SCOTTISH HOSPITALS INQUIRY

Provisional Position Paper 11

Potentially Deficient Features of the water system of the QEUH/RHC

Contents

1. Purpose of the Paper

1.1. This Provisional Position Paper ("PPP") has been produced to assist the Chair in addressing the terms of reference in respect of the built environment of the Queen Elizabeth University Hospital/Royal Hospital for Children (QEUH/RHC), Glasgow, as it relates to the water system (including drainage).

1.2. On 13 December 2023 the Chair issued Direction 5 and indicated his intention that the Inquiry should answer four Key Questions by leading evidence at the Glasgow III hearing due to commence on 19 August 2024 so that those Key Questions can be answered using that evidence along with the evidence from the hearing in the autumn of 2021 ("Glasgow I"); the hearing in the summer of 2023 ("Glasgow II"); all relevant Provisional Position Papers; and the evidence led in respect of ventilation principles and practice at hearings of the Inquiry in respect of Royal Hospital for Children and Young People/Department of Clinical Neurosciences.

1.3. As explained in Part A of Direction 5, this necessarily involves two important stages in respect of the water system (including drainage). Firstly, it is necessary to understand what features of the water systems (including drainage) require to be considered by the Inquiry and secondly to determine the extent to which any such feature is or was in an unsafe condition, in the sense that that feature presented an additional risk of avoidable infection to patients.

1.4. The Inquiry is aware that within the construction contract between Greater Glasgow Health Board ("GGC") and Multiplex Construction Europe Limited ("the Contract"), the word "Defect" is a defined term. The definition of a Defect in the Contract is different from the concept that is addressed in the Key Questions. It should be noted that a separate PPP will be produced later in the first half of 2024 which will analyse the Contract to the extent that it is necessary to answer the Inquiry's Terms of Reference.

1.5. To ensure clarity at the first stage of this process the Inquiry will need to decide whether any particular feature of the water system of the hospital is or was unsafe in the sense that the feature presented an additional risk of avoidable infection to patients and as such can be identified as a "Potentially Deficient Feature". It is those Potentially Deficient Features that the Inquiry will consider.

1.6. This PPP sets out the Inquiry teams' understanding of the water system in place at the hospitals in the period following handover in the first part of 2015, and in particular to set out the Inquiry Team's understanding of the history of the raising of concerns with various aspects of that system. Chapters 5 to 23 of this PPP contain an identification of those Potentially Deficient Features. As is discussed in more detail in Chapter 24 it may be that it is the aggregation of

the effect of a number of these potentially deficient features that places the water system (including drainage) in an unsafe condition, in the sense that that it presented or presents an additional risk of avoidable infection to patients.

1.7. The question of whether those Potentially Deficient Features were in an unsafe condition, in the sense that that feature presented an additional risk of avoidable infection to patients will require to be determined only after evidence has been led and submissions received in the Glasgow III hearing.

1.8. To that end, the main body of this Note is formed of a series of sections corresponding to elements of the water system in respect of which one or more concerns were raised in reports, audits, meetings, etc., and sets out the Inquiry team's understanding of actions taken in response. The intention is for the Inquiry team to be able to articulate in this Note a comprehensive view of the potentially deficient features of the water system.

Procedure to be adopted

1.9. The Chair is likely to be invited by the Inquiry team to make findings in fact based on the content of this PPP. Any core participant or any other person holding relevant information is invited to seek to correct and/or contradict any material statement of fact which it considers to be incorrect and to point to what evidence exists to support the position taken by the core participant or other person. It follows that the Inquiry's understanding of matters set out in this note may change and so this paper is provisional.

1.10. As explained in Direction 5, in order to focus the Glasgow III hearing on features that require to be considered in order to answer the Key Questions, Core Participants are invited to respond to this PPP within three weeks of its publication on the Inquiry website and to direct themselves to answer four questions:

[1] Whether the description of the water system (including drainage) contained within the PPP is accepted as being correct and if there are points in respect of which the Core Participant challenges the description of the system, specifically what the points of disagreement are and what evidence exists to support the position taken by the CP;

[2] Whether the description of any Potentially Deficient Feature is accurate notwithstanding that the Core Participant may not accept that the feature described is potentially deficient or deficient in any sense;

[3] Where the PPP describes the date or dates upon which a Potentially Deficient Feature became known to a particular person or organisation whether the Core Participant accepts that date of knowledge or offers an

alternative date notwithstanding that the Core Participant may not accept that the feature described is potentially deficient or deficient in any sense; and

[4] Whether there are any other features of the water system (including drainage) which should be considered by the Inquiry to be Potentially Deficient Features and what evidence exists to support that conclusion.

1.11. Subsequent Inquiry hearings may touch on some of the matters to a varying extent contained within this PPP but they may not; if parties wish to address the issues dealt within in this PPP then they are invited to do so now. In the absence of a response on a matter, the Chair is likely to be invited by the Inquiry team to make findings in fact based on the content of this PPP.

1.12. Please be aware that all responses to this PPP received by the Inquiry will be published on its website as soon as possible after the deadline for responses has passed.

2. An overview of the water system

2.1. The water system at the QEUH site was designed to enable the circulation of water within QEUH and RHC, from the input at the public water mains to the output at the [public sewer].

2.2. **Input: public water mains.** The fundamental requirement for a system such as that in place at QEUH is that the supply be of 'wholesome water'. This is a legislative requirement which requires that the water supplied be fit for use for drinking, cooking, food preparation and washing, without risk to human health. This does not require that it be sterile – the public supply is expected to contain microorganisms to some extent, without posing a risk to health.

2.3. Scottish Water are the suppliers of the wholesome water at QEUH. The supply is drawn from two input mains at the boundary of the site, one at Hardgate Road and one at Govan Road.

2.4. **Initial storage: raw water.** The water drawn from the public water mains is stored in two raw water storage tanks, each of 100,000 litres in capacity.

2.5. **Secondary storage: filtered water.** In order to provide an enhanced degree of cleanliness, the raw water is filtered before being put to use inside QEUH. There are two stages to this process – firstly it passes through a filtration plant; and once this is done it is stored within a filtered water storage tank.

2.6. Filtration plant. There are two ultrafiltration plants, which take water from the raw water storage tanks and pass it through filters with very small pores. This means that solid matter, including organic matter, above a certain size will be removed from the water supply.

2.7. Filtered water storage tanks. There are two tanks in which the filtered water is stored. These are larger than the raw water storage tanks, at 275,000 litres in capacity. The hot and cold domestic water systems within QEUH are both drawn from these filtered water storage tanks. They are configured into compartments, in order to enable work to be carried out without disrupting the supply of water within the QEUH systems entirely.

2.8. Filters were also present in other areas within the water system, such as where thought appropriate in individual taps.

2.9. **Booster pumps.** The filtered water is moved from storage into circulation by means of two sets of booster pumps. The pumps operate by raising the pressure of the system to an appropriate level to secure an even water flow to each point where it is required. The pressure varies according to location.

2.10. **Hot and cold systems.** There are separate hot and cold water systems. Water is directed by the booster pumps to separate plant rooms for the cold or hot systems.

2.11. The hot and cold systems have separate pipes which are grouped together in the ceiling voids, with valves present on the hot water system to allow maintenance, and also to regulate flow so as to help maintain a consistent temperature.

2.12. The requirements for the project were for pipework to be in stainless steel. The Inquiry is aware that copper piping was also used.

2.13. **Cold water system.** The cold water system was designed to operate as a one-way system, such that water leaving a plant room and moving towards an outlet would not return to the plant room.

2.14. The proper operation of the system would see the integrity of the cold water supply maintained by regular flushing, either: by continual flow-through of water because the outlets at the 'end of the line', such as taps, showers, toilets, etc., were used regularly; or by dump valves triggered at a certain temperature, which thereby opened automatically to provoke flow, thereby flushing the system in that way. In other words, a key feature was that the normal operation of the system should remove the possibility of there being unused sections of pipe where water could collect for a prolonged period and risk becoming stagnant.

2.15. **Hot water system.** The hot water system was designed to operate on a pipe system entirely separate from that for the cold water system. It is not a one-way system, but operates via calorifiers, which consist of plate heat exchangers, used to heat indirectly water which is within buffer storage vessels. From there water circulates through hot water pipes, operated by pumps, so that there is a constant supply of hot water throughout the system.

2.16. The hot water system relied upon an Energy Centre, divided into two separate compartments to ensure continued independent operation.

2.17. Expansion vessels are used to stabilise the hot water system. As the hot water expands and contracts, the pressure in the system may alter. Including expansion vessels in the hot water system provides variable capacity so that the pressure can remain stable. The expansion vessels are formed of tanks which contain a rubber bladder full of air; when the water expands the extra pressure causes the bladder to contract, so that the system overall gains additional capacity.

2.18. **Outlets.** These are the taps, showers, toilets, bathing equipment and any other outlets by which water is drawn for use from the water system. The design of QEUH with single-occupancy rooms resulted in an increased number of outlets compared with older hospitals of similar capacity.

2.19. Taps. May be of complicated design. Certain features within taps may contribute to a higher risk of contamination, such as the roughness of its interior surface, or the presence of devices to regulate water flow.

2.20. Basins and sinks. Physical features of the design, such as shelving, may contribute to a risk of contamination. The drains may also be a site of contamination. A particular risk in a design comes from susceptibility to splashing, which may distribute water over a wider area than the basin or sink in question.

2.21. Showers. These are complicated pieces of equipment, of which certain features may create sites of risk. Valves, hoses and the shower head are examples of this. They may also be used less frequently than other equipment, creating a risk that water trapped within such equipment might grow stagnant.

2.22. **Flexible hoses.** Flexible hoses were specified as not to be used in QEUH, but the Inquiry is aware that some were installed. They are typically used in the connection of fixed pipework to a peripheral outlet or equipment, such as a shower unit. They may pose a risk as the lining used in them, necessary to accommodate flexibility, may be of a type as to be susceptible of contamination.

2.23. **Peripheral equipment.** Various items with specific purposes were plumbed into the water system at QEUH. Dishwashers were installed and connected with flexible hoses. Water coolers were installed as integrated parts of the water system. Other water coolers operated as standalone units and were not integrated into the water system.

2.24. **Monitoring.** A Building Management System network was installed, comprising various components linked to allow for the monitoring of plant,

energy consumption, temperature, etc.

2.25. Meters were also integrated into the system to monitor cold water consumption and other usage in specific units.

2.26. **Waste system.** Waste from basins, sinks and toilets flows by gravity through PVC piping. Each point of entry to the waste system are through a water trap (e.g. a u-bend) to prevent foul air from entering the system. The waste system allows for venting to remove foul odours from the waste system. Discharge is ultimately to an underground foul waste system, and from there to a public sewer at Govan Road.

2.27. **Regulation and Guidance.** As waterborne healthcare associated infections are considered to be preventable, the design, maintenance and operation of hot and cold water supply, storage and distribution systems in healthcare premises is subject to detailed regulation and guidance including that contained in Scottish Health Technical Memorandum 04-01 parts A to G, issued by Health Facilities Scotland; Legionnaires' disease, the control of legionella bacteria in water systems, Approved Code of Practice and guidance on regulations, L8, issued by the Health and Safety Executive (HSE); and HSG274, Legionnaires' disease Part 2: The control of legionella bacteria in hot and cold water systems, also issued by HSE.

2.28. In terms of that guidance, Management (defined as 'the owner, occupier, employer, general manager, chief executive or other person who is ultimately accountable') has the overall responsibility for the implementation of procedures to ensure that safe, reliable hot and cold water supply, storage and distribution systems operate within an organisation. It is responsible for the provision of a wholesome water supply in the relevant premises under its authority, such as a hospital. As is explained in SHTM 04-01 part B para 2.1, all premises are required to have a Legionella risk assessment and a written scheme for controlling any identified risks in accordance with the Health and Safety Executive's Approved Code of Practice L8 (SHTM 04-01 part B para 5.1). Management is required to appoint, amongst others, a 'Designated Person'; an 'Authorising Engineer' to provide an annual audit to the Designated Person; and a 'Legionella Risk Assessor' to provide a Legionella Risk Assessment which should be reviewed on an annual basis. It is provided that a 'Water Safety Group' commission and develop a 'Water Safety Plan' including a risk assessment which should be reviewed on an annual basis (SHTM 04-01 part B para 5.28).

3. Glossary

Acronym/ Abbreviation	Definition
AICC	Acute Infection Control Committee
ARU	Acute Receiving Unit
AP	Authorised Person
BEMS	Building Energy Management System
BMS	Building Management System
BMT	Bone Marrow Transplant
CaFM	Computer Aided Facilities Management
CBUs	Chilled Beam Units
CHP	Combined Heat and Power
CHWB	Clinical Hand Wash Basins
CLO_2	Chlorine Dioxide
CWST	Cold Water Storage Tank
DMA	DMA Water Treatment Ltd
DHCW	Domestic Hot and Cold Water
DHW	Domestic Hot Water
DHWS	Domestic Hot Water System
EPDM	Ethylene Propylene Diene Monomer
F&E	Facilities and Estates
FMFirst	Facilities Management Software
GGHB	Greater Glasgow Health Board
GNB	Gram-Negative Bacteria
HAI	Healthcare Associated Infection
HFS	Health Facilities Scotland
HPS	Health Protection Scotland
HPV	Hydrogen Peroxide Vapour
ICD	Infection Control Doctor
ICE	Imaging Centre of Excellence
IMT	Incident Management Team
IPCT	Infection Prevention Control Team
IPS	Integrated Plumbing System
LP1	Legionella pneumophila serogroup 1
LTHW	Low Temperature Hot Water
LUO	Little Used Outlet
MPX	Multiplex Construction Europe Limited
MTHW	Medium Temperature Hot Water
NEC	New Engineering Contract
GGC	NHS Glasgow and Greater Clyde
OPD	Out Patient Department
PAG	Problem Assessment Group

PALL	Pall Corporation
PB	Polybutylene
PE-X	Cross-linked Polyethylene
PICU	Paediatric Intensive Care Unit
POU	Point of Use
POUF	Point of Use Filter
PPVL	Positive Pressure Ventilation Lobby
Ps	Pseudomonas spp
PsA	Pseudomonas aeruginosa
PVC-C	Chlorinated Polyvinyl Chloride
QEUH	Queen Elizabeth University Hospital
RHC	Royal Hospital for Children
SABs	Staphylococcus aureus bacteremia
SBAR	Situation, Background, Assessment, Recommendation
SGH	South Glasgow Hospital
SHTM	Scottish Health Technical Memorandum
spp	species (plural)
TMT	Thermostatic Mixing Tap
TMV	Thermostatic Mixing Valve
TVC	Total Viable Count
USS	Ultrasound Scan
WHBs	Wash Hand Basins
WRAS	Water Regulations Advisory Scheme
WSG	Water Safety Group

4. List of sources

4.1. The sources used by the Inquiry team have been arranged in chronological order within each of the sections noted below. Where a source exists in an evidence bundle already issued by the Inquiry, this is reflected in the reference of the source.

Guidance

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- A39465202 - Health Facilities Scotland, Minutes of a special meeting to discuss Opitherm taps, 5 June 2014 – Bundle of documents in relation to Water PPP – Page 816.

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GGC documents

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- A38694868 – SBAR dated 2 March 2017 – water coolers and risk to patients – Bundle of documents for the Oral hearing commencing on 12 June 2023 in relation to the Queen Elizabeth University Hospital and the Royal Hospital for Children, Glasgow – Bundle 4 – NHS Greater Glasgow and Clyde: Situation, Background, Assessment, Recommendation (SBAR) Documentation – Page 93.
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- A38675852 – Minutes – NHSGGC Board Water Safety Group Meeting – 3rd September 2019 – Bundle of documents in respect of the Water Safety Group in relation to the Glasgow 3 Hearings – Page 112.
- A36591627 – 13.09.2019 IMT Gram Negative Blood Ward 6A – Bundle of documents for the Oral hearing commencing on 12 June 2023 in relation to the Queen Elizabeth University Hospital and the Royal Hospital for Children, Glasgow – Bundle 1 – Incident Management Team Meeting Minutes (IMT Minutes) – Page 360.
- A37854452 - NHS Greater Glasgow and Clyde, 'Briefing paper: Ward 6a (Haematology/Oncology)', 16 September 2019 – Bundle of documents in relation to Water PPP – Page 898.
- A38662166 - Briefing for other patients and parents regarding cleaning and sink drains in wards 2A and 2B dated 18 September 2018 – Bundle of Documents for the Oral Hearing Commencing 12 June 2023 – Bundle 5 – Communications Documents - Page 150.
- A37854558 - NHS Greater Glasgow and Clyde, SBAR in relation to Ward 6a, 2 October 2019 – Bundle of documents in relation to Water PPP – Page 904.
- A39123887 – Media Statement titled "NHS GREATER GLASGOW AND CLYDE STATEMENT" by NHS Greater Glasgow and Clyde Health Board dated 4 December 2019 – Bundle of Documents for the Oral Hearing Commencing 12 June 2023 – Bundle 5 – Communications Documents – Page 410.
- A38668814 – Minutes - Water Review Meeting (Technical) - 17 April 2020 – Bundle of documents in respect of the Water Technical Group / Water Review Group Minutes in relation to the Glasgow 3 Hearings - Page 192.
- A38668807 – Minutes – Water Technical Group Meeting - 03 July 2020 – Bundle of documents in respect of the Water Technical Group / Water Review Group Minutes in relation to the Glasgow 3 Hearings - Page 195.
- A38668806 - Minutes – Water Technical Group Meeting - 18 September 2020 – Bundle of documents in respect of the Water Technical Group / Water Review Group Minutes in relation to the Glasgow 3 Hearings - Page 198.

