend on high flows and constant pressure to ensure hygienic clean infection control strategy is maintained. Clinical fixtures need to be provided with the following:
- The cold-water pressure range at fixtures shall be between the following:
- Minimum: 1.38 Bar (gauge)
- Maximum: 5.52 Bar (gauge)
- The cold water piping maximum flow velocity shall be the following:
- Piping to 50mm: 1.5 meters per second (m/s)
- Piping 65mm and larger: 1.8 meters per second (m/s)
- A pumped water system ensures that an adequate water supply is provided throughout the healthcare facility. The potable water booster pumps must be variable driven speed pump system.
- The booster pumps should be a multi-stage pumping system rather than duty-standby single pumps. This approach provides a longer system life with higher energy efficiencies as well as a wider range of flow rates for the facility.
- As part of the healthcare facility resiliency strategy and to continue to provide the healthcare facility with clean, hygienic water, the booster pumps must be connected to the emergency power supply.
- All booster pumps should have automatic control to prevent stagnation.
- Many healthcare facilities may have higher occupant loads on upper floors, thus the pumping amount to these levels will be higher. This amount of pumped water should be controlled by transmitting sensors within the tanks at high level.
- A low-level water alarm should also be provided so that the pump does not run dry.
- The water pump and water storage plant room must be installed with a waterproof and non-dusting floor as well as and non-dusting walls and ceilings. The floors must fall to the dedicated floor drainage locations provided. The drainage floor gully should be provided with a trap. The trapped gully should incorporate provisions to either avoid or replenish any trap-water seal loss. In hot climates, traps are usually susceptible to evaporation, thus a to Primer valve must be installed (refer to Drainage (section 6) for more details).

Hot Water Strategy

- Hot water is to be provided by 2 types of systems to healthcare facilities:

  Warm Water to Clinical Hand Wash Basins (Including Scrub Sinks) & General Hand Wash Basins

  Hot Water to Clinical Sterile Areas, Kitchens, Maintenance Areas and Cleaners Sinks.
- The Hot water system in healthcare facilities should be designed as outlined by BS 6700 (with respect to the Water Supply (Water Fittings) Regulations 1999, BS EN 806 (Parts 1–5), BS 8558 and BS EN 6700.
- The potable water serving the hot water plant shall be treated via Ultraviolet, before connecting to the hot water system.
- In Healthcare facilities hot water system can be vented or unvented systems.
- Vented hot water systems were adopted in older healthcare facilities. This approach consists of a cold-water storage (open to atmosphere) provided above sanitary fixtures which feeds a hot water storage vessel. This approach is no longer accepted in new facilities.
- Unvented hot water systems are connected to a boosted main line (network or internal water system) via a valve assembly set. This strategy maintains the efficiency of the system by maintaining the water quality.

Types of Hot Water Generating Systems

- There are four main type of hot water systems that are acceptable in healthcare facilities (they include direct and indirect heating methods) the following:

  Electrical Hot Water Generation (Direct)

  Fuel Burning Hot Water Generation (Indirect, Including Boiler/Steam)

Solar Hot Water Generation with a combination of one or both of the above (Direct & Indirect)

Heat Pump System

- In healthcare facilities, the design of the system must be provided with a backup water heating strategy along with the above-mentioned hot water systems. Generally, the electrical heating element is the back-up to the other two systems, but it may also be the primary source of hot water generation.
- Solar water system to be provided with a duty and standby system setup.

Hot Water Storage & System

- The water storage temperature must be kept at minimum of 60 - 65℃ to any prevent bacterial growth within the stagnant water.
- Energy conservation is achieved with an integral thermostat set between 60- 65℃ and return water temperature is to be from 50 – 55℃.
- The domestic hot water pressure range at fixtures shall be between the following:

Minimum: 1.38 Bar (gauge)

Maximum: 5.52 Bar (gauge).

- Many healthcare facilities use instantaneous hot water system approach by having an electrical hot water generation locally to the department or sometimes to each wash hand basin. This approach not only has huge capital costs on purchasing the units but on the operational costs also.
- Having local small hot water generators does have its advantages over a large central storage system. They are easier to maintain and provide a quicker hot water temperature provision. Furthermore, balancing the hot water system becomes much easier and less of a problem. But this approach also wastes a lot of energy and moves away from sustainable design. Most of hot water generated is heated but not used as the basin is only used for approximately 30 seconds.
- A central hot water system is the best approach for healthcare facilities.
- A hot water return should always be provided to the central hot water system, unless provided with electrical trace heating tape.
- A central hot water system encourages a low risk of infection concerns for healthcare facilities.

Hot water Return Approach

- Hot water return systems are used to ensure that water temperatures to each of the sanitary fixtures are provided with the appropriate temperature and it ensures that the initial heat generated from the hot water flow is used once again as part of the main hot water system.
- A balancing valve is to be provided on the hot water return system.
- The hot water return is to ensure hot water is provided almost instantly when needed, keeps water consumption low and prevents bacterial growth within the hot water system.
- All hot water supply pipes shall be insulated with flame-safe molded pipe insulation, having a factory-applied jacket suitable for temperature increase.
- The hot water return connection shall be as close to the sanitary fixture as possible. This allows for hot water to be achieved between 10-20 Seconds.

Direct Hot Water Approach

- Direct hot water system approach can be used. This may be provided in RDL5-6 facilities where the return system may take longer to return to the central hot water plant.
- The direct approach will require a hot water system pumps and the pipes to be trace heated to maintain the hot water temperature of the system.
- The trace heating ensures that the hot water is maintained at a minimum temperature of 50℃.
- All hot water supply pipes shall be insulated with flame-safe molded pipe insulation, having a factory-applied jacket suitable for temperature increase.

Hot water temperatures

- In healthcare facilities, the provision of a hot water is required for several healthcare operational needs and systems, Such as the following:

Main Facility Kitchen

Food Preparation Areas

Facility Laundry

Clinical Service Areas

- The remaining areas outside these areas will depend on the operational policy of the healthcare facility provider.
- For above areas mentioned to be provided with hot water for a single hot water supply to a fixture, the draw-off water temperature must be a minimum of 50℃ and maximum of 55℃.
- Hot water temperatures must be achieved within a certain time frame as per BS 6700.
- This requirement is to ensure that appropriate control of microbial elements in hot water systems are in place. For 50℃, this water temperature must be achieved within 30 Seconds and for 55℃, this temperature must be achieved within 60 Seconds.

Hot Water Plant Safety Blow Down (Air Vent)

As part of the healthcare facility infection control strategy, it is important to preserve the quality of the stored water. The previous practice was to provide a vent pipe to terminate back into the hot water storage vessel. This approach is no longer permitted. The vent should be arranged to discharge over a separate air-break-to-drain (tundish) and then to a floor drain as per BS EN 1717.

Instantaneous Water Heaters

- Generally Instantaneous hot water heaters are susceptible to scale formation, where they will require frequent maintenance. If the design engineer wants to specify such a system, they must ascertain the water quality being provided to the healthcare facility. Furthermore, if the system is to be used for shower areas the system should be thermostatically controlled and provided with a BEAB mark of approval.
- Instantaneous hot water heaters may only be used for RDL 1-3 healthcare facilities.

Hot Water Storage Calorifiers

- Storage calorifiers are usually cylindrical vessels mounted either vertically or horizontally; the base of the vessel usually where the heating element is located or where there is an indirect heat exchange. Sometimes areas below the element can have a lower water temperature than the heated water above. This area can provide an ideal breeding ground for bacteria.
- Galvanized type cylinders are particularly susceptible to scale formation, which can also provide a source of nutrition and shelter for bacteria. Therefore, galvanized cylinders are not allowed in healthcare facilities.
- The storage water cylinder lining should be resistant to bacterial growth.
- Storage requirement for hot water should be based on the peak water usage with a 24-hour usage. As mentioned earlier in these guidelines, there may be multiple peak demand areas. Therefore, it is important that the issue of vessel stratification is dealt with.
- Many storage vessels suffer from stratification. The lower levels provide a breeding ground for legionella bacterial growth since they are not heated properly. Therefore, destratification pumps attached/mounted in the cylinder are to be provided in larger vessels.