- A32700430 - NHS Greater Glasgow & Clyde Acute Infection Control Committee paper 30 September 2020 – Bundle of documents in relation to Water PPP – Page 909.
- A32700431 - NHS Greater Glasgow & Clyde Acute Infection Control Committee paper, 8 December 2020 – Bundle of documents in relation to Water PPP – Page 919.
- A33448013 – Oversight Board Infection Timeline (Timeline of Incidents for the period 2015 to 2019) - Bundle of documents for the Oral hearing commencing on 12 June 2023 – Bundle 6 – Miscellaneous documents – Page 922
- A40543960 - NHS Greater Glasgow and Clyde, Response to RFI No 8: Filtration Processes – Bundle of documents in relation to Water PPP – Page 929.
- A44311391 - NHS Greater Glasgow and Clyde, Part 1(i) of response to s.21 Notice number 8 – Bundle of documents in relation to Water PPP – Page 945.
- A44311388 - NHS Greater Glasgow & Clyde, Part 1(ii) of response to s.21 Notice number 8 – Bundle of documents in relation to Water PPP – Page 967.
- A44311369 - NHS Greater Glasgow & Clyde, Parts 1(iii), 1(iv) & 2(i) of response to s.21 Notice number 8 – Bundle of documents in relation to Water PPP – Page 978.
- A44311444 - NHS Greater Glasgow & Clyde, Parts 2(i), (ii) and (iii) of response to s.21 Notice number 8 – Bundle of documents in relation to Water PPP – Page 988.

External documents

- A44976432 - Mercury, ‘Domestic Water Service Survey’, undated – Bundle of documents in relation to Water PPP – Page 999.
- A44674683 - Multiplex Construction Europe Limited, ‘Description of the Above Ground Drainage’, undated – Bundle of documents in relation to Water PPP – Page 1000.
- A44312597 - Nicholson Plastics Ltd, Tank Report/Investigation, undated – Bundle of documents in relation to Water PPP – Page 1003.
- A44313070 - Water & Pipeline Services Ltd, Scottish Water Byelaw rectification report, undated – Bundle of documents in relation to Water PPP – Page 1017.
- A33818735 - Capita Symonds, ‘NEC 3 Supervisor’s Report No. 10’, March 2011 – Bundle of documents in relation to Water PPP – Page 1021.
- A44312871 - Capita Symonds, ‘NEC 3 Supervisor’s Report No. 30’, September 2013 – Bundle of documents in relation to Water PPP – Page 1048.
- A44312885 - Capita, ‘NEC 3 Supervisor’s Report No. 36’, April 2014 – Bundle of documents in relation to Water PPP – Page 1091.

- A34316123 - TUV SUD/Wallace Whittle, ‘New South Glasgow Hospitals Specification CHP Systems’, September 2014 – Bundle of documents in relation to Water PPP – Page 1126.
- A35823695 - Mercury Mechanical, ‘PR32 - Domestic Water System Description’, 16 September 2014 – Bundle of documents in relation to Water PPP – Page 1164.
- A36384755 - Capita, ‘NEC 3 Supervisor’s Report No. 45’, January 2015 – Bundle of documents in relation to Water PPP – Page 1168.
- A33870103 – Report prepared by DMA Water Treatment Ltd titled “L8 Risk Assessment (Pre-Occupancy) NHS Greater Glasgow and Clyde South Glasgow University Hospital” dated 1 May 2015 relating to site assessment concluding on 29 April 2015 – Bundle of documents for the Oral hearing commencing on 12 June 2023 – Bundle 6 – Miscellaneous documents – Page 122.
- A44312702 - DMA water, ‘Gap Analysis of L8/HSG 274 and SHTM 04-01 requirements’, 8 March 2016 – Bundle of documents in relation to Water PPP – Page 1208.
- A44976593 - Mercury, ‘Domestic Water System Sample Schedule’, 16-17 November 2016 – Bundle of documents in relation to Water PPP – Page 1217.
- A33869858 - ‘Item 487 – Irrigation FM first tickets’, 29 November 2016 – Bundle of documents in relation to Water PPP – Page 1221.
- A32402296 - Capita, ‘Stage 3 Adult and Childrens' Hospital and Energy Centre Final Defects Certificate 26.01.2017' – Bundle of documents in relation to Water PPP – Page 1222.
- A44312599 - Legionella control, ‘Legionella Management and Compliance Audit – Domestic Water Systems’, 4 May 2017 – Bundle of documents in relation to Water PPP – Page 1236.
- A41890259 – PAG Minute dated 6 February 2018 – Cuprividus – Aseptic Pharmacy RHC – Bundle of documents for the Oral hearing commencing on 12 June 2023 in relation to the Queen Elizabeth University Hospital and the Royal Hospital for Children, Glasgow – Bundle 2 – Problem Assessment Group Meeting Minutes (PAG Minutes) – Page 82.
- A33870243 – Report by DMA Canyon Ltd titled “L8 Risk Assessment GGC QEUH and RHC following site surveys in September 2017, October 2017, gap analysis in January 2018 and review date September 2018 – Bundle of documents for the Oral hearing commencing on 12 June 2023 – Bundle 6 – Miscellaneous documents – Page 416.
- A40732034 – Draft meeting report prepared by Dr Susanne Lee dated 25 April 2018 - Bundle 8 – supplementary documents for the Oral hearing commencing on 12 June 2023 – Page 134.
- A33795394 - Innovated Design Solutions, ‘Forensic Analysis Report’, 10 May 2018 – Bundle of documents in relation to Water PPP – Page 1266.

- A44311873 - Intertek, water inlet valve report number ITSS-0718-0001W, 11 July 2018 – Bundle of documents in relation to Water PPP – Page 1358.
- A33795375 – Report prepared by Intertek dated 11 July 2018 – Bundle of documents for the Oral hearing commencing on 12 June 2023 – Bundle 6 – Miscellaneous documents - Page 632
- A33869865 - 'Item 487 – Irrigation System comments', 19 July 2018 – Bundle of documents in relation to Water PPP – Page 1363
- A33870454 - DMA Canyon, 'Water System Risk Assessment' January 2019 – Bundle of documents in relation to Water PPP – Page 1364.
- A44312419 - Intertek, 'Examination of Corroded Valve Body', January 2019 – Bundle of documents in relation to Water PPP – Page 1377.
- A41501722 – The Herald on Sunday page 9 article "Early fungal outbreaks at hospital revealed" dated 26 May 2019 – Bundle of Documents for the Oral Hearing Commencing 12 June 2023 – Bundle 5 – Communications Documents – Page 313
- A43262538 - Scottish Water Byelaws Inspection Report, 28 February 2020 – Bundle of documents in relation to Water PPP – Page 1390.
- A44311662 - Element Materials Technology certificate ref no: E 105723, 14 October 2021 – Bundle of documents in relation to Water PPP – Page 1398.
- A44311682 - Element Materials Technology certificate ref no: E 105725, 14 October 2021 – Bundle of documents in relation to Water PPP – Page 1399.
- A44311652 - Element Materials Technology certificate ref no: E 105724, 14 October 2021 – Bundle of documents in relation to Water PPP – Page 1400.
- A44311688 - Element Materials Technology certificate ref no: E 105722, 14 October 2021 – Bundle of documents in relation to Water PPP – Page 1401.
- A44312654 - Pro Lp Consulting Ltd, Authorising Engineer Water Systems Management and Compliance Audit of NHS Water Systems, 28 February and 1 March 2022 – Bundle of documents in relation to Water PPP – Page 1402.
- A44312832 - Pro Lp Consulting Ltd, Authorising Engineer Water Systems Management and Compliance Audit of NHS Water Systems, 11 January 2023 – Bundle of documents in relation to Water PPP – Page 1420.
- A43262488 - Scottish Water Byelaws Inspection Report, 10 March 2023 – Bundle of documents in relation to Water PPP – Page 1446.
- A44039957 - Multiplex Construction Europe Limited, Response to s.21 Notice number 8 – Bundle of documents in relation to Water PPP – Page 1451.

5. Incoming mains supply

5.1. The QEUH and RHC are supplied by two incoming mains supplies from Scottish Water,[1] known as the Hardgate Road and Govan Road supply.

[1] A35823695 - 'PR32 - Domestic Water System Description' – Bundle in relation to Water PPP – Page 1164.

5.2. SHTM 04-01 gives comprehensive advice and guidance on water safety for healthcare premises. That guidance advises:

> "Normally, the source of water supply to healthcare premises is by one or more service pipe connections from the mains of the water supply authority."[2]

5.3. Having two incoming mains provides continuity of the water supply in the event that one supply fails. Both supplies enter the building in the basement manifold room and basement tank room.

Bypass pipes

5.4. There is a potentially deficient feature in respect of the bypass pipes. These are sections of pipework which lead directly from the public water mains to a location after the booster pumps and in doing so bypass the filters designed to remove unwanted elements from the public supply before use in the hospitals. The concern is that, when they were in use, the water in the hospital system would not be as clean as had been intended.

5.5. The Inquiry team understand that DMA Water Treatment Ltd (DMA) were instructed in the regulatory role of 'Legionella Risk Assessor', an independent professional advisor to the NHS Board tasked with, among other things, providing a Legionella Risk Assessment.[3] DMA issued an L8 Legionella Risk Assessment on 1 May 2015.[4] This noted a number of concerns in relation to the water systems at the hospitals. Among other things, the report advised:

> "There was bypass pipework set up to run from the Hardgate Road mains to the domestic (Bulk) water supply system connecting in after the Booster Pumps (5.0 Bar set). This was noted during DMAs initial site walk round and reported to Estates. DMA again noted this during the site survey of the CWSTs [Cold Water Storage Tanks] on 02/04/15 and again reported this to Estates."[5]

5.6. The pipework bypassed all CWSTs and filtration sets.[6] DMA noted this may have led to sediment and other debris, which would otherwise have been removed by the filtration set, being introduced into the system. DMA advised that this could be a contributory factor to the out of specification microbiological results that had recently been recorded in an NHS sampling

[2] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 269. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[3] A33103409 - SHTM 04-01 Part B, July 2014 – Bundle in relation to Water PPP – Pages 423 and 424.
[4] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 122.
[5] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 206.
[6] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 212.

programme.[7] The Inquiry team understand 'out of specification' to mean water samples where particular microbe levels are exceeded. In such an event escalation procedures and remedial actions are recommended.[8]

5.7. SHTM 04-01 advises that deposits of sediment and debris in hospital pipework can give rise to breeding grounds for health debilitating bacteria as well as biofilms which can ultimately cause deterioration of adjacent material surfaces. To avoid these potentially damaging circumstances, the SHTM provides that all incoming cold water supplies destined for domestic use within NHS Scotland premises should be filtered.[9] The SHTM also describes filtration as: "essential for healthcare premises pipework systems" to maintain hygienic conditions."[10]

5.8. DMA were advised in mid-April 2015 that the bypass had been removed,[11] though information from Estates staff suggested it was in place for a number of weeks.[12]

5.9. For the period the bypass was in place and in use it is a potentially deficient feature for the purposes of Glasgow III.

Inlet valves

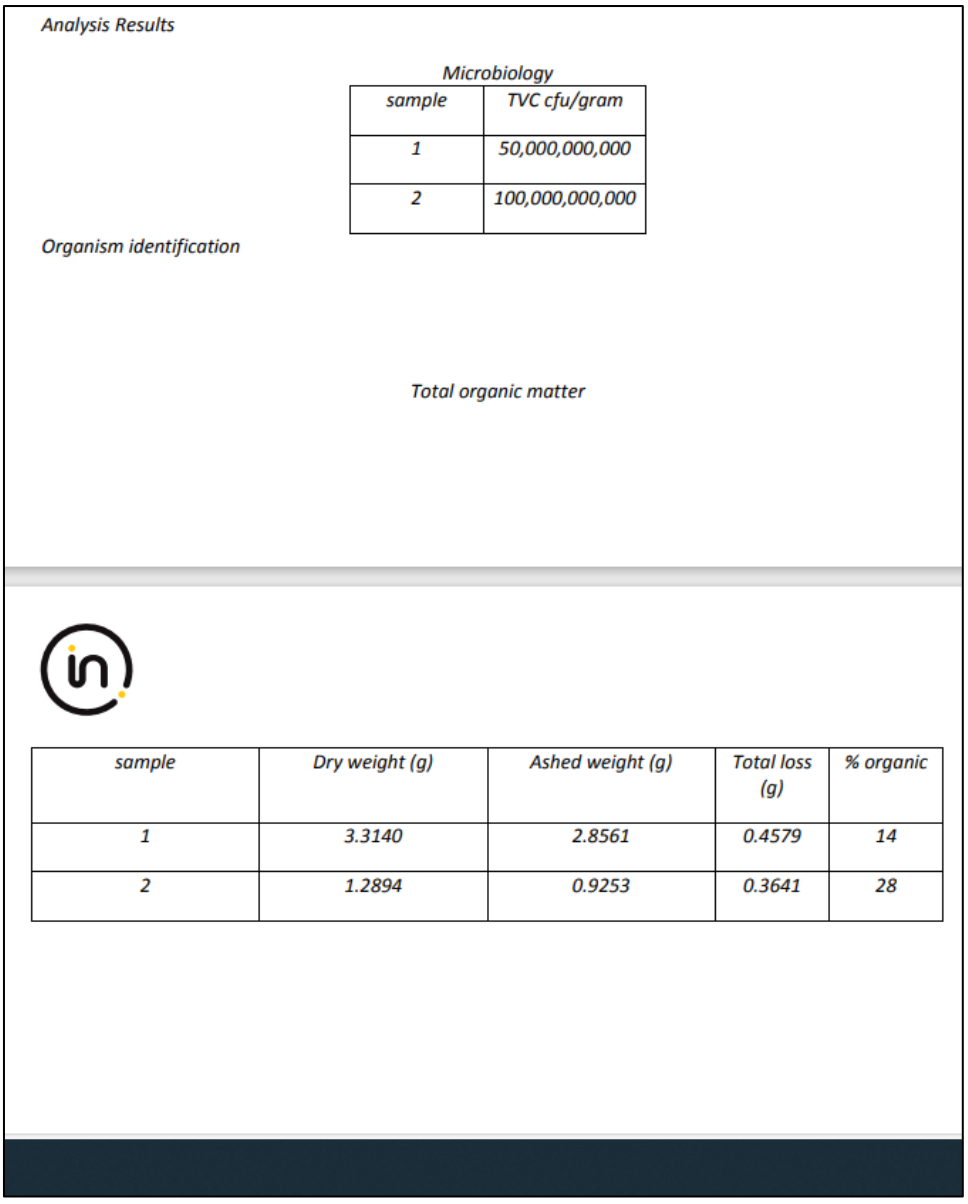
5.10. There is potentially deficient feature in respect of the integrity of inlet valves on the mains supply into QEUH. Deposits were observed on the inside surface of a valve, though limited information is available as to the significance of this.

5.11. On 11 July 2018, a mains water inlet valve from QEUH was analysed for microbial contamination by Intertek.[13] The laboratory was asked to investigate deposits visible on the internal surface of the pipework."[14] Intertek advised:

"The meter was removed from the pipe to gain access to all areas of the

[7] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Pages 212 and 136.
[8] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 374 features a diagram whereby this understanding has been derived.
[9] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 674; The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 81.
[10] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 616; The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 12.
[11] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 206.
[12] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 212.
[13] A44311873 - Intertek water inlet valve report, 11 July 2018 – Bundle in relation to Water PPP – Page 1359.
[14] A44311873 - Intertek water inlet valve report, 11 July 2018 – Bundle in relation to Water PPP – Page 1359.

unit. When removing the meter further deposits were found on the internal surface of the pipe and on the casing of the meter fan. The deposits were white in colour and solid to the touch."[15] "2 samples of the deposits were taken for analysis"[16]



Analysis Results

Microbiology

sample	TVC cfu/gram
1	50,000,000,000
2	100,000,000,000

Organism identification

Total organic matter

sample	Dry weight (g)	Ashed weight (g)	Total loss (g)	% organic
1	3.3140	2.8561	0.4579	14
2	1.2894	0.9253	0.3641	28

5.12. The screenshot above notes the results from Intertek's report. The significance of these results is not yet known to the Inquiry team. These inlet valves are potentially deficient features for the purposes of Glasgow III.

[15] A44311873 - Intertek water inlet valve report, 11 July 2018 – Bundle in relation to Water PPP – Page 1359.
[16] A44311873 - Intertek water inlet valve report, 11 July 2018 – Bundle in relation to Water PPP – Pages 1360 to 1362.

Double check valves

5.13. The potential for 'backflow' at the mains input to QEUH is a potentially deficient feature of the water system. 'Backflow' occurs where a system is designed for water flow in one direction, but a feature of its operation (e.g. a pressure difference in certain circumstances) creates the possibility that water might be caused to flow in the opposite direction. At this location the concern was that water taken into the hospital at the mains input might be caused to flow back out, and into the public water mains.

5.14. A Scottish Water bylaws inspection was conducted in June 2019. GGC have advised the Inquiry team they are unable to locate a copy of Scottish Water's original report, however, note it identified non-compliances with Scottish Water bylaws.[17] GGC advise that, in response, a double check valve was installed on the incoming mains supply, preventing backflow from the Hospital water system into the Scottish Water main system.[18] A bylaw rectification report issued by Water & Pipeline Services Ltd notes this was completed by 14 June 2019.[19]

5.15. The potential for backflow on incoming supplies throughout other areas of the QEUH was also identified as a potentially deficient feature. Scottish Water Byelaws Inspection Reports of 28 February 2020 and 10 March 2023 identified numerous points across the site where there was insufficient backflow protection, representing a contamination risk.[20] It is not known what remedial actions if any have been taken to address those concerns. These issues are potentially deficient features for the purposes of Glasgow III.

Drain points and low turnover

5.16. The existence of certain points in the incoming water system where there was low turnover, and therefore a lack of regular and normal opportunities for flushing, is a potentially deficient feature of the water system. Specific concern was raised regarding the potential for contamination at drain points which were little-used. Without a means of regular flushing, whether through normal use or a specific flushing regime, a risk may arise of that site becoming contaminated.

5.17. DMA issued a further Legionella Risk Assessment on 25 April 2018 following

[17] A44311444 - Parts 2(i), (ii) and (iii) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 995.
[18] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 985.
[19] A44313070 - Water & Pipeline Services Ltd, Scottish Water Byelaw rectification report, undated – Bundle in relation to Water PPP – Page 1020.
[20] A43262538 - Scottish Water Byelaws Inspection Report, 28 February 2020 – Bundle in relation to Water PPP – Page 1390; A43262488 - Scottish Water Byelaws Inspection Report, 10 March 2023 – Bundle in relation to Water PPP – Page 1446.

site surveys in October 2017 and a gap analysis review meeting in January 2018. The Inquiry team again understand this was in their regulatory role of 'Legionella Risk Assessor'. That report noted:

> "DMA have described both the Govan Road and Hardgate Road supplies as medium risk due to the drain points etc. on the pipework for which there is no record of flushing. We have described the Hardgate Road (small) as a High Risk due to the low turnover to the Fire Suppression system."[21]

5.18. A review of DMA's recommendations dated 29 January 2019 suggests these drain points were incorporated into the flushing regime.[22] The existence of these points of low turnover and a lack of regular and normal opportunities for flushing is potentially deficient feature for the purposes of Glasgow III.

6. Raw water storage tanks

6.1. The guidance in SHTM 04-01 is clear:

> "Water is stored in healthcare premises for the following reasons: · to provide a reserve supply during failure of the main cold water supply; · to reduce the maximum demand on the cold water main; · to provide accommodation for the expansion of any water subjected to heat, that is, hot water and heating services; · to reduce the pressure from that of the distribution system."[23]

> "The following generally covers the range of uses [of stored water]: · cold water services, domestic, laundry etc; · cold water feed to hot water services; · drinking water supplies; · treated cold water for laundries, heating etc when local supplies are unsuitable; · break tanks on cold water supplies serving points of use where backflow is, or is likely to be, harmful to health due to a substance representing a serious hazard, for example, supplies to pathology laboratories; · feed and expansion for heating service; · fire-fighting"[24]

> "Storage should be designed to minimise residence time in the cistern and maximise turnover of water to avoid stagnation and deterioration of water quality."[25]

[21] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 421.
[22] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Pages 87 and 88.
[23] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 283. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[24] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 283. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[25] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 283. The same provision is in v1 of that guidance from August 2011 (archived July 2014).

6.2. The incoming mains to the QEUH and RHC supply two raw water storage tanks. A separate Trades Water tank supplies various outlets such as the fire suppression system for the helipad.

6.3. Once water from the raw water storage tanks is filtered, it is pumped to two potable bulk cold water storage tanks. The arrangement of these tanks allows them to be maintained without disrupting the building's water supply. The water levels in the tanks can also be adjusted to reflect water demand by the use of float switches so the tanks can achieve optimal turnover of water.

6.4. In total there are 5 water storage tanks in the building. Water is pumped from the potable bulk cold water storage tanks via main distribution risers to serve plant rooms, where it is distributed to supply cold water across the hospital and the energy centre.

Tank lid hollow supports

6.5. The use of certain types of hollow tank lid supports within the water tanks is a potentially deficient feature. On 19 November 2013 Health Facilities Scotland (HFS) issued an alert advising that the use of hollow pipes as lid supports in cold water storage tanks was likely to lead to stagnation and harbouring of harmful micro-organisms. HFS recommended that hollow pipes be replaced with solid structures.[26]

6.6. GGC have advised the Inquiry that hollow lid supports were replaced with solid lid supports on 25 January 2015.[27] Whilst there were hollow tank lid supports within the water tanks this was a potentially deficient feature for the purposes of Glasgow III.

Deadlegs around the water tanks

6.7. The existence of 'deadlegs' around the water tanks at QEUH is a potentially deficient feature. A 'deadleg' arises where some arrangement of a water system creates a location where water may become stagnant, for example where the configuration is open only at one end, or where it is open at both ends but used in such a way that water does flow through the location thereby flushing it. Stagnancy creates a risk of allowing organisms to grow in that location.

6.8. In their 2015 Legionella Risk Assessment, DMA noted:

> "At the time of survey DMA noted that the Hardgate Road supply into Raw Water Tank 1A has been isolated creating a deadleg and NHS

[26] A33625416 - Estates and Facilities Alert EFA/2013/004 – Bundle in relation to Water PPP – Page 812.
[27] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 979.

> Estates confirmed this had been isolated for a number of weeks pending repair by Mercury Engineering. This has still not been completed at the time of this report. The outlet from this tank has remained live during this period which means this is acting as a balance tank with no through flow of water leading to stagnation and film formation on the water surface."[28]

6.9. A similar set up was noted on the Trades system, creating stagnation in both affected tanks. DMA advised this may be contributing to any out of specification microbiological results.[29]

6.10. DMA recommended that tank 1A be completely isolated from service until the mains inlet could be repaired, and the CWST cleaned and disinfected prior to re-use (including the mains line).[30] A review of DMA's recommendations dated 16 December 2018 stated this work was completed by Mercury of behalf of Multiplex in 2015.[31] Regarding the Trades system, the same review noted that the Trades tank in question provided water to fire fighting services for the helipad only and was isolated from the rest of the domestic water system.[32]

6.11. DMA issued a further Legionella Risk Assessment on 25 April 2018.[33] That report appears to identify the same Trades Water tank deadleg highlighted in DMA's 2015 assessment.[34] DMA advised:

> "One side of the Trades tank was valved off due to a reported inlet valve issue in 2015 (though tank full with signs of stagnation). It would appear that this tank has been offline since the construction phase."[35] "The RHS 'Trades' Water tank appears to have been isolated for approximately 3 years with no recorded flushing of the deadleg this has created."[36]

6.12. In their 2018 report DMA recommended that the Trades water tank should be incorporated into the weekly flushing regime until such times as the CWST

[28] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 212.
[29] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 137.
[30] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 212.
[31] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 845.
[32] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 847.
[33] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 416.
[34] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 464.
[35] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 469.
[36] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 421.

issue was corrected."[37] DMA recommended that the tank be cleaned and disinfected prior to it being reinstated – or if not required drained and left isolated, ensuring any deadlegs created on the inlet and/or outlet were removed or incorporated into the site flushing regime.[38]

6.13. A GGC review of DMA's recommendations by GGC dated 29 January 2019 stated that both Trade tanks were cleaned, with the RHS tank drained and isolated.[39] Elsewhere the review stated the RHS tank was removed.[40] GGC have also advised the Inquiry that one of two 'trade' water tanks was taken off line and the deadleg removed in July 2018.[41]

6.14. These two examples are potentially deficient features for the purposes of Glasgow III.

Temperature rise / lack of flow in the tank system

6.15. A series of concerns were raised regarding temperature control and turnover of water in the tank system. It was speculated that the two may be linked, such that a lower turnover of water would mean water remaining in the tank in question for longer than envisaged, as a result of which contamination would be a possible result, either because the water became stagnant or because it allowed the water to rise in temperature. Either of those may pose a risk of growth occurring in the water. The existence of such an arrangement would be a potentially deficient feature within a water system.

6.16. DMA's 2015 report noted:

> "Greater than 2°C temp rise from mains to stored water in CWST [Cold Water Storage Tank] 1A and 1B."[42]

6.17. According to DMA, the temperature of the water stored in the tanks should have not been more than 2°C higher than the incoming mains. It was noted that poor control over water temperature may lead to Legionella colonising and proliferating in the tank, producing a possible source of bacteria to infect other water services downstream. [43] DMA recommended further monitoring of

[37] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 464.
[38] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 469.
[39] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 89.
[40] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 87.
[41] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 983.
[42] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 143.
[43] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 211.

the storage temperatures, with capacities of the tanks altered to match usage requirements if necessary.[44]

6.18. A GGC review of DMA's recommendations by GGC dated 16 December 2018 stated this concern has diminished with full occupancy of the building and increased water turnover.[45] A DMA Gap Analysis of 8 March 2016 notes that six monthly condition/temperature inspections were taking place for the cold water storage tanks.[46] However, in relation to "annual cleaning and disinfection of CWST and downservices… TVC [Total Viable Counts] and Legionella samples should be taken upon completion of disinfection works", the same report narrated that this had not been carried out.[47]

6.19. Water tank storage temperature was again highlighted as a concern in DMA's 2018 report:

> "Storage temperate in 2B combined with heavier water mark may indicate this CWST is not turning over as well as the others."[48]

6.20. DMA noted that the storage temperate in 2B should be monitored and CWSTs balanced."[49] A review of DMA's recommendations dated 29 January 2019 suggests that tanks were cleaned in July 2018 in response to this concern.[50]

6.21. In March 2019 HFS issued a Water Management Issues Technical Review.[51] HFS noted:

> "From the information provided the Hardgate Road tank is not turning over as much as the Govan Road tank." "the water meter results show one tank turnover less the other and therefore a risk of stagnation exists"[52]

6.22. HFS suggested the tanks were checked for balancing,[53] and that turnover of

[44] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 143.
[45] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 846.
[46] A44312702 - DMA Gap Analysis, 8 March 2016 – Bundle in relation to Water PPP – Page 1212.
[47] A44312702 - DMA Gap Analysis, 8 March 2016 – Bundle in relation to Water PPP – Page 1213.
[48] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 468.
[49] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 468.
[50] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 88.
[51] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 70
[52] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 118
[53] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 118

the tanks was checked, managed and recorded.[54] GGC have advised the Inquiry that in March 2019, Schneider Electric (Schneider) were engaged to monitor and control turnover of water in the storage tanks.[55]

6.23. GGC advise that in May 2020, increased Cold Water Storage tank Sampling was introduced as part of ongoing risk reduction actions and monitoring water quality."[56] It is not known whether these actions have resolved the concerns around temperature rise and lack of flow in the tank system.

6.24. These temperature differentials are potentially deficient features for the purposes of Glasgow III

Debris within tanks

6.25. A series of concerns were raised regarding debris within the tanks. The presence of debris poses a risk of contamination in two ways: the debris itself may be regarded as a contaminant; and the debris provides a surface upon which organic growth may occur.

6.26. DMA's 2015 report stated:

> "DMA noted small debris including washers in Bulk Water Tank 2B".[57] "The volume of debris within the water tanks appeared to be more than would be expected considering the Bulk Water tanks are fed via 0.5 micron filter sets."[58]

6.27. DMA recommended that tank 2B be cleaned to remove debris and then disinfected.[59]

6.28. The same concern was identified in DMA's 2018 report:

> "DMA noted small debris including washers in Bulk Water Tank 2B in our initial assessment from 2015 and these are still present."[60] "[Tank 2B] DMA were advised during the initial occupation phase that the filter system was bypassed due to issues with the pumps and filter set and this may have introduced debris (and potentially bacteria) into the system and as the tanks have not been cleaned since this time anything

[54] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 148
[55] A44311444 - Parts 2(i), (ii) and (iii) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 995.
[56] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 987.
[57] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 212.
[58] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 144.
[59] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 144.
[60] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 422.

flushed into the system may have colonised parts of the system."[61]

6.29. DMA recommended that tank 2B be cleaned to remove debris and then disinfected. A further recommendation was made to confirm the competency of staff completing CWST inspections and that inspections were being completed. DMA also advised that the filter system should be checked as the level of debris was unexpected downstream of a 0.2 micron filter. [62]

6.30. In response to this concern, GGC have advised the Inquiry that the bulk water tanks were cleaned in June-July 2018.[63] A further Legionella Risk Assessment was issued by DMA Canyon (formerly DMA Water Treatment Ltd) in January 2019. The Inquiry team understand this was in the regulatory role of 'Legionella Risk Assessor'. That report narrated:

> "The CWSTs were cleaned and disinfected in summer 2018 by DMA. Large amounts of debris were found in the water tanks, including large particles of rust coloured materials (particularly in the Govan Road supplied tanks), sponges in a Raw water tank (believed to have been left over from initial pre-handover cleaning and disinfections, bolts/washers in post filter tanks (again believed to have been left over from initial pre-handover cleaning and disinfection)."[64]

6.31. An Intertek report of 11 July 2018 notes that tests were conducted on debris recovered from the tank, indicating a large biofilm presence on the debris.[65] On biofilm, the report noted:

> "Any part of the system where the flow rate is slowed increases the chance of a biofilm forming as organisms are more likely to be able to attach to the surface. Increased surface area gives more opportunity for organisms to attach and a biofilm to form. Materials used in the construction of the water system have the potential to provide nutrients potentially increasing the natural fauna in the water…ambient temperature water offers better conditions for organisms to develop in higher concentrations- there are exceptions to this"
>
> A biofilm also supplies a degree of protection to the organisms living in it. The extracellular polymers secreted by the organisms and used as the building structure for the biofilm form a protective layer which provides more resistance to physical and chemical treatment than the organisms would have in their planktonic state. It is not unusual in

[61] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 468.
[62] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 468.
[63] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 983.
[64] A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1371.
[65] A33795375 – Intertek report 11 July 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 642.

> biofilms to find a low number of dominant species although the total number of species could in reality be significantly higher."[66]

6.32. Baffles are features within a water system which are present to direct water flow. Their presence may constitute a potentially deficient feature, should they provide surfaces with a potential to contaminate water if organic material is able to grow on them.

6.33. DMA's 2018 report noted that in respect of the raw cold water storage tanks:

> "Raw Water CSWTs [sic]: Some evidence of biofilm forming on baffles at mains inlets, possibly due to splashing etc."[67]

6.34. DMA advised that baffles should be inspected periodically (e.g. monthly and cleaned as and when required.[68] It is not known to the Inquiry team what if any remedial action in addition to the cleaning of the tanks in summer 2018 was taken in response to this concern.

6.35. The existence of these debris and biofilm within the tanks and on baffles are potentially deficient features for the purposes of Glasgow III.

Screens around tanks

6.36. An absence of screening at certain locations around the water tanks is a potentially deficient feature of the system. Screening of parts which are open to the outside, such as vents, would reduce the potential for contaminants to enter. An absence of screening may in certain circumstances therefore create a risk of being a potential entry-point for contaminating material.

6.37. DMA's 2018 report stated that all raw and bulk cold water storage tanks should have suitable screens fitted to the 'warning pipe' and it should be confirmed that the overflow is suitably screened.[69]

6.38. SHTM 04-01 states:

> "Many hospitals…now store all water in tanks arranged to contain water of drinking quality, having sealed lids and screened vents. This offers complete flexibility, avoids problems with stagnation and is recommended practice."[70]

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[66] A33795375 – Intertek report 11 July 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 641 and 642.
[67] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 435.
[68] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 435.
[69] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 436.
[70] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 303. The same provision is in v1 of that guidance from August 2011 (archived July 2014).

6.39. In response to this concern GGC have advised the Inquiry that insect screens were fitted to the external overflow pipe on 18 June 2018.[71]

6.40. The absence of these screens are potentially deficient feature for the purposes of Glasgow III

Corrosion and non-compliant fittings in tanks

6.41. The presence of corrosion on tank fittings is a potentially deficient feature, because deterioration of the corroded part could produce material, such as rust, which could detach from the part and enter the water supply. A series of such concerns were identified for elements of the water system around the tanks.

6.42. There is an undated a tank report/investigation produced by Nicholson Plastics Ltd, believed to date from July 2021.[72] The report appears to have been instructed by DMA following concerns relating to corroding fittings in the tanks and resulting debris, which was considered unusual for the age of the tanks (approximately 8 years).[73] The report noted:

> "Immediately on attendance it was evident corrosion is taking place on fasteners, strengthening tie bars and internal dividing wall supports. This occurs above and below the water line but is more prevalent above the water line where oxidisation occurs. Resultantly there is continual debris and contaminants from the corrosion entering the stored water either in solid or liquid form."[74] "As time passes the fasteners & more importantly retaining tie bars will weaken through further corrosion which will result in further contamination, potential weaknesses within the integrity of the seals on the tank panels as forces are lessened and may result in leaks and potentially catastrophic failure".[75]

6.43. It was also noted that marking stamps on fasteners showed non-compliant use of sub-standard A2 stainless steel (grade 1.4301) instead of compliant A4 (grade 1.4401), which is described as the expected minimum specification for a tank within a hospital.[76] The report advised that sample steel components could be removed from the tank and sent for analysis for avoidance of doubt:

> "The importance of the use of the correct compliant grade of stainless steel cannot be understated particularly when coming into contact with

[71] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 983.
[72] A44312597 - Nicholson Plastics Tank Report – Bundle in relation to Water PPP – Page 1003. A44311444 - Parts 2(i), (ii) and (iii) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 997 advises the tank report was conducted in July 2021.
[73] A44312597 - Nicholson Plastics Tank Report – Bundle in relation to Water PPP – Page 1003.
[74] A44312597 - Nicholson Plastics Tank Report – Bundle in relation to Water PPP – Page 1003.
[75] A44312597 - Nicholson Plastics Tank Report – Bundle in relation to Water PPP – Page 1016.
[76] A44312597 - Nicholson Plastics Tank Report – Bundle in relation to Water PPP – Page 1003.

levels of free chlorine no matter how diluted."[77]

6.44. Mesh openings were also identified on vent air intakes, allowing the tank to 'breath'. The openings in this mesh were recorded to be greater than the permitted standard of 0.65mm, enabling air containing contaminants to be drawn into the tanks under heavy draw off. Damaged & misaligned lid cover panels were also identified that may have contributed to this issue.[78]

6.45. GGC have advised the Inquiry that, following Nicholson Plastics' tank inspection, testing of fittings was undertaken.[79] Testing of rods and bolts was conducted on 14 October 2021 but the test certificates provided do not explain the purpose of the tests or the meaning of the results, but it does appear that some of these elements are made from steel that appears to be out of specification.[80]

6.46. The Inquiry team understand that Pro Lp Consulting Ltd were instructed in the regulatory role of 'Authorising Engineer', to act as an independent professional advisor to the NHS Board. In terms of SHTM 04-01, an Authorising Engineer acts as an assessor who, among other things, monitors the performance of the water service and provides an annual audit to the NHS Board.[81] A Pro Lp Consulting Ltd Authorising Engineer Management and Compliance Audit dated 28 February and 1 March 2022 advised: "The records show that the cold-water storage tanks were cleaned and disinfected in October 2021 and January 2022."[82] It is not known if this was undertaken in response to the Nicholson Plastics report or resolved the concern regarding corroding fittings.