Hot water circulating pump

- For all healthcare facilities, the hot water circulating pumps have been installed on the hot water flow side or the hot water return side. When installed on the flow or return the connection is provided with a valve assembly set along with a bypass and where the pump is mounted or connected.
- In healthcare facilities, the type of pump installed is important. For example, duplex pumps should not be installed as the purpose of the system is to keep circulating to maintain water temperature. But rather a clean dry standby pump should be provided or a permanently installed standby pump should be made available.

Water System Isolation Valves

- In healthcare facilities, it is important that the design provides a strategy for future maintenance as well as system durability. Isolation valves are to be fitted before entering main sanitary fixtures in toilets, clinical departments etc. Please note that for the design or maintenance of the design, these isolation valves should not be used for balancing the system flow rates.

Thermostatic Mixing Valves

- In healthcare facilities there is a risk of scalding (water burning) for vulnerable patients and ensuring that that scalding does not affect them, the hot water service needs to be blended down to warm conditions with a use of a thermostatic mixing valves (TMV). There are three main types of TMVs: TMV-01, TMV-02 and TMV-03. TMV-03 is the type of valve that must be installed in healthcare facilities. While the other two are for a more domestic type of installation and operate at a lower operating pressure than TMV-03.

- In healthcare facilities wash hand basins and scrub sinks will be provided with a TMV that allows outlet temperature control. This limits the maximum temperature of water delivered from the basin taps. Diagram 5.3 below provides a brief detail on the installation of a TMV to a basin.
- Not all sanitary fixtures will require TMV's. Some sanitary fixtures such as stainless-steel sinks in dirty utilities, clean up rooms, kitchens need a higher temperature requirement. All areas not used for hand washing facilities i.e. any tap outlet to other fixtures other than a wash hand basin (such as dirty utility, clean utility, pantry, and kitchen etc.) shall not have TMV's installed. Diagram 5.3 below provides a brief detail of the installation without a TMV.

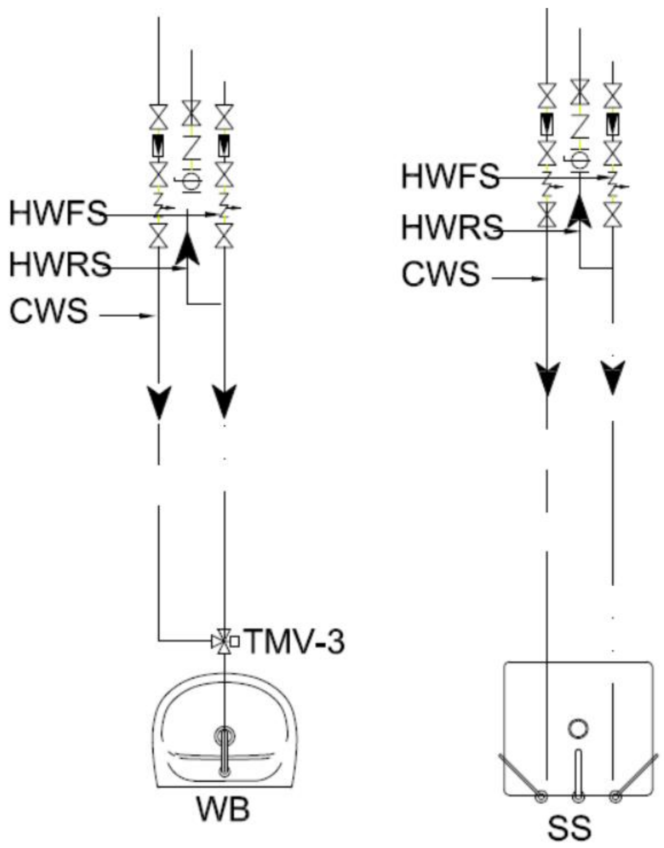

Diagram 5.3 – Location of TMV in relation to Sanitary Fixture

- In recent years, sanitaryware manufacturers have provided a combined TMV and sanitary tap into a single fitting. Some of these are as per healthcare requirement and some are not. The fittings that in contact with the water being discharged must be WRAS approved or equivalent.
- TMV's, along with the hot water return should always be installed as close as to the sanitary fixture as possible to remove any dead leg concerns as many of facilities have high ceilings and long runs (maximum 3m from the basin).
- Close location of the TMV to the sanitary fitting ensures ease of maintenance.
- Table 5.5 below provides the water temperatures required for sanitary fittings required to be installed with a TMV-03 (this must have an enhanced performance testing certificate).