6.47. In any event, the Compliance Audit also stated: "Legionella sampling has been undertaken on a monthly basis across the hospital and includes testing on the cold water storage tanks. There have not been any positive legionella tests completed in the past year."[83] The audit goes on to explain that a system for sampling water and recording the remedial actions for any out of specification results has been in place since 2018. A repeat audit by Pro Lp Consulting Ltd dated 11 January 2023 advised that cold water storage tanks are cleaned and disinfected on an annual basis.[84]

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[77] A44312597 - Nicholson Plastics Tank Report – Bundle in relation to Water PPP – Page 1016.
[78] A44312597 - Nicholson Plastics Tank Report – Bundle in relation to Water PPP – Page 1003.
[79] A44311444 - Parts 2(i), (ii) and (iii) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 997.
[80] A44311662 - Certificate ref: E 105723 – Bundle in relation to Water PPP – Page 1398; A44311682 - Certificate ref: E 105725 – Bundle in relation to Water PPP – Page 1399; A44311652 - Certificate ref: E 105724 – Bundle in relation to Water PPP – Page 1400; A44311688 - Certificate ref: E 105722 – Bundle in relation to Water PPP – Page 1401.
[81] A33103409 - SHTM 04-01 Part B, July 2014 – Bundle in relation to Water PPP – Pages 423.
[82] A44312654 - Pro Lp Consulting Ltd Audit 2022 – Bundle in relation to Water PPP – Page 1418.
[83] A44312654 - Pro Lp Consulting Ltd Audit 2022 – Bundle in relation to Water PPP – Page 1418.
[84] A44312832 - Pro Lp Consulting Ltd Audit 2023 – Bundle in relation to Water PPP – Page 1443.

6.48. The existence of these non-compliant stainless steel tank fittings is a potentially deficient feature for the purposes of Glasgow III

Water testing of tanks

6.49. A series of concerns arose as a result of testing undertaken at QEUH, the nature of which depended upon the particular testing being undertaken.

6.50. A timeline of incidents produced by the GGC Oversight Board noted in August 2018 that:

> "Water testing of tank room shows water mostly negative post filtration but raw water tanks have positive results from drain connections which are not capped or sanitised. This action is to be progressed. Bulk storage tanks also positive - believed to be due to environmental conditions – noted to be cockroaches, fungal odour, room not ventilated, water ingress and dried algae on floor. Area to be disinfected, repainted with anti-fungal paint, repairs made and pest control called in. Testing to be done once work completed."[85]

6.51. The same timeline noted that in December 2018, the first set of water samples from the tank room returned with good results.[86] However the timeline noted that in June 2019:

> "continual fungi results from water tanks but it was possibly due to cross-contamination during the sampling process which has now been modified to ensure this does not occur. Noted smell of mustiness from sprinkler tap room which was used as a storage room. Agreed area is to be cleaned and sanitised, tanks repaired and sealed to the floor."[87]

6.52. It was also noted in the timeline that, by July 2019, work to address mould in 'the water tank' had been carried out.[88] However it was noted that in August 2019:

> "Testing showed positive results for Ps [Pseudomonas] and coliforms from the main water tank room. Two filtered water tanks and an outlet downstream of the tanks in the children's OPD [Out Patient Department] on ground floor were sampled and have been submitted to lab. Noted that water sampling is identifying consistent activity for mould and yeast which have been sent for typing. Noted that where counts are low this is often due to dirty taps or sampling errors. Need to know coliform counters and results of nearby outlets upstream and downstream, and

[85] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 960.
[86] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 962.
[87] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 965.
[88] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 966.

results following disinfection and resampling. The ongoing issues in the basement plant room in terms of yeast and mould need to be further investigated"[89]

6.53. It was noted in the timeline that, in October 2019:

"Testing of basement tanks post filter shows Delftia in one tank and room. One Ps found in the drain points and TVCs are showing in raw water tank but only in certain lines. Noted that room has high level of humidity and musty smell."[90]

6.54. It was noted in the timeline that, in December 2019:

"Sampling of the air vents at top of tanks to be performed to see if anything there which might Infect tanks. Discussion will also be held with F&E [Facilities & Estates] to see what options there are to increase ventilation which is an issue. Re-sampling also to be done to determine if air in room is infecting the tank."[91]

6.55. A report produced for an GGC Acute Infection Control Committee (AICC) meeting of 30 September 2020 stated:

"A number of out of specs have been identified in the RAW water tank samples drains over the month:-

SAB's

H. Hyphomycete

M. Sterilia

Delfia Acidovorans

Acinetobacter Ursingii

TVC's

Roseomonas Mucosa

Enhydobacter Aerosaccus

Acinetobacter Iwoffii

Sphingobium Xenophagum"[92]

[89] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 966.
[90] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 967.
[91] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 968.
[92] A32700430 - AICC paper 30 September 2020 – Bundle in relation to Water PPP – Page 914.

6.56. A report appearing to date from 8 December 2020 and produced for an GGC AICC meeting noted:

> "A number of out of specs (16) have been identified in the RAW water tank over the month for TVC's, moulds and in some cases GNB's"[93]

6.57. As discussed above, Pro Lp Consulting Ltd's Authorising Engineer Management and Compliance Audit dated 28 February and 1 March 2022 advised that the cold-water storage tanks were cleaned and disinfected in October 2021 and January 2022."[94] Pro Lp Consulting Ltd's repeat audit dated 11 January 2023 advised that cold water storage tanks are cleaned and disinfected on an annual basis.[95] It is not known if this has resolved the above concerns.

6.58. The presence of these organisms in the tanks as discovered by these tests is a potentially deficient feature for the purposes of Glasgow III.

7. Filtration and filtration control

7.1. Concerns were raised at certain times regarding the operation of the filtration system, either because it was set up in such a way as to exclude useful functions which it might perform or had been operated in a way as to create potential risks to the safety of the water supply.

7.2. According to SHTM 04-01, filtration is normally used to prevent ingress of suspended solids into plant and pipework, and as such may be defined as the process of separating solids from liquids using a porous medium.[96]

7.3. The SHTM provided that all incoming cold water supplies destined for domestic use within NHS Scotland premises should be filtered.[97] 'Absolute filtration' of a specified size indicates that the filtration plant can remove 99.9% of all particles above a given size. 'Nominal filtration' is referred to when 95% of all particles above a specified size will be removed.[98]

7.4. The level of filtration within NHS Scotland where stainless steel pipework systems are installed should be 0.5 micron absolute, although this can be

[93] A32700431 - AICC paper 8 December 2020 – Bundle in relation to Water PPP – Page 925.
[94] A44312654 - Pro Lp Consulting Ltd Audit 2022 – Bundle in relation to Water PPP – Page 1418.
[95] A44312832 - Pro Lp Consulting Ltd Audit 2023 – Bundle in relation to Water PPP – Page 1443.
[96] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 675. The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 82.
[97] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 674. The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 81.
[98] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 675. The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 82.

relaxed to 5 microns on receipt of written guarantees from the pipework and fittings manufacturers that the system should have a life-span not less than that provided by a plastic pipework installation.[99]

7.5. The filtration plant should be capable of providing fully automatic operation and include self-cleaning and back-washing modes so that the filter medium does not become a reservoir of bacteria capable of contaminating the service pipework.[100]

Reconfiguration in event of fault

7.6. A potentially deficient feature arises in respect of the connection of particular filtration units to particular water tanks. In other words, due to these direct connection filtration units are thus unable to cover shortfalls in the other tanks to which they are not connected.

7.7. DMA's report of 1 May 2015 stated:

> "The filtration units fill separate Bulk Water Tanks (filtration unit 1 supplying 1A & 1B and filtration unit 2 supplying 2A & 2B). There is no way to reconfigure set-up to allow the filtration units to fill the other tanks under fault conditions."[101]

7.8. It is not clear what remedial action was taken in respect of this, however GGC have advised the Inquiry that an additional filtration unit was fitted in the basement plantroom and commissioned in March 2019, increasing the number of units from two to three. The three units were commissioned within the BMS system by Schneider on a duty-duty-standby rotation allowing one unit to be offline for planned maintenance when required, leaving two units operational.[102]

7.9. The lack of a system to enable reconfiguration at handover is a potentially deficient feature for the purposes of Glasgow III.

Bypass of the filtration system

7.10. This potentially deficient feature is covered at Chapter 5 of this Note.

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[99] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Pages 676 and 638. The preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 83 states that the level of filtration should be 0.5 micron absolute, with no further qualification.
[100] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 676. The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 84.
[101] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 212.
[102] A44311388 - Part 1(ii) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 974.

Failure of filtration units

7.11. The reliability of the filtration units around the handover period is a potentially deficient feature. The specific concern was around periods offline, due to unreliability, creating a knock-on effect by preventing the tanks from being refilled as the water was used.

7.12. The 2015 DMA Report states:

> "There have been issues reported with filtration units failing leading to Bulk Water tanks draining down."[103] "Upon inspection DMA noted that water levels in Bulk Water Tanks 2A & 2B were extremely low. NHS Estates were informed and advised this was due to a fault on the filtration system which had led to the Raw Water supply to the tanks being shut down. As site estates staff do not currently have access to the BEMS system, they were unaware of this fault. DMA were later advised a similar fault had occurred on the other filtration set affecting Bulk Water Tanks 1A/1B. In order to ensure continuity of supply to all areas the bypass between 1A/1B and 2A/2B was opened on both occasions. DMA were advised Estates staff are unsure why the bypass is closed as all four Bulk Water Tanks were classified as linked. Until site staff have access to the BEMS and the filter system monitoring it may be advantageous to leave the bypass open, ensuring all tanks are balanced and to introduce an inspection/monitoring regime at suitable intervals."[104]

7.13. GGC have advised the Inquiry that the DMA Report refers to water levels in tanks 2A and 2B being low (and not 1A and 1B) and that GGC understood this is "what led to the by-pass being opened by the escorting Estates Manager who was with the assessors at that time. This action by the Estates Manager was recorded in documentation sent to the Sector Estates Manager on 9th April 2015."[105]

7.14. GGC have further advised: "The 2015 DMA Risk Assessment records verbal reports of issues with the filtration units. GGC have no record of faults or if there were faults, how and when they were resolved. No record of faults or repairs were given to GGC at handover."[106]

7.15. This unreliability of the filtration units is a potentially deficient feature for the purposes of Glasgow III.

[103] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 137.
[104] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 212.
[105] A40543960 - GGC response to RFI No 8 – Bundle in relation to Water PPP – Page 939.
[106] A40543960 - GGC response to RFI No 8 – Bundle in relation to Water PPP – Page 935.

Service records

7.16. The availability of records prompted a concern when the system was being audited for risks posed by legionella.. A Legionella Management and Compliance Audit of 4th May 2017 stated:

> "No chemical water treatment is being used on site. The water coming into the site goes through an ultra-filtration membrane process…The membrane filtration system service records were not available at the time of the audit."[107]

7.17. The auditors recommended for any service records of the filtration system to be added to the legionella records.

7.18. An GGC review dated 29 January 2019 of recommendations from reports on the water system advised that filter cleaning reports are now stored on the 'SGH shared drive'.[108]

7.19. This non availability of records is a potentially deficient feature for the purposes of Glasgow III.

Flushing

7.20. A concern arose that the system may have been flushed without using the filtration system, the risk being that items normally excluded by the filters would have been able to enter.

7.21. A Water Management Issues Technical Review produced by Health Facilities Scotland in March 2019 noted:

> "There is evidence that flushing took place without the main water system filters in place. These filters are designed to prevent organisms above 2μm entering the water supply".[109]

7.22. This is a potentially deficient feature for the purposes of Glasgow III

8. Pipework

8.1. In respect of the materials to be used for pipe work SHTM 04-01 advises:

> "The materials generally used for the conveyance of water in healthcare premises are stainless steel or plastics. Copper is only used in exceptional circumstances such as, an extension to existing premises

[107] A44312599 - Legionella Management and Compliance Audit – Bundle in relation to Water PPP – Page 1261.
[108] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 88.
[109] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 145.

with short life expectancy, or very small stand alone premises."[110]

"Pipework in buildings should be designed and routed in a manner that will promote good turnover of water particularly in cold water service systems."[111]

"All cuttings of pipe should be capped immediately after they have been cut from a length of pipe and so also should the remainder of the length. If not, site supervisory staff should reject them from use on the system."[112]

"Temporary caps should be fitted to all open pipe ends of the pipework during installation, to protect it from ingress of dirt when it is not being worked on."[113]

Installation of pipework

8.2. It was observed in 2019 that methods around the time of installation of the pipework may have exposed it to a risk of contamination. In addition, a concern was raised that water may have been introduced to the pipework before commissioning, potentially for a prolonged period.

8.3. An NEC 3 Supervisor's report of March 2011 noted:

"Installation of hot, cold, heating and chilled water pipework on all levels is progressing, and generally being installed to a good standard. A few open ends were still being left for extended periods. Brookfield [Multiplex] to again be reminded to seal ends against ingress of dirt."[114]

8.4. It is not clear to the Inquiry team when this concern was first identified. This is the first explicit mention of open-ended pipework in the Supervisor's reports.

8.5. Open ended pipework was still being identified as a concern in the Supervisor's report of September 2013.[115] By April 2014 it was noted that there had been a marked improvement in all areas.[116] Installation of pipework was nearing completion in January 2015.[117]

[110] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 324. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[111] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 329. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[112] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 631; The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 28.
[113] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 631; The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 28.
[114] A33818735 - Capita Supervisor's Report No. 10 – Bundle in relation to Water PPP – Page 1031.
[115] A44312871 - Capita Supervisor's Report No. 30 – Bundle in relation to Water PPP – Page 1062.
[116] A44312885 – Capita Supervisor's Report No. 36 – Bundle in relation to Water PPP – Page 1107.
[117] A36384755 – Capita Supervisor's Report No. 45 – Bundle in relation to Water PPP – Page 1191.

8.6. In relation to this concern, a Water Management Issues Technical Review produced by HFS in March 2019 noted:

> "The Project Supervisor has noted in several reports that various pipes were left open-ended and unprotected during the installation period. There is no evidence to suggest that this pipe work was rejected, therefore the pipe work was probably subject to contamination and the introduction of moisture via condensation. There is evidence that water was in the pipe work in some areas of the building in August 2014. Commissioning of the systems was not until November 2014."[118]

8.7. The leaving open of pipework during and after installation is a potentially deficient feature for the purposes of Glasgow III.

Deadlegs of pipework and insufficient backflow protection

8.8. A potentially deficient feature of the water system related to the presence of 'deadlegs', this being where the pipework was set up or operated in such a way as to have lengths of pipe which did not see regular water flow. The potential risk was that the water may become stagnant, with potential for organic growth, not mitigated by regular flushing. Insufficient backflow protection on certain pipework was also noted as a potentially deficient feature, representing a risk that contaminated water might flow in a direction unintended by the purpose of the pipe.

8.9. DMA's 2015 Risk Assessment identified deadleg pipework in a number of areas of the hospital, including in plantrooms and a Medical Day Unit.[119] These were highlighted red for attention as soon as reasonably practicable.

8.10. A GGC review of DMA's recommendations dated 16 December 2018 considered that most of these were not deadlegs. For example, deadlegs noted by DMA in Hydrotherapy Plantroom A-1FMB-030 were described as "fill points for the drench shower/bib tap and are on a flushing regime".[120] More general deadlegs noted on the domestic water system were described as connections required for flushing purposes.[121] By contrast, deadleg pipework identified in Medical Day Unit MDU-005 was noted as having been removed on 24 July 2018.[122]

8.11. GGC have advised the Inquiry that the deadlegs identified by DMA were

[118] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 74.
[119] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Pages 156 and 163.
[120] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 859.
[121] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 852.
[122] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 859.

removed between 2015 and 2017.[123] While the DMA Report of 25 April 2018 appears to identify much of the same deadleg pipework as in their 2015 report,[124] an GGC review of DMA's recommendations dated 29 January 2019 disagreed that these were deadlegs.[125]

8.12. Scottish Water Byelaws Inspection Reports of 28 February 2020 and 10 March 2023 identified numerous instances of high risk deadlegs and insufficient backflow protection across the QEUH site.[126] It is not known what remedial actions if any have been taken to address those concerns.

8.13. These identified deadlegs and lack of backflow protection are a potentially deficient feature for the purposes of Glasgow III.

Copper tails

8.14. Copper tails are lengths of pipe forming a connection between the main piping system and a fitting such as a tap. Their being made of copper, rather than the stainless steel specified for the water system, is contrary to the standards for materials to be used for pipe work in SHTM 04-01 discussed above.

8.15. DMA's 2015 report states:

> "there were copper tails on connections to a small number of outlets e.g. Infrared taps in non-patient toilets and in the endoscopy wash room DCT-009."[127]

8.16. SHTM 04-01 advises that corrosion of copper piping within DHCW [Domestic Hot and Cold Water] services in many Scottish hospitals and other Healthcare Premises is a serious problem."[128] As a result of the implications of the use of copper as a piping material, the SHTM recommends careful consideration prior to the material being proposed for use for DHCW services pipework in new or refurbishment projects. The strongest recommendation is made that it should be employed only for small, localised repairs.[129]

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[123] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 980.
[124] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Pages 425 and 449.
[125] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Pages 87 and 88.
[126] A43262538 - Scottish Water Byelaws Inspection Report, 28 February 2020 – Bundle in relation to Water PPP – Page 1390; A43262488 - Scottish Water Byelaws Inspection Report, 10 March 2023 – Bundle in relation to Water PPP – Page 1446.
[127] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 232.
[128] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 617; The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 13.
[129] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 618; A

8.17. The DMA Report of 25 April 2018 identifies the same concern regarding copper tails.[130] It is not clear to the Inquiry team what if any remedial action was taken to address this concern.

8.18. The existence of copper tails within the system is a potentially deficient feature for the purpose of Glasgow III.

Placement of pipework

8.19. The location of the pipework in the ceiling voids is a potentially deficient feature of the water system for the purposes of Glasgow III due to the relative difficulty of accessing such pipework as the location might make monitoring of the system more difficult.

8.20. DMA's 2015 report stated:

> "Domestic water pipework runs above ceilings throughout the building. Access for ongoing monitoring will be problematic as ceiling tiles cannot be easily removed within the hospital environment and alternative methods of monitoring should be considered should current BEMS [Building Energy Management System] monitoring points not be sufficient for the hot flow and return system (e.g. additional BEMS monitoring points installed)."[131]

8.21. The DMA report of 2018 identified the same concern.[132]

8.22. GGC reviewed the recommendations from DMA's 2015 and 2018 assessments on 16 December 2018 and 29 January 2019 respectively. It was noted in response to this concern:

> "This is a note, not a non-compliance…MEMS monitoring points are considered sufficient."[133]

Use of carbon steel pipework

8.23. One section of pipe was found to be made from 'carbon steel', a different material to the specified stainless steel. Multiplex have advised the Inquiry that:

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similar provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 14.

[130] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 426.

[131] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 232.

[132] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 426.

[133] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Pages 851 and 894; A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Pages 95, 96 and 102.

> "during April 2016 GGHB [Greater Glasgow Health Board] advised Multiplex that it had experienced a leak in the domestic water system in ARU2 [Acute Receiving Unit] and when repairing identified that a carbon steel fitting had been connected to the domestic water stainless steel pipework. Mercury carried out remediation of this."[134]

8.24. SHTM 04-01 advises:

> "The materials generally used for the conveyance of water in healthcare premises are stainless steel or plastics."[135] "The character of water in Scotland is such that steel, whether galvanised or not, should not be used at all for domestic hot and cold water installations. Any existing premises with such pipework shall have this scheduled for early replacement."[136] "Stainless steel, PVC-C, PB and PE-X piping may be used in hot water systems and in cold water systems."[137]

8.25. In response to this concern GGC have advised the Inquiry that the section of pipe was removed and a local disinfection undertaken.[138] Multiplex have advised that, during November 2016, Mercury and GGHB carried out a survey at random locations around the Hospital to confirm that this was an isolated incident. No carbon steel was identified during the survey.[139]

8.26. The use of carbon steel pipework in the water system is a potentially deficient feature for the purposes of Glasgow III.

Biofilm and corrosion

8.27. As part of an incident in 2018 a concern arose around exposed metal parts within sink waste pipes and the seal joining those pipes with plastic pipes. This potentially deficient feature arose from the fact that direct contact between metal and waste material was causing corrosion, with the join also forming a location where organic growth could occur.

8.28. IMT Minutes dated 8 June 2018 stated:

> "Colin Purdon showed the group an unused waste pipe that has been

[134] A44039957 - Multiplex Response to s.21 Notice number 8 – Bundle in relation to Water PPP – Page 1452.
[135] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 324. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[136] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 324. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[137] A33103412 – SHTM 04-01 Part E, Aug 2015 – Bundle in relation to Water PPP – Page 625; The same provision can be found in the preceding guidance A46213604 - SHTN 2, Dec 1999 – Bundle in relation to Water PPP – Page 22.
[138] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 979.
[139] A44039957 - Multiplex Response to s.21 Notice number 8 – Bundle in relation to Water PPP – Page 1452. See also A44976432 - Domestic Water Service Survey – Bundle in relation to Water PPP – Page 999 and A44976593 - Domestic Water System Sample Schedule – Bundle in relation to Water PPP – Page 1219.

> fitted to all sinks within the RHC. It showed an exposed metal part of the pipe attached to a plastic pipe with a silicon seal around the join. Colin then produced a pipe that had been taken out of an existing CHWB [Clinical Hand Wash Basin] within a room in ward 2A which showed a thick bio film around the joint and inside the pipe as well as signs of corrosion to the metal.
>
> "Colin spoke about the pipe work and said the most recent version does not have exposed metal parts so no water/chemicals etc will be in contact with metal parts.
>
> "…Dr Inkster has proposed that all drains within high risk areas should be replaced with this updated version of pipe work."[140]

8.29. It appears from the IMT Minutes that this replacement work continued into late 2018, with a completion date set for 14 December of that year.[141]

8.30. This is a potentially deficient feature for the purposes of Glasgow III.

9. Plant rooms

9.1. The cleanliness of plant rooms was raised as a potentially deficient feature of the water system. IMT Minutes of 27 December 2018 stated:

> "all plant rooms checked, most plant rooms contained rubbish, food stuffs and bird droppings. Excessive in some. Plant room 12 – evidence of infestation with birds roosting on beams and pipes. Two live pigeons found."[142]

9.2. The same Minute advised that all plant rooms were cleaned and would be inspected every two weeks for evidence of pest infestations. The Inquiry team therefore understand this concern may be an ongoing one, dependent on appropriate operational procedures in order to be managed. It is not known if anything more has been done to help resolve the concern.

9.3. An IMT Minute of 14 August 2019 stated that a water sample taken from a basement plant room had tested positive for Klebsiella and Pseudomonas putida. It was not known if this was a pre or post filter sample.[143] It is not known what if any action was taken to resolve this concern.

9.4. A timeline of incidents produced by the GGC Oversight Board noted 'ongoing

[140] A36690464 – 08.06.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 - Page 111.
[141] A36629319 – 22.11.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 238.
[142] A36605180 – 27.12.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 251.
[143] A36591626 – 14.08.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 344.

issues' in August 2019 in the basement plant room in terms of yeast and mould that needed to be investigated further.[144] The same entry on the timeline notes that water samples from the main water tank room tested positive for Pseudomonas and coliforms, as well as for mould and yeast. It is also not known what if any action was taken to resolve this concern.

9.5. The cleanliness of plant rooms is a potentially deficient feature for the purposes of Glasgow III.

10. Cold water distribution supply, cold water dump valves, layout of hot/cold pipes

10.1. SHTM 04-01 states:

> "The [cold water distribution] installation should be designed to avoid waste, undue consumption, misuse and contamination. Every water fitting through which water is supplied for domestic purposes should be installed in such a manner that no backflow of fluid from any appliance, fitting or process can take place"[145]
>
> "All pipework should be insulated, except for any exposed final connections to sanitary appliances, and should be arranged to eliminate or minimise dead-legs."[146]
>
> "The control of water temperature in the cold water service, however, will essentially rely on good insulation and water turnover. Cold water services should be sized to provide sufficient flow at draw-off points. Stagnation should be avoided."[147]

Single Cold Water Supply

10.2. The fact that, in general, all units were supplied by the single bulk water system is a potentially deficient feature of the water system at QEUH. The concern is that this lack of flexibility created a risk when it came to functions such as disinfecting the system, such that co-ordination would be required to ensure that this be done at suitable times.

10.3. DMA's report of 2015 stated:

> "It should be noted that there is no separate dedicated supply to the

[144] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 966.
[145] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 294. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[146] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 295. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[147] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 295. The same provision is in v1 of that guidance from August 2011 (archived July 2014).

> Renal (or other medical) systems, with all being fed from the Bulk Water system. This means that system disinfections will require to be very carefully scheduled or carried out locally as the disinfection procedure/chemical may interfere with the renal/medical systems and impact on patient welfare."[148]

10.4. The Inquiry team understand that the nature of this concern is an ongoing one, dependent on appropriate operational procedures in order to be managed. DMA's report of 2018 recommended:

> "an emergency action plan is formulated to allow for system disinfection if/when required and this should include alternative supplies to Renal (or other) medical systems, or alternative arrangements made for the period disinfection is being carried out."[149]

10.5. A report produced by DMA in January 2019 noted:

> "DMA understands that suitable filtration and testing regimes have been implemented on the renal system in light of the ClO_2 [Chlorine Dioxide] dosing systems being installed, and that supply pipework to the renal plants have been altered to bypass the local ClO_2 'top-up' units. Emergency procedures should be considered and formulated to allow for system disinfection if required. Alternatively, a separate independent supply should be considered for this system."[150]

10.6. It is not clear what further remedial actions have been taken for this concern.

10.7. This single point of supply system is a potentially deficient feature for the purposes of Glasgow III.

Cold Water Temperature

10.8. Variations in the temperature in the cold-water system were raised persistently as a potentially deficient feature of the system. Higher temperatures create a greater risk of organic contamination, that being of particular concern with regard to legionella.

10.9. DMA advised in their 2015 report:

> "The cold water temperatures recorded by DMA vary considerably with the majority being more than 5°C higher than those recorded at the water tanks and with peak temperatures of 30°C being noted. Additional control measure such as flushing, disinfections and background dosing flushing should be implemented until such times as the area/department

[148] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 231.
[149] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 421.
[150] A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1371.

fully occupied, storage and distribution temperatures and microbiological results are consistently satisfactory."[151]

10.10. SHTM 04-01 recommends that, in normal circumstances, cold water should be delivered below 20°C. Anything above 20°C creates the potential for Legionella bacteria to breed. At cold water draw-off points, a temperature of no greater than 2°C above the temperature measured in cistern and cold-water header tanks should be reached within two minutes.[152]

10.11. Due to the temperature deviations and out of specification NHS microbiological sampling results, DMA recommended fitting supplementary control systems (e.g. background dosing such as chlorine dioxide), in order to maintain microbiological control and/or biofilm monitors (such as BioSense sensors/controller) to assist in focusing remedial actions onto identified areas of microbial activity.[153]

10.12. Heat gain on the cold-water system was recorded again by DMA in both their 2018 and 2019 reports:

"Investigations should be carried out as to the reasons for this with appropriate remedial actions taken e.g. additional insulation, installation of flushing valves, manual flushing of outlets, servicing of TMVs to reduce likelihood of back flow of hot into cold (or opposite). Sampling, disinfections and background dosing should be considered as part of the escalation process should any issues persist."[154]

10.13. GGC reviewed the recommendations from DMA's 2015 and 2018 assessments on 16 December 2018 and 29 January 2019 respectively. It was noted in response to this concern:

"Temperature issues were due to lack of occupancy on the site and has subsequently been resolved around full occupancy. Each sector/ward area had a robust flushing and sampling regime carried out prior to occupancy by clinical staff/patients etc."[155]

"This is a note - not a non-compliance. Set point increase on calorifiers [noted as having a possible beneficial effect of improving cold water

[151] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 231.
[152] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 295. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[153] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 231.
[154] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 425; A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1373.
[155] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 850.

temperature] was done in 2015."[156]

10.14. The full extent of remedial actions undertaken is not known to the Inquiry team. GGC have advised the Inquiry that from November 2018 to January 2019, a Continuous Chlorine Dioxide dosing system was installed in the QEUH and RHC.[157] It is not known if this fixed the concern or whether it was done in response to either of the DMA reports or the findings of the 2018 Water Incident IMT.

10.15. In any event the variations of the temperature of the cold-water system is a potentially deficient feature for the purposes for Glasgow III.

Dump Valves in the cold-water system

10.16. The presence of dump valves might serve to mitigate concern about variations of the temperature of the cold-water system by causing automatic flushing should the cold water reach a particular temperature. However, a concern was raised as to whether those were functioning properly. The dump valves may therefore themselves have constituted a potentially deficient feature. The consequent risk would be of the higher temperatures going unaddressed.

10.17. DMA's 2015 report stated:

> "there are ongoing commissioning problems on the cold water dump valve system and the system is not operating as intended. DMA have noted during site surveys there were areas with cold water temperatures in excess of 20°C and dump valves are fitted, but the valves not discharging. Corrective action should be taken and once fully operational the control set points and parameters for discharging should be referenced in site written scheme."[158]

10.18. The Inquiry team understand that dump valves reduce the ability for water to stagnate, by purging it automatically from the cold-water distribution system. At QEUH, the dump valves were intended to purge water when the building management system detected cold water temperatures of 23°C.

10.19. GGC reviewed the recommendations from DMA's 2015 assessment on 16 December 2018. It was noted in response to this concern:

> "Dump valves were not fully operating at this time since they had been installed without the valve heads connected correctly. New Draft written scheme has been amended. Flushing occurred for 12 week

[156] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 95.
[157] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 984.
[158] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 231.

commissioning period."[159]

10.20. GGC have advised that, after April/May 2015, cold water dump valve heads were connected to BMS system to rectify this concern.[160] The dump valve system was not mentioned in DMA's 2018 or 2019 report. Accordingly, the Inquiry team understand that the above actions resolved the concern.

10.21. The non-operation of the dump values in the first few months of occupation of the hospital is a potentially deficient feature of the system for the purposes of Glasgow III.

Steam humidifiers

10.22. Steam humidifiers were present on the system for a time without being operational, and as such were identified as a potentially deficient feature of the water system. The consequence (as might be the case for any unused equipment) was of its mere presence constituting a deadleg, there being as a result a length of 'pipe' which would not see throughflow of water.

10.23. DMA advised in their 2015 report:

> "The steam humidifiers do not appear to have been commissioned as yet (and DMA were informed by Estates these may not actually be commissioned in the immediate future) creating deadlegs on the cold system within the relevant plantrooms. It is advised that these have suitable backflow protection installed on the lines where the tee-off from the main line or are included in the site flushing regime until such times as the units are commissioned and fully operational."[161]

10.24. In response to this concern GGC have advised that the steam humidifiers referred to were removed in February 2018.[162] Steam humidifiers were not raised as a concern in DMA's 2018 report. Accordingly the Inquiry team understand this action resolved the concern.

10.25. The non-commissioning of the steam humidifiers in the first few months of occupation of the hospital is a potentially deficient feature of the system for the purposes of Glasgow III.

Pipework runs and sentinel outlets

10.26. In 2015 it was identified that in some places the configuration of the pipework

[159] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 851.
[160] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 979.
[161] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 233.
[162] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 981.

meant that long sections of pipe existed which might see little flow of water, creating a risk of stagnancy if flushing did not otherwise take place. DMA's 2015 report stated:

> "The bib taps, irrigation points etc. and 12th floor heli-pad fire suppression system which are fed from the Trades system have very long runs through the building and plantrooms to the outlets. All points on the trades system should be included in the site flushing regime – though additional flushing (outlets run for extended periods) may be required to bring temperatures on distribution system down particularly during periods of low use (e.g. in winter when irrigation system is not required to operate frequently).
>
> "No outlets on the Trades system have been designated as 'sentinel outlets'. Due to the type of system and the extended pipe runs to the outlets it may be prudent to designate all outlets from this system as sentinel and include in monthly monitoring and site flushing regime."[163]

10.27. The same concern is flagged in DMA's 2018 and 2019 reports.[164] The 2019 report notes that irrigation points are no longer connected to the water system, but still recommends inclusion of all points on the Trades system in the site flushing regime. DMA also note in their 2019 report that a programme of removing all non-essential bib taps and outlets on the Trades system is under way. The meaning and significance of sentinel outlets are not clear to the Inquiry team. It is also not clear what if any remedial action has been taken in relation to the recommendation for sentinel outlets on the Trades system.

10.28. GGC reviewed the recommendations from DMA's 2015 and 2018 assessments on 16 December 2018 and 29 January 2019 respectively.[165] In response to DMA's concern it was noted that the irrigation system was disconnected in early 2017 and that the Trade system only supplied the fire-fighting equipment for the helipad. Flushing was not considered to be required.[166] It is not yet clear to the Inquiry team how this sits with DMA's recommendation for flushing.

10.29. The parts of the trades system identified in the 2015 DMA report and described above are potentially deficient features for the purposes of Glasgow III.

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[163] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 233.
[164] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 427; A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1375.
[165] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 844; A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 86.
[166] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 860.

Out of specification sampling results

10.30. The 2015 DMA report stated:

> "A microbiological sampling sweep was being undertaken whilst DMA were on site carrying out the site surveys. No results for these samples have been forwarded to DMA for comment or recommendations, though DMA were advised that system disinfections were being carried out on 24th April due to 'out-of-specification' results being returned and that an increased flushing regime had been implemented in the areas where out of specifications results obtained."[167]

10.31. The Inquiry team understand 'out of specification' to mean water samples where particular microbe levels are exceeded. In such an event escalation procedures and remedial actions are recommended.

10.32. As discussed at paragraphs 10.8 to 10.14 of this Note, the out of specification sampling results in conjunction with temperature deviation led DMA to recommend fitting supplementary control systems (e.g. background dosing such as chlorine dioxide), in order to maintain microbiological control and/or biofilm monitors (such as BioSense sensors/controller) to assist in focusing remedial actions onto identified areas of microbial activity.[168]

10.33. GGC have advised the Inquiry team that the water systems were re-sterilised in late April/May 2015 as a result of these failed samples.[169] However in light of the later contamination concerns discussed elsewhere in this PPP, the Inquiry team's current understanding is that this re-sterilisation did not resolve the presence of microbes in the hospital's water system. GGC have advised the Inquiry that from November 2018 to January 2019, a Continuous Chlorine Dioxide dosing system was installed in the QEUH and RHC.[170] It is not known if this fixed the concern.

10.34. That the cold water system was out of specification is a potentially deficient features for the purposes of Glasgow III.