Healthcare Areas & Fixtures	Maximum Recommended Temperature ℃

Showers & Hair Washing Facilities	41
Unassisted Baths	44
Baths for Assisted Bathing	46
Bidets and Hand-Held Shatafs	38
Any Basin	38-41

Table 5.5 – TMV location and Maximum Temperatures

- For assisted baths and areas, water temperature is to be monitored and checked by hospital operational staff (Medical or Non-Medical Staff)
- Some facilities may wish to provide higher temperatures than the above recommended maximum temperature value. If healthcare operators wish to do so, then a safe means must be provided to prevent access to these areas by vulnerable patients.

Healthcare Sanitary Fittings

- Healthcare requirements for sanitary fittings differ from other commercial facilities. The goal is always an infection free, safe, hygienic environment for all users (vulnerable users in particular).
- International Water Supply Regulations places limits on water draw of and requirements to prohibit basin or sink waste plugs (blocker), therefore no drainage waste plugs shall be provided for all sinks and basins.
- Providing an overflow or a waste plug provides an environment for bacterial growth and infection infringement concern. No overflow hole shall be provided for all sinks and basins.
- In healthcare facilities sensor taps should be used for basin washing facilities or as per Part B of these Guidelines.
- The sensor tap solenoid valve is to be checked at least once a month.
- Since legionella is most dangerous in its spray form and can live in the system at any time, spray-type mixer taps are prohibited in healthcare facilities.
- Water flow from the mixer tap should fall in such a way that it forms a shape around the basin discharge area.
- The basin spout should not discharge directly over the waste drain or in an area that causes splashing.
- Some sanitary mixing taps have flow restrictors and aerators at the point of discharge. Flow restrictors or aerators shall not be provided for basins or sinks in healthcare facilities. These tend to be locations where bacterial growth can occur as well as restrict high flows required for healthcare washing requirements.
- Showers in healthcare facilities are generally provided with an integral TMV along with the shower mixing valve.
- Shower heads should not be installed with adjustable spray option around the shower head. This type of issue leads to water stagnation issues.
- Moveable flexible hose type systems should be provided with a back-flow prevention valve and should be selected on ease of descaling and disinfection.
- The purpose of having a back-flow prevention on hose type fixtures such as 'Shatafs" handheld bidets and hose showers is to ensure that submersion of the units into a WC or floor drains does not contaminate the supply system.
- Handheld Bidets or 'Shatafs' should be served from the same water supply serving wash hand basins. They must not be served from water supply lines serving WC's (unless this is the same line

serving the basins).

Irrigation Water Supply

- For healthcare facilities, the irrigation system needs to be spilt into two different systems.

  Internal and external landscape areas where patients, staff and visitor will be loitering.

  Internal and external landscape areas where there will not be any patient, staff, and visitor loitering
- Water used for irrigation shall be served from a dedicated irrigation water tanks for each area mentioned above.
- The internal irrigation system is prohibited to be served with a TSE water supply to areas described in section 5.19-1(a)above.
- Irrigation to areas described in section 5.19-1(a) can only be served with clean potable water supply (Non-Cooled).
- Irrigation to areas described in section 5.19(b) can be served with TSE water from STP plant or treated condensate water supply (or both).