11. Hot water distribution supply

11.1. SHTM 04-01 states that:

> "Hot water is taken from the top of the storage vessel, or water heater,

[167] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 233.
[168] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 231.
[169] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 979.
[170] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 984.

> and will normally be circulated around the building in a piped distribution system. The flow temperature should be set to 60°C and the minimum temperature of all return legs to the vessel or water heater should be 50°C… The individual outlets, taps, mixing valves or other outlet devices will be served from the distribution system; this should be designed such that the minimum temperature at the most distant taps or outlets is 55°C. The control of Legionella requires there to be a minimum temperature of 50°C in hot water service systems."[171]

Water temperature

11.2. Concern was raised in 2015 that temperatures in the hot water system being below that recommended by guidance. DMA's 2015 report stated:

> "hot [water] temperatures frequently recorded below 55°C at supply to TMVs. It should be noted though that direct hot taps did reach temperatures of 55°C and supply to TMVs was almost invariably above 50°C... As 55°C at all outlets is the control parameter set by SHTM 04-01 corrective actions should be carried out to ensure this is achieved. This may include increasing the calorifier set points - see calorifier sections for further comments and recommendations."[172]

11.3. Calorifiers are dealt with separately at Chapter 12 of this Note.

11.4. GGC have advised the Inquiry that the temperatures of calorifiers were increased from 60°C to 65°C in May 2015 to resolve the low temperatures identified by DMA.[173]

11.5. DMA's 2018 and 2019 reports suggests an improvement in hot water temperatures, describing them as "generally satisfactory".[174] However an HFS Water Management review of March 2019 noted:

> "The hot water is designed for 60°C flow and 55°C return. It has been advised by GGC that these temperatures are not what is being found in practice due to issues with the Energy Centre."[175]

11.6. Pro Lp Consulting Ltd's Authorising Engineer Management and Compliance Audit dated 28 February and 1 March 2022 advised:

> "The calorifier flow and return temperatures generally appear to be

[171] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 308. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[172] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 231.
[173] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 979.
[174] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 425; A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1373.
[175] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 82.

acceptable. They are monitored on the monthly sheets and also on the Scheider BMS."[176]

11.7. It is not clear to the Inquiry team whether the concern regarding hot water temperature has therefore been resolved and therefore the hot water system temperature is a potentially deficient feature for the purposes of Glasgow III.

Deadlegs in the hot water system

11.8. The set-up of the hot water system is identified as a potentially deficient feature, in that its configuration led to the existence of (at least potential) deadlegs. Again, the risk from a deadleg would be from the potential for stagnant water to build up unless flow arose from use or from flushing.

11.9. DMA's 2015 report stated:

> "DMA have been advised by Mercury Engineering that the domestic hot water systems do not operate on a conventional flow and return system, with principle, sub-ordinate and tertiary loops, instead utilising a reverse return circuit. This means that there are longer 'deadlegs' to the outlets than SHTM 04-01 advises."[177]

11.10. DMA's 2018 report stated:

> "At the time of initial assessment in 2015 DMA were advised that there are minimal localised "tertiary" loops and that the drops to individual outlets were as short as was reasonably practical to install. It was noted that hot temperatures generally rose very quickly when DMA were recording temperatures throughout the building and the flow and return circuits appear to be circulating hot water in most areas."[178]

11.11. DMA's January 2019 report advised that alterations had been made to the hot flow and return system in Wards 2A & 2B to bring the flow and return loops down as close as practical to the actual outlets, though those wards remained out of use at the time of the report.[179] It is not clear to the Inquiry team whether this means the concern has been resolved. The existence of such deadlegs is therefore a potentially deficient feature for the purposes of Glasgow III.

[176] A44312654 - Pro Lp Consulting Ltd Audit 2022 – Bundle in relation to Water PPP – Page 1414.
[177] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 232.
[178] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 425.
[179] A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1373.

12. Calorifiers

12.1. SHTM 04-01 explains:

> "Storage calorifiers are usually cylindrical vessels mounted either vertically or horizontally…the entire storage volume should be capable of being heated to 60°C without permanent pockets of lukewarm water."[180]

> "Where more than one calorifier or heating device is used, they should be connected in parallel, taking care to ensure that the flow can be balanced so that the water temperature from all the calorifiers is not less than 60°C at all times."[181]

Temperature

12.2. A concern has been repeatedly raised about the temperature of hot water. Too low a temperature creates the risk potential for growth of certain microorganisms. The remedial measures for this included addressing the output of the calorifiers.

12.3. DMA's report of 2015 advised:

> "The return temperatures recorded at the calorifiers were consistently below 55°C which DMA were advised was the control set point for these, though when calorifiers were at full temperature the returns were reaching 50°C. It may be prudent to increase calorifier set points to ensure calorifier returns remain above 55°C as this is the control set point. This may also help maintain a 60C minimum flow temperature when demand is placed on the calorifiers as the building becomes occupied. Increasing the calorifier temperatures may also have the beneficial effect of increasing the cold water usage as more cold water will be required at TMVs to blend water to TMV set point and so may assist in reducing the high cold water temperatures being recorded within the system.
>
> "When DMA were on site on the 21st of April there was a significant drop on the temperatures of the calorifiers 31-01/02/03, 31-07/08/09 and 21-01/02/03 which we understand was caused by a failure on the heating system. Temperatures recorded on these calorifiers on this day (as recorded in the following sheets) was 40- 45°C. This represented a significant break in the control system and there were no records of any remedial or corrective actions and no records of additional control measures. DMA would advise corrective actions and additional control measures (e.g. system pasteurisation/disinfection) should be carried out

[180] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 311. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[181] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 312. The same provision is in v1 of that guidance from August 2011 (archived July 2014).

in accordance with SHTM 04-01 in instances of this type. When DMA re-checked the affected calorifier temperatures on 27th April 2015 the temperatures had improved though 31-07/08/09 were still significantly lower than expected.

When calorifiers are running at full temperature they appear to be achieving 60°C consistently, though this cannot be fully verified as estates staff did not have full access to the BEMS system at the time of survey. There have been some exceptions to this as highlighted in the supportive data following where one calorifier appears to be the lead calorifier and subsequently has lower temperatures than the connected calorifiers in the bank of 3. This may be a balancing issue and should be investigated and corrected (e.g. Calorifiers 22- 01/02/03 with 02 being significantly lower temperature than 01 & 03)."[182]

12.4. GGC have advised the Inquiry that the temperatures of calorifiers were increased from 60°C to 65°C in May 2015 to resolve the low temperatures identified by DMA.[183] However DMA's 2018 report noted the same concern with respect to calorifier return temperatures and temperature discrepancies between lead and connected calorifiers in banks of three.[184]

12.5. DMA's report of January 2019 advised

"whilst carrying out flushing works and ClO_2 testing in wards 2A & 2B during December 2018 there were multiple instances of hot temperatures dropping off and being recorded at <55°C. This was reported to Estates on each occasion, with DMA advised there were issues in the Energy Centre which were causing a reduction in the MTHW supply to the Adult & Children's Hospital, which had a knock on effect to the calorifiers. Generally when advised issues were rectified the temperatures recovered quickly to ≥60°C within the wards.

"Distribution flow temperatures were consistently above 60°C, with return temperatures to calorifiers consistently above 55°C on all calorifiers (Plantroom 21 calorifiers just above 55°C), as recommended within L8/HSG 274 Part 2 and SHTM 04-01. All base temperature appeared satisfactory at time of survey also (26/09/18)"[185]

12.6. These repeated concerns about water temperatures in the hot water system is a potentially deficient feature for the purposes of Glasgow III.

[182] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 219.
[183] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 979.
[184] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 424.
[185] A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1372.

Non-operational Calorifiers as Deadlegs

12.7. One concern arising from the calorifiers related to a period when one was observed not to be in operation, with the result that it itself effectively came to form a deadleg because water was no longer flowing through it.

12.8. DMA's 2015 report advised:

> "Calorifier 32-03 was offline when DMA had an initial site familiarisation walk-round with Mercury Engineering in early January 2015. This calorifier was still offline when DMA were on site on 21st April 2015. This was creating deadlegs on the cold supply, hot flow and hot return to the calorifier and Estates staff were unable to confirm the reason for this calorifier being offline. This calorifier had been reinstated when DMA revisited on 27/04/15 though Estates not aware of any flushing, pasteurisation or disinfection of calorifier being carried out prior to reinstatement. DMA would recommend the calorifier (and hot system) is disinfected/pasteurised legionella samples taken from the calorifier and system prior to reinstatement to confirm these corrective actions have been effective."[186]

12.9. The above concern was not mentioned in DMA's 2018 or 2019 reports. The Inquiry team therefore presume the concern was resolved, however it is not clear what remedial action was taken to affect this.

12.10. The 2015 and 2018 DMA reports noted a deadleg to calorifiers in plant room 33.[187] An GGC review of this recommendation dated 16 December 2018 advised that no such deadleg was identified.[188]

12.11. Whether calorifiers have acted as deadlegs is a potentially deficient feature of the water system for the purposes of Glasgow III

Flushing

12.12. In 2015 concern was raised regarding the extent to which the calorifiers were flushed. Insufficient flushing would create the potential for the calorifiers to be locations where contamination could accumulate. DMA's 2018 report advised:

> "DMA noted very dirty water was purged from a number of calorifier drains which may indicate the flushing regime should be increased (Estates advised during the Gap Analysis that base flushing is being carried out though were unable to provide supporting evidence), or that

[186] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 219.
[187] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 226; A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 482.
[188] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 849.

> the methodology for flushing should be reviewed to ensure the calorifier base is being purged and not just the supply pipework."[189]

12.13. An GGC review of this recommendation dated 29 January 2019 noted:

> "The blowdown of all calorifiers and expansion vessels is carried out on a monthly basis at present."[190]

12.14. DMA's report of January 2019 advised:

> "Generally water flushed from drain on calorifiers and expansion vessels ran clear either instantly or after only a very short period of time (typically <10 seconds)."[191]

12.15. For the period before the commencement of regular blowdown or flushing of the calorifiers and expansion vessels insufficient flushing would be a potentially deficient feature of the water system.

13. Expansion vessels

13.1. The expansion vessels were identified as a potentially deficient feature of the water system. A concern was raised regarding the design of them created a risk of them (or at least areas within them) acting as 'deadlegs' such that they were not being reliably flushed, with the result being a risk that contamination could accumulate.

13.2. SHTM 04-01 sets out a description of the typical format of such vessels, as well as indicating the potential for unsafe features to arise:

> "The expansion vessels forming part of the pumping sets are typically pressurisation vessels, are typically vertical in orientation and have either a diaphragm or nitrogen fill in the upper space. They introduce a potential problem of colonisation by Legionella, as the plantroom space temperature will exceed that of the incoming water. They should be preferably of a design such that water flows through the vessel, entering at low level, and discharging at a higher level below the water line. Interconnecting pipework should be kept to a minimum, and the vessel should be insulated to minimise heat gain. All materials in contact with water should be WRAS-approved. It is important that the expansion vessel is located on the cold feed rather than on the hot water side of the system."[192]

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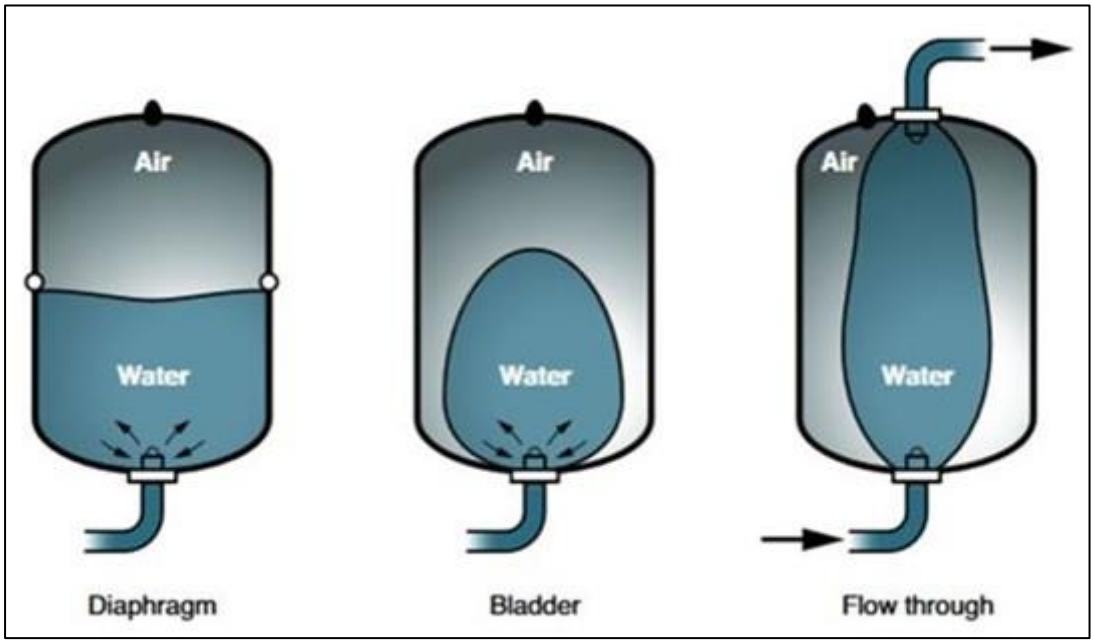
[189] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 424.
[190] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 91.
[191] A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1372.
[192] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 315. The same provision is in v1 of that guidance from August 2011 (archived July 2014).

13.3. HSE guidance on Legionnaire's Disease illustrates common designs for expansion vessels, including the directions of water flow, and describes further the risk of certain materials providing a surface location for contamination:

> "…In pressurised systems, a means of accommodating water expansion (caused by the water heating) is required. This is often achieved with the use of an expansion vessel. However, these may not fill and empty where the system pressure and temperature remains steady….



13.4. These internal bladders are often made of synthetic rubber such as EPDM and may support the growth of microorganisms. Vessels with a 'flow through' design should provide less opportunity for water to stagnate and become contaminated (as in the latter design)."[193]

13.5. DMA Canyon, in their Risk Assessment dated 25 April 2017, raised a concern regarding the design of expansion vessels, indicating that they were not of the 'flow through' type recommended in the passages above, and raised the possibility that the vessels had not received servicing:

> "Wherever possible/practical expansion vessels should be 'flow through' vessels and suitably insulated. Where this is not possible a expansion vessel should be included in site flushing regime (to correct procedure). Estates advised during the Gap Analysis that no expansion vessel flushing is being carried out and we would advise this is started immediately in addition to any servicing of the vessel which may also

[193] A46126597 - HSG274 Part 2 – Bundle in relation to Water PPP – Page 209.

have been missed previously"[194]

13.6. DMA's Water System Risk Assessment dated January 2019 repeated the above concern, while noting that remedial work was to be undertaken, as well as recording improved results in a flushing test from that carried out for the 2018 DMA report (set out above at the section on 'calorifiers – flushing'):

> "The expansion vessels attached to the calorifiers are not of a flow through design as recommended in HSG 274 Part 2 (info Box 2.1) and SHTM 04-01 Part A (Para 8.22) and they are not insulated as recommended in SHTM 04-01 Part A (Para 8.22). Estates advised that there is an intention to alter the pipework and vessels to accommodate flow through vessels in early 2019. Generally water flushed from drain on calorifiers and expansion vessels ran clear either instantly or after only a very short period of time (typically less than 10 seconds). No internal records of inspection for calorifiers were available" [195]

13.7. GGC have indicated to the Inquiry that work to address the above issue took place in February/March 2019:

> "Feb/Mar 2019
>
> 1(iii): Material change made to the water system (whether the physical infrastructure or system or working) as a result of concerns about its safety
>
> Replacement of 24 Domestic Hot Water expansion vessels (all plantrooms)
>
> (iv) Succinct explanation why material change was made
>
> Recommendation of 2017 DMA Risk Assessment (received in April 2018). The new design would be a flow through to remove the need for flushing the drains on the expansion vessels as this is deemed a dead leg"[196]

13.8. GGC have also indicated to the Inquiry that, as at May 2023, work was ongoing to replace domestic hot water expansion vessels as those had reached the end of their life cycles, but is not understood to have been a response to any wider concern.[197]

13.9. The use of non-flow through expansion vessels is a potentially deficient

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[194] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 435.
[195] A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1372.
[196] A44311444 - Parts 2(i), (ii) and (iii) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 985.
[197] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 987.

feature of the water system for the purposes of Glasgow III.

14. Chilled Beam Units ("CBUs")

14.1. The Inquiry team understand the chilled beam system is a separate water system designed supply water to the CBUs to control the cooling and heating within patient rooms.[198]

14.2. An IMT Minute of 19 June 2019 raised a concern of leaks from CBUs due to a boiler failure.[199] A later IMT of 1 August 2019 questioned why patients were situated underneath CBUs when there was a risk of condensation and/or leaking water dripping onto them. It was also noted that all patient rooms within the QEUH (with the exception of Ward 4B BMT) and RHC had CBUs.[200]

14.3. The merits of CBUs in hospitals, the existence of guidance on their use and their presence in the various wards in the hospital is discussed in the PPP on the Potentially Deficient Features of the ventilation system of the QEUH/RHC and reference is made to that document.

14.4. The IMT Minute of 1 August 2019 advised that sample fluid was taken from the chilled beams and tested for the presence of gram negative organisms.[201] 4 water samples (2 hot and 2 cold) were taken. The two hot water samples came back negative. The two cold water samples came back with heavy growth of pseudomonas oleovorans and small numbers of aeruginosa.[202]

14.5. It was agreed the CBUs would be cleaned every six weeks instead of the three month regime in place at that time.[203] New mechanical connectors to replace leaking fittings and biocide dosing were introduced in late August/early September 2019.[204]

14.6. Since the introduction of biocide to the cold water system of the chilled beams water samples were negative/clear.[205] The Inquiry team therefore understand

[198] A37991876 – 01.08.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 335.
[199] A36591625 – 19.06.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 Page 323.
[200] A37991876 – 01.08.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 335.
[201] A37991876 – 01.08.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 335.
[202] A37991958 – 08.08.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1– Page 339.
[203] A37991876 – 01.08.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 336.
[204] A41890723 – 23.08.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 351.
[205] A36591627 – 13.09.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 361.

this concern was resolved.

14.7. However the use of CBUs in the hospital is a potentially deficient feature for the purposes of Glasgow III.

15. Metering, temperature control, monitoring

15.1. SHTM 04-01 provides:

> "Domestic hot & cold water systems should be temperature monitored by the Building Management Systems performing to SHTM 08-05 to ensure compliance with the temperature standards specified in the relevant regulations and guidance. System parameters must be detailed in the Written Scheme for the Water system. The minimum Building Management System performance of the water system must be to ensure:
>
> - Domestic Hot Water is continuously monitored and records the parameters highlighted above i.e. 60°C flow (minimum) from the water heating device to ensure 55°C at the supply to the farthest draw-off (sentinel) point in the circulating system under normal use and no less than 50°C return (lowest limit) to the water heating device;
>
> - Cold Water is continuously monitored and records from the point where it enters a building as described above, i.e. no more than 20°C (highest limit);
>
> - failures outwith the parameters are subject to alarms and service response messages;
>
> - performance data require to be secured and retained for at least 5 years, but must be easily available to the Authorised Person (Water), the other independent professional advisors, assessors and others with an interest in system performance."[206]
>
> "DHW [Domestic Hot Water] and CW [Cold Water] system performance data is valuable for assurance and continuous improvement of Legionellosis risk control. Data should be reviewed and exploited as follows:
>
> - produce a BMS [Building Management System] plot covering a typical week, for each DHW and CW system;
>
> - identify non-compliant systems and prioritise them for remedial actions by risk category;

[206] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 374. This provision does not feature in v1 of that guidance from August 2011 (archived July 2014).

- repeat the plots on an annual basis and when there is a change e.g. change of use, engineering modifications, etc;

- maintain hard copy records in the Water Safety Log Book."[207]

15.2. The BMS system comprises a network of sensors, meters and controllers, which enable GGC to monitor the performance and condition of the water system. Water meters measure the cold water consumption of particular systems and areas of the hospital.

Temperature recording

15.3. Concern was raised on several occasions regarding the recording of temperature within the hot water system. The lack of records were indicated as making it difficult or impossible to form a true view of the position in that part of the system.

15.4. A Legionella Control AE Audit of 4 May 2017 stated:

> "There are very few measures made of stand alone hot water temperatures. Accordingly, in these records, it is difficult to know how the hot water system is performing in the hospital. It is recommended that temperatures are taken from the hot water pipework that supplies hot water to the Thermostatic Mixing Taps."[208]

15.5. It is not clear what if any remedial action was taken in respect of this concern.

15.6. A 'draft meeting report' of 25 April 2018 produced by Leegionella Ltd stated:

> "Currently there is no information available on water temperatures as there has been a problem with the BMS system and data loss as a consequence. This means the Trust is not able to show due diligence and I am therefore unable to comment on the temperature control regime."[209]

15.7. It is not clear what if any remedial action was taken in respect of this concern.

15.8. Pro Lp Consulting Ltd's Authorising Engineer Management and Compliance Audit dated 28 February and 1 March 2022 stated:

> "The record for the temperatures at the hot outlets appear to be missing for the months of April – only two sheets of records for that month, June, September, October, November and December 2020. Although the temperature records were not available for all months, it was stated that an inspection of the facilities management system, showed that the

[207] A33103411 - SHTM 04-01 Part G, July 2015 – Bundle in relation to Water PPP – Page 493.
[208] A44312599 - Legionella Management and Compliance Audit – Bundle in relation to Water PPP – Pages 1252 and 1253.
[209] A40732034 – Draft meeting report - Bundle 8 for Oral hearing commencing 12 June 2023 – Page 141.

> checks had been undertaken, except for November 2021. The bulk of the hot temperatures that are recorded in the records are from the TMV outlet as it is not allowed to remove IPS panels in many areas without an HAI Scribe. This does not therefore inform us as to what is going on in the hot water flow and return systems with the required level of detail. The BMS does however have end of line sensors within the Adults and Children hospitals and many of these will be on secondary loops. The BMS alarms if the temperatures are getting out of specification at these sensors. It is recommended that non TMV'd hot and cold outlets are identified in areas requiring HAI Scribes for panel removal, in order that a picture can be built up of the hot and cold water temperatures in that particular area, without the need to remove panels. Please note that this recommendation was also made in February 2020. It is recommended that a search is made to attempt to find the missing temperature records for 2020, and if found, that these records are added to the logbook."[210]

15.9. A repeat audit dated 11 January 2023 noted:

> "A review of the records show that the recorded hot temperatures are all hot temperatures from TMT or TMV blended outlets. It is important to know what the actual hot water system temperatures are. It is also conceded that there are situations where it will not be possible to remove lift off panels to get to the hot and cold feeds to the TMVs/TMTs. It is recommended that non TMT'd or TMV'd outlets are used to record the temperatures of the actual hot water temperatures going to the TMT or TMV, or that temperatures are recorded from the surface of hot water pipes going to the TMT's/TMV's."[211] "…it was stated at the time of the audit that these issues are being addressed."[212]

15.10. The report also advised:

> "A review of the records show that the recorded temperatures are all hot temperatures from TMT or TMV blended outlets. It is important to know what the actual cold water system temperatures are. It is also conceded that there are situations where it will not be possible to remove lift off panels to get to the individual cold-water pipes. It is recommended that non TMT'd or TMV'd outlets are used to record the temperatures of the actual cold water temperatures going to the TMT or TMV, or that temperatures are recorded from the surface of cold water pipes going to the TMT's/TMV's."[213]

15.11. It is not clear what if any remedial action was taken in respect of this concern.

15.12. The absence of complete records of temperatures in both the hot and cold

[210] A44312654 - Pro Lp Consulting Ltd Audit 2022 – Bundle in relation to Water PPP – Pages 1414 and 1418.
[211] A44312832 - Pro Lp Consulting Ltd Audit 2023 – Bundle in relation to Water PPP – Page 1438.
[212] A44312832 - Pro Lp Consulting Ltd Audit 2023 – Bundle in relation to Water PPP – Page 1440.
[213] A44312832 - Pro Lp Consulting Ltd Audit 2023 – Bundle in relation to Water PPP – Pages 1438 and 1439.

water systems is a potentially deficient feature for the purposes of Glasgow III.

Control measures other than temperature control

15.13. The reliance upon temperature as a control measure has been identified as a potentially deficient feature. A concern was raised regarding the risk of relying too much on temperature as a means of control, in particular because in a large system it may be difficult or impossible for temperature to be reliably maintained.

15.14. Leegionella Ltd's 'draft meeting report' of 25 April 2018 stated:

> "It is a concern that a hospital intended for high risk patients was not designed with a multiple barrier water safety plan approach and relies solely on temperature as a control measure. It is predictable highly [sic] that in large complex systems that water temperatures are unlikely to meet the control temperature target at every outlet 100% of the time (55°C within one minute at hot outlets and < 20°C within 2 minutes)"[214]

15.15. An Authorising Engineer Water Systems Management and Compliance Audit produced by Pro Lp Consulting Ltd and dated 11 January 2023 advised that, while temperature is the primary means of control within the water systems, it is now supported by the use of chlorine dioxide as a secondary disinfectant.[215]

15.16. The absence of a multiple barrier water safety plan approach and reliance solely on temperature as a control measure is a potentially deficient feature for the purposes of Glasgow III.

Temperature control

15.17. A concern was raised in relation to the design philosophy of the Medium Temperature Hot Water system, which therefore may also have been a potentially deficient feature. The nature and explanation of that concern appears to be highly technical. To avoid potential misunderstanding, the Inquiry team have not attempted to paraphrase or summarise the matter. It has therefore been narrated fully in the paragraph below.

15.18. A Forensic Analysis Report of 10 May 2018 by Innovated Design Solutions stated the following in relation to this concern:

> "From our forensic analysis it would appear there was likely to be inherent irregularities in terms of the original MTHW [Medium Temperature Hot Water] heating primary circulation design philosophy. These may have subsequently resulted in system temperature control instability, and consequently led to the CHP system underachieving

[214] A40732034 – Draft meeting report - Bundle 8 for Oral hearing commencing 12 June 2023 – Page 138.
[215] A44312832 - Pro Lp Consulting Ltd Audit 2023 – Bundle in relation to Water PPP – Page 1441.

intended desired level of performance"[216]

…

"the system was designed with the intention of varying volume flow rate within the primary MTHW distribution circuit as necessary to suit heat load requirements within the Adult and Children's Hospital, and the Laboratory Building (i.e. to suit demand on the secondary side of heat exchangers). In order to achieve this variable volume strategy, record documentation indicates that the Adult and Children's Hospital primary MTHW circuit was designed to operate on a constant temperature basis of 105°C flow, and 75°C return, with the Laboratory Building primary MTHW circuit being designed to operate on a constant temperature basis of 105°C flow, and 85°C return. These primary distribution temperatures would afford a mean water temperature at each plate heat exchanger of 90°C and 95°C respectively, and therefore, the associated plate heat exchangers should have been designed and selected to suit these varying mean water temperatures.

"The apparent design decision to operate the primary MTHW circuit serving the Laboratory plate heat exchangers on a differing basis of 105°C flow, and 85°C return, appears to be unusual as this would inevitably result in an increased mixed common primary return temperature above the 75°C indicated on record drawings. This would in all probability have resulted in system temperature control instability, particularly as the CHP operation was noted as being monitored against a set point temperature of 74°C (as detailed in foregoing CHP section).

"From examination of record documents it would appear that the original strategy in terms of operational temperatures has been modified from that initially intended (i.e. fundamentally deviating from the design principle). System modifications have included an alteration to monitor and control the common MTHW primary circuit return temperature to the CHP [Combined Heat and Power] units, apparently endeavouring to restrict this temperature to 74°C (i.e. new dump valve set point, and noted as 'ideal' return temperature within User Manual). This alteration appears to have been deemed necessary to maintain performance of the CHP units, however, implementation of this modification does not seem to have taken any cognisance of the associated potential consequential effects.

"System alterations essentially appear to cause variation in primary MTHW flow temperature, lowering it considerably below the original design intent of 105°C. An inevitable effect of this is that it presents the potential for secondary side heat output availability being reduced significantly below intended capacity, in view of the reduction in mean water temperature at heat exchangers.

"The revised strategy appears to be reliant on any secondary side heat

[216] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1268.

load requirement (i.e. LTHW / DHWS) being communicated by a decrease in the primary side MTHW return circuit temperature, which in turn would eventually signal a demand for additional heat load generation (i.e. to enable boilers). Given the probably quantity of system water content, and diverse functions of the various facilities being served via heat exchangers, there would seem to be the potential for a minor increase in heat load demand to be undetected, in view of the insignificant deviation a minor load would likely create in terms of difference in primary side MTHW return temperature being monitored remotely within the Energy Centre.

"If a secondary side heat demand requirement was sufficient to create the necessary temperature differential within the common mixed primary MTHW return circuit, the time taken to effectively convey this via the primary distribution (i.e. be detected/acknowledged/processed by the controls system, acted upon by the boilers, and circuit temperature raised to the necessary level) would in all probability be prolonged. This may extend underperformance/inadequacy experienced by the associated facilities served within the Adult and Children's Hospital.

"In particular, the domestic hot water services appear to have been originally designed on the basis of direct heating utilising MTHW/DHWS plate heat exchangers, as to afford rapid recovery of domestic hot water temperatures, and minimise risks associated with legionella. Given the lower than originally intended operational temperatures observed during our investigation works, and temperatures indicated within the User Manual, the revised control strategy would appear to have resulted in the primary distribution operating on a low temperature hot water basis, and unlikely to afford rapid heat recovery.

"Due to the above, not only do we anticipate there to be a potential risk in relation to relatively low secondary side heat demands being undetected (i.e. from 1 or 2 plate heat exchangers), but the practical duration necessary to rectify the associated thermal inadequacies would appear to be likely prolonged due to the inability of the system, and associated plant, to react (effectively). If the foregoing is found to be transpiring, this would be of particular concern in relation to the domestic hot water services as the subsequent control modification would have potential to increase the risks associated with legionella growth within the system."[217]

15.19. It is not clear what if any remedial action was taken in respect of this concern, and it remains a potentially deficient feature for the purposes of Glasgow III.

Corrosion of water meters

15.20. One of the water meters was identified as a potentially deficient feature of the

[217] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1312 to 1314.

water system due to the identification of corrosion.

15.21. A corrosion report of January 2019 produced by Intertek stated:

> "The water meter (valve) body showed no evidence of external corrosion. Internally corrosion and paint blistering were seen around the section changes close to the flanges and around the neck."[218]

15.22. The cause and significance of this corrosion is not clear from the terms of the report.

15.23. GGC have advised the Inquiry that, in response to this concern, 8 water meters demonstrating minor corrosion were replaced in February 2019 during installation of the Continuous Chlorine Dioxide dosing system.[219]

15.24. These water meters are a potentially deficient feature for the purposes of Glasgow III.

16. Hand wash basins, taps, point-of-use filters

Hand wash basins

16.1. There are hand wash basins throughout the hospital to enable regular hand washing. They give rise to a potential concern due to their being the connection-point between taps and drains, both of which raised issues of concern in their own right. Some were also identified as potentially deficient features due to little use being made of them, the risk being that they might amount to deadlegs.

16.2. SHTM 64 SHTM describes the purpose and features of the hand wash basins as follows:

> "**Basins**
>
> 2.19 Basins should have a smooth form and easily cleaned surfaces. Overflows should not be provided for infection control reasons.
>
> 2.20 Three sizes of basin should fulfil most of the user requirements in health buildings:
>
> [description of purposes of large, small and medium basins]
>
> …

[218] A44312419 – Intertek Examination of Corroded Valve Body – Bundle in relation to Water PPP – Page 1381.
[219] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 986.

Basin selection

2.26 When selecting taps for clinical procedures, and certain activities in food-preparation and laboratory areas, taps and supply fittings will be required to be operated without the use of hands.

2.27 Fittings actuated by a proximity sensor are now a preferred alternative to lever-action taps.

2.28 The design team should select the appropriate combinations of basins and taps illustrated on the assembly data sheets for:

- clinical procedures …
- personal washing …
- hand-rinsing …"[220]

16.3. In their 2018 summary of findings related to bloodstream infections in Wards 2A/2B RHC, GGC recorded that an infection concern related to a tap and wash hand basin in 2A had been identified and action taken in 2016:

> "In February 2016 a patient within ward 2A RHC was identified as having a bloodstream infection (BSI) as a result of Cupriavidus pauculus. NHSGGC investigations included water samples from outlets within the aseptic suite of the pharmacy department where the parenteral nutrition was made that the child had received. Cupriavidus pauculus was isolated from water samples taken from a tap on a wash hand basin within this area. Typing by Colindale reference laboratory confirmed the isolate from the washhand basin and the patient were the same. The wash hand basin was subsequently removed as a result"[221]

16.4. Separately, GGC have referred to the removal of a wash hand basin following the February 2016 investigations, not because of a positive test result, but because a concern was raised as to the irregular use of that outlet:

> "Removal of wash hand basin in RHC level Aseptic Pharmacy Suite
>
> Following hypothesis of investigation into Cupriavidus linked incident in Feb 2016 the sink was identified as a little used outlet."[222]

16.5. It is understood that the removal of little used outlets is good practice as a means of avoiding the presence of deadlegs.

16.6. The 2018 summary also records a concern relating to a sink in 2017, although

[220] A33662290 - SHTM 64, Dec 2009 – Bundle in relation to Water PPP – Pages 108 to 110.
[221] A33448003 – HPS Report December 2018 – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 – Page 38.
[222] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 980.

in that case the issue appears to have been resolved with chemical treatment:

> "A further single case of Cupriavidus pauculus was identified in September 2017. NHSGGC reported that a second hand hygiene sink was found to be positive but following assessment was unable to be removed. Silver hydrogen peroxide treatment was undertaken and repeat testing resulted in zero total viable counts from this outlet."[223]

16.7. Minutes of a Problem Assessment Group in February 2018 record a regular chemical treatment regime for a sink within the Aseptic Pharmacy. The minutes are ambiguous in relation to whether the concern arose from an incident in September 2017 or September 2016. However, given that the 'background' section of the minutes refers only to a case in September 2017, it appears: (a) that this sink is likely to be the same one as mentioned by GGC and referred to in the paragraph above; and (b) that in September 2017 the link between the cupriavidus infection and the sink was unclear:

> "A 2nd patient case was identified in September 2017 and at that time, no links were made to the previous case or the aseptic pharmacy. More recent investigations found that this patient did in fact have chemotherapy which came from the aseptic pharmacy.
>
> JG also confirmed that the clinical hand wash basin which was a concern resulting from the September 2016 PAG has been re-treated by estates this morning. In addition the sink is cleaned daily with bleach and once weekly with porceine."[224]

16.8. In a Legionella Audit of 4 May 2017, a concern was raised in passing that the cleaning regime in place might disguise the risks posed by basins/sinks being little used:

> "…It may be that the cleaning staff are cleaning every wash hand basin and sink every day, and, as a result, technically these outlets will not be classed as little used. A check should be made to ensure that domestic staff are cleaning all wash hand basins and sinks in the appropriate manner."[225]

16.9. As part of the response to the 2018 Water Incident, in which focus inter alia fell upon the drainage system within wards at RHC, sink drains were specifically referred to as an area of concern in a communication to patients:

> "You may be aware that two of our wards have been experiencing disruption whilst we have introduced an enhanced cleaning programme.