Grey Water (WC Flushing Only) & WC Flushing Systems (Non-Chilled Systems)

- Grey water strategies are generally avoided for healthcare facilities, due to the level of water treatment is sometimes not sufficient to be used with the healthcare facilities. But they maybe times where Due to the local water requirements and local water shortages, strategies have been provided within this design to allow for water to be re-used. Green Building Code requirements encourage the use of a grey water system, therefore grey water systems are allowed but only for the following systems:

  Non-loitering Irrigation Areas

  WC Flushing Systems

  Maintenance Bib Tabs
- All other areas except for the areas mentioned above (5.20-1) shall not be provided with grey water service.
- The following sources can be used for grey water systems:
- Water from Basins, Showers, Floor drains that have been treated (Waste-Water Drainage) and RO Water Rejection Water

Steam System

- There are three types of steam services provided for any healthcare facility and they are the following:

  Plant Steam – A steam supply service used for Healthcare facilities Laundry and food and beverages area

  Clean Steam – A steam supply service used for healthcare laboratories and sterile store units (SSU)

  Pure Steam – A steam supply used for high grade healthcare facilities or biotech or pharmaceutical laboratories.
- In healthcare facilities, the quality of steam will depend upon the application it will be used for and this will be known for the healthcare briefing provided by the healthcare facility operator. The water quality serving the steam system must be treated (including softened water in some cases to reduce the mineral deposits in the system).
- Plant Steam and Clean Steam are main type of services that will be used in healthcare facilities.

Source of Steam System

- There will be two types of sources for the steam system used for healthcare sterile services and they are the following:

  Central Steam Boiler System

  Local or Central Electric Generation Steam Boiler
- Both systems will provide any healthcare facility with the quality of steam they require, depending on the water quality supply into the system.

Plant Steam

- Plant steam is based on having central local plant serving the healthcare facility. This system then serves multiple applications.

- The steam system must have chemical additives added to control the pH level of the steam as well as the foaming of the water.

Clean Steam

- Clean steam requires a supply of specialized treated water such as RO or DI water.
- The production of clean steam contains no dissolved minerals on surfaces of cleaned items.
- Where medical equipment requires steam supply, it shall be clean steam.
- Medical Equipment with integrated steam generators shall be provided with RO or DI water service to generate clean steam.

Steam System Pipe Materials

- Piping must be stainless-steel due to the quality of the water and its contents.
- Stainless-Steel is a non-reactive metal and is able to resist corrosion as well as being a hard metal.
- Other types of metal such as copper are more active metals and they can leach.
- Plastic Pipes or FRP are not allowed for steam service pipes.

Central Steam Generation vs Local Steam Generation

- While the option is the most economical to operate a central steam generation plant it is not the most efficient type of system for healthcare facilities. Having a local generation makes the system resilient against any failures as the local generation is intended for a single unit and purpose. If unit fails, the parts are easily repaired or replaced, whereas failure of the central steam plant system will have devastating impact on healthcare facility operation.
- Some healthcare operators may use a combination of both systems. A combination of both systems should only be used for the following reasons:

  Redundancy – Having the local steam generators be a backup set of steam generation

  Sterilization Speed – Increase the Sterilization speed by having the incoming steam at a lower temperature and the integral unit being the second stage of steam (this will require advance control strategy)
- Both steam generation methods can be used for healthcare facilities, but proper maintenance must be provided to the units.
- Steam equipment serving SSU areas to be provided with equipment backup.

Public Health Maintenance

- In healthcare facilities, it is crucial to have a maintenance strategy to maintain the quality of the system along with a fully qualified team.
- Water tanks are to be cleaned on a weekly basis. The water tank must be a divided water tank that allows the system to operate for least 12 hours without incoming water. All cleaning within the tank must be completed within that time.
- Post treatment tanks cleaned after the water treatment process (except UV water treatment) must be cleaned to a level where large particles have been removed as reasonably as possible.
- After the tanks or water treatment systems have been cleaned, the healthcare operator will need to observe the water system for 24 hours to ensure for the system is fully clean, safe, and hygienic for the healthcare facility.
- For hot water systems, the maintenance team must have a strategy in place to check the hot water heating element being used. This can usually be done monthly via the access manhole provided by the element.
- For steam, correct healthcare design and maintenance of the system is needed. This will allow for a successful steam sterilization outcome to the required healthcare areas. Maintenance tasks should ensure that wet packs are minimized, equipment staining, and chamber scale is minimized in the system.
- The maintenance team for the facility must be familiar with water maintenance strategy as well the equipment installed within the facility.