[223] A33448003 – HPS Report December 2018 – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 – Page 38.
[224] A41890259 – PAG Minute 6 February 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 2 - Page 83.
[225] A44312599 - Legionella Management and Compliance Audit – Bundle in relation to Water PPP – Page 1262.

> This is the result of a build-up of material (known as biofilm) in the sink drains in Ward 2A and 2B. This is the same sort of biofilm we get in domestic sink drains but as the patients in these wards are being treated for cancer their immune system is compromised and they are more susceptible to infection"[226]

16.10. Work, including sink replacement, is understood to have taken place until December 2018:

> "work ongoing within Ward 2A/2B. Pipe work modification is ongoing along with the sink/tap replacement. Materials for new treatment room and prep room have been ordered. Everything is currently on target for completion on the original date set for 14th December."[227]

16.11. Following the 2018 Water Incident, an extensive programme of replacement works was undertaken by GGC over the period from October 2018 to March 2022, as is referred to them in a response to the Inquiry. The following entries bearing on sinks/basins are recorded there:

> "replacing the clinical wash hand basins – selected for splash reduction
>
> localized chlorine dioxide system – to commence treatment (earlier than main installation)" [228]

16.12. The extent to which hand wash basins gave rise to the build-up of biofilm, excessive splashing and that some were underused used are potentially deficient features for the purposes of Glasgow III.

Taps, flow straighteners and point-of-use filters

16.13. In relation to the risks of taps, flow straighteners and point-of-use filters, SHTM 04-01 explains:

> "thermostatic mixing [tap] devices have complex internal structures that can entrap waterborne bacteria and biofilm. Risk assessments should be carried out to determine the potential to replace thermostatic mixing devices with ordinary in augmented care accommodation
>
> "…taps should be ideally removable and easily dismantled for cleaning and disinfection
>
> "…Rosettes, flow straighteners and aerators have been found to be heavily colonised with biofilm but their removal can create turbulent flow at increased pressure resulting in splashing of surrounding surfaces and

[226] A38662166 - Briefing dated 18 September 2018 – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 5 – Page 150.
[227] A36629319 – 22.11.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 238.
[228] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 984.

flooring. Current advice is that they should be removed but this should be subject to risk assessment."[229]

"Point-of-use filters have been found to provide protection from exposure to bacteria such as Legionella and Pseudomonas by preventing the dispersal of bacteria from showers and other water outlets.

"…The filters do not eradicate the organism but prevent discharge to the environment from the filtered outlet only; by retaining the organism within the pipework, it may be possible for the organisms to multiply and regressively 'seed' other parts of the distribution system."

"Filters will also need to be changed routinely, depending on usage of the outlets. Their use should be considered only as part of an overall regime of bacterial control to be used where the most vulnerable patients are treated. Installation of point-of-use filters should be risk assessed and designers should be aware of the reduced flow that will arise from increased resistance."[230]

Flow straighteners

16.14. Flow straighteners were identified as a potentially deficient feature of the water system. An SBAR of April 2014 advised that GGC sought advice from Health Protection Scotland (HPS) on the use of 'Horne Optitherm' taps. These taps incorporated 'flow straighteners' and had been procured for all clinical environments within the new QEUH and RHC. UK and Scotland-wide pseudomonas guidance published in June 2013 had subsequently advised that flow straighteners could develop biofilm and recommended for flow straighteners to be removed from taps.[231]

16.15. HPS recommended that GGC install the procured taps in all clinical areas other than those in high risk units, where the flow straighteners could either be removed or new compliant taps without flow straighteners could be fitted instead.[232]

16.16. A special meeting to discuss Optitherm taps was convened on 5 June 2014 and attended by GGC and HFS. The minutes stated the meeting had been

[229] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Pages 320 and 317. These provisions do not feature in v1 of that guidance from August 2011 (archived July 2014).
[230] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 280. A similar provision features in v1 of that guidance from August 2011 (archived July 2014).
[231] A37746908 – SBAR dated April 2014 – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 3 - Page 5.
[232] A37746908 – SBAR dated April 2014 – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 3 - Page 6.

requested by GGC to review their situation.[233] The minutes noted:

> "it was unanimously agreed that as the taps installed within the new build development had complied with guidance current at the time of its specification and briefing and that the hospital was in the process of being commissioned, it should be regarded as being in the 'retrospective' category, not "new build". There was no need to apply additional flow control facilities or remove flow straighteners and any residual perceived or potential risks would form part of the routine management process."[234]

16.17. HFS' Water Management Issues Technical Review of March 2019 advised in relation to this matter:

> "There is evidence from the contractor that percentages of the Horne taps failed the initial disinfection tests, were disinfected and retested (a month-and-a-half) later and failed the second test. There is no evidence within ZUTEC of any additional testing to resolve these failures. There is also evidence that as a result of re-disinfection, some retested outlets passed the second test (after first failure)."[235]

16.18. The extent to which the use of flow straighteners in taps gives rise to a potentially deficient feature for the purposes of Glasgow III is discussed at paragraphs 16.25 to 16.36 below.

Servicing and testing of Thermostatic Mixing Valve taps

16.19. The DMA 2015 report advised that the vast majority of hot outlets were fed via Thermostatic Mixing Valves taps ("TMV") – 'Horne' taps in clinical areas and 'Markwik' taps in non-clinical areas.[236] DMA recommended that TMVs should be serviced and have fail safe tests carried out routinely. DMA further recommended that strainers should be cleaned on a regular basis.[237]

16.20. In their report of 2018, DMA raised concerns with respect to those recommendations. DMA advised:

> "TMV servicing in high risk areas…has recently been carried out by DMA as we were advised the Estates regime may have lapsed. Servicing of some outlets (e.g. Armitage Contour Taps) is restricted as

[233] A39465202 - Special meeting to discuss Opitherm taps – Bundle in relation to Water PPP – Page 816.
[234] A39465202 - Special meeting to discuss Opitherm taps – Bundle in relation to Water PPP – Page 818.
[235] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 100.
[236] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 138.
[237] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 232.

DMA have been advised we are unable to remove IPS panels. This gives further cause for concern as Estates were unable to confirm if the strainers on the supplies have ever been removed for cleaning/disinfection or taps fully serviced.

"…Horne Optitherm TMV taps are designed to be demounted for maintenance and servicing elsewhere but the facilities for this are yet to be completed and commissioned.

"...In addition, the strainers located on the supplies to the TMV taps in 'Non-Clinical' areas (e.g. patient, visitor and staff toilets) are located behind panels and therefore infection control procedures are required (Scribe) in order to remove panels for service. We understand no servicing of any of these valves and the associated strainers in non-high risk areas has been carried out since the hospital opened and there has been a very limited program of servicing in 'high risk' areas.

"We are unaware of any servicing works being carried out and had access to servicing records on TMV taps in other areas of the hospital at the time of assessment"

"The recent (prior to assessment delivery) issue with regards to Cupriavidus bacteria being detected in the system water has highlighted that the servicing requirements of the TMV taps should be reviewed to ensure that in addition to manufacturers service instructions being carried out the servicing of TMV taps includes any additional control measures as deemed necessary by infection control e.g. full thermal bypass/disinfection of the taps where practicable and safe (this would require to be carried out remotely from patient areas) and flow regulator, O rings and other components cleaning, disinfection and/or replacement." [238]

16.21. DMA concluded that the six monthly servicing of TMV's, including fail safe tests and cleaning/disinfection of strainers, was not being carried out at that time.

16.22. An GGC review of this recommendation dated 29 January 2019 stated:

"All High Risk areas have had TMT servicing and maintenance carried out until most recently when Point of Use (PoU) filters were installed. The only area where routine maintenance is not being carried out is on taps and showers across the QEUH/RHC. This will begin once the full water system chlorinisation project at the QEUH has been completed. High Risk Areas are currently protected by PALL filters installed at each outlet. All reactive maintenance is being auctioned through FMFirst (CaFM System)."[239]

[238] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 602.
[239] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 96.

16.23. An Authorising Engineer Management and Compliance Audit produced by Pro Lp Consulting Ltd and dated 11 January 2023 advised that TMVs are serviced by DMA once a year. The auditors recommended for the practicability of twice yearly servicing to be reviewed and that a confirmed, risk assessed and agreed way forward was created.[240]

16.24. The extent to which the testing and servicing of TMV taps gives rise to a potentially deficient feature for the purposes of Glasgow III is discussed at paragraphs 16.25 to 16.36 below.

Organisms in taps

16.25. At an IMT meeting of 2 March 2018, it was noted that one outlet in room 3 of Ward 2A had tested positive for Pseudomonas aeruginosa.[241] Taps and showerheads were removed for components to be swabbed and tested. The IMT stated:

> "Hypothesis is that outlets are the source and that seeding of others has taken place. Flow straighteners which encourage biofilm formation are known to be high risk and have been implicated in outbreaks previously."

16.26. Due to the number of outlets positive in a high-risk area, it was decided to proceed to Silver Hydrogen peroxide dosing straight away.[242] It was decided that outlets would be replaced starting with those that had tested positive, but the recommendation was for all to be changed. It was also decided that resampling would take place once dosing was complete.

16.27. At an IMT of 6 March 2018 it was noted that initial sampling carried out on a removed tap showed Cupriavidus growing from the hot tap and flow straightener.[243] It was decided that all taps would be removed from patient rooms, with flow straighteners changed and sanitised.[244] The timeline produced by the GGC Oversight Board notes that flow straighteners would be replaced on a 3 monthly basis.[245] It was also noted in the IMT of 6 March 2018 that routine testing of the water outlets would take place monthly.

16.28. At an IMT of 9 March 2018 it was noted that visual inspection of the

[240] A44312832 - Pro Lp Consulting Ltd Audit 2023 – Bundle in relation to Water PPP – Page 1441.
[241] A36690451 – 02.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 54.
[242] A36690451 – 02.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 55.
[243] A36690471 – 06.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 57.
[244] A36690471 – 06.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 58.
[245] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 958.

thermostatic mixing valve component showed green pigmentation in keeping with bacterial growth. Laboratory results were awaited.[246] It was also stated that all TMV thermostat mixing taps had multiple components in them with complex structures making it easy for microorganisms to grow.

16.29. At an IMT of 12 March 2018, it was noted that microbiology results from the testing of the taps had returned multiple positive results for Cupriavidus and two results for Stenotrophomonas, described as a significant pathogen within the patient group in Ward 2A.[247] Due to the number of positive results which came back emergency measures were put in place including the provision of sterile water for drinking and bottled water for washing and bathing.[248]

16.30. At an IMT of 16 March 2018 it was noted there had been three additional hospital acquired bacteraemia cases. It was agreed that filters would be put onto every tap within the wards affected, with Ward 2A being prioritised if filters were limited.[249] At an IMT meeting of 19 March 2018 it was agreed that control measures could be lifted once the filters were fitted to the taps and negative results had been obtained.[250]

16.31. At an IMT of 21 March 2018 it was noted that, despite the system being dosed four times and counts being lowered, Cupriavidus was still present in a number of outlets. Ward 2B and 3C were described as having widespread Cupriavidus, while multiple water samples were positive from outlets in Ward 4B.[251]

16.32. It was agreed that Facilities would carry out tests on the water outlets on a weekly basis to ensure filters were working once installed. If counts started to get high then filters on affected outlets could be changed. It was noted that the filters being fitted to the taps had a working life of 30 days. Facilities were introducing a rolling program to change these filters from day 25.[252]

16.33. At an IMT of 23 March 2018 it was noted that numerous environmental gram negative pathogens were returned from swabs taken of taps from Ward 2A,

[246] A36690458 – 09.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 60.
[247] A36690457 – 12.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 63.
[248] A36690457 – 12.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 64.
[249] A36690477 – 16.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 69.
[250] A36690507 – 19.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 71.
[251] A36690549 - 21.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 76.
[252] A36690549 - 21.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 78.

RHC and Ward 4B QEUH.[253] By an IMT of 27 March 2018 it was noted:

> "The group agreed to step down the Infection Control measures put in place for affected wards within the QEUH and RHC sites as point of care filters have been fitted to all water outlets and showers. Patients can now use the CHWB to carry out hand hygiene and also use the showers if required. Patients no longer require Ciprofloxacin.
>
> "The only issue is with drinking water which IPCT will include in their communication email.
>
> "Post IMT it was agreed to proceed with [lifting precautions on] BMT patients but that filters would need to be changed every 7 days as we have proven microbiological efficacy to that point. This will mean BMT patients can shower."[254]
>
> "Dr Inkster informed the group that this IMT will be disbanded from today as it has dealt with all the acute issues. A separate group consisting of IPCT, Facilities, HPS and HFS will look into the remit of filter replacement, introduction of new taps, introduction of chlorine dioxide dosing to the water system and drain cleaning."[255]

16.34. GGC have advised the Inquiry that from October 2018 to March 2022, material changes were made to the water system including in RHC Ward 2A and 2B replacing taps with a different model for easier maintenance.[256]

16.35. At an AICC (Acute Infection Control Committee) meeting of 18 September 2020, a number of out of specification results (including Stenotrophomonas) were returned from various filtered taps in RHC Ward 1C PICU/QEUH Ward 6A and other wards.[257] It was agreed that the cleaning regime and refresher training would be reviewed with Facilities. The filters in the affected taps were sent for testing, with the Water Technical Group later highlighting in their meeting of 18 September 2020 the potential risk for contamination behind the filters.[258] The Inquiry team therefore understand that the nature of this concern is an ongoing one, dependent on appropriate operational procedures in order to be managed.

16.36. As a consequence, the fitting of TMV taps with flow straighteners, the

[253] A36690544 – 23.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 82.
[254] A36690556 – 27.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 88.
[255] A36690556 – 27.03.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 90.
[256] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 984.
[257] A32700430 - AICC paper 30 September 2020 – Bundle in relation to Water PPP – Page 913.
[258] A38668806 - Water Technical Group Meeting 18 September 2020 – Bundle of documents in respect of the Water Technical Group / Water Review Group Minutes in relation to the Glasgow 3 Hearings - Page 200.

servicing and testing regime for those taps, and the time taken to replace those taps are all potentially deficient features for the purposes of Glasgow III.

17. Stainless steel sinks and taps, trough sinks

17.1. This section refers to trough sinks which are different from hand wash basins and exist for medical staff to clean their hands and forearms. These were identified periodically as a risk due to their being used infrequently, creating a risk that their presence might constitute a deadleg; and from splashing, distributing water over a wider area.

17.2. SHTM 64 describes the purpose and features of these as follows:

> "**Scrub-up troughs**
>
> 2.37 Scrub-up troughs should be provided to enable one or more surgeons and nurses to scrub their hands and forearms.
>
> 2.38 Troughs should be wall-hung and fitted with a single waste outlet.
>
> 2.39 Taps should be wall-mounted and deliver safe, thermostatically (TMV3 D08) controlled hot water …
>
> 2.40 For infection control reasons sensor-controlled fittings are generally required for controlling the flow of water at scrub-up troughs and these can also offer the additional benefit of controlled run times. The relationship between the taps and the trough is critical in order to avoid splashing." [259]

17.3. An SBAR was raised on 17 October 2016 as part of an investigation into an outbreak of Serratia:

> "**Situation**
>
> Following an increased incidence of Serratia marcescens, the IPCT and clinical staff reviewed the use of sinks in the unit. The trough sinks in the trolley bays are very close to a number of procedure trolleys. This adds a risk of water splashing from tap water and also soap scum onto the procedure trolleys during scrub.
>
> **Background**
>
> Ward 1D, PICU, has two trolley bays that each have a trough sink. The rational was that these sinks would be used to undertake surgical scrub if a surgical procedure was required in one of the single rooms, since none of the single rooms have trough sinks. The trough sinks in the trolley bays are not used very often and therefore pose a risk. Removal of little-used outlets is recommended by HPS as good practice to

[259] A33662290 - SHTM 64, Dec 2009 – Bundle in relation to Water PPP – Pages 110 and 111.

reduce the risk to patients from water borne organisms" [260]

17.4. It was recommended that, if feasible, trough sinks should be removed from the trolley bays in question, and as a replacement measure, trough sinks should replace hand wash basins in the nearby single rooms.[261]

17.5. GGC have informed the Inquiry that subsequent to the SBAR, on or around 10 March 2017, the water on the unit tested negative. They have also informed the Inquiry that the replacement work was carried out in February 2018:

> "Trough sinks removed from trolley bays in Ward 1D PICU. In response to PAG Investigation into 3 serratia cases."[262]

17.6. In June 2018, an Incident Management meeting investigating Acinetobacter in RHC made reference to a decision to remove further trough sinks from common areas into individual rooms:

> "A total of 3 trough sinks identified in a previous IPCT meeting were to be removed from the corridor and placed into rooms."[263]

17.7. Minutes in July 2018 recorded this work as not proceeding for the time being:

> "The removal of the trough sinks will be put on hold until an alternative trough sink can be procured and fitted into the ante rooms. The current clinical hand wash basin within patient rooms are too small for a surgical scrub technique."[264]

17.8. DMA Canyon's Water System Risk Assessment of January 2019 recorded the replacement of trough sinks as being among the measures undertaken in late 2018 to address the issues which had arisen within RHC:

> "In late 2018 Wards 2A & 2B in the Children's Hospital was closed to allow for extensive alterations to be made to the local water system, running hot flow and return services as close as is practical to the outlets, changing taps and WHBs, trough sinks removed from anterooms within the isolation rooms in 2A and other rooms repurposed to suit ward operations."[265]

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[260] A38694859 – SBAR 17 October 2016 trough sinks in trolley bays – Bundle for Oral hearing commencing 12 June 2023 – Bundle 4 – Page 53.
[261] A38694859 – SBAR 17 October 2016 trough sinks in trolley bays – Bundle for Oral hearing commencing 12 June 2023 – Bundle 4 – Page 53.
[262] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 981; NB also A38172003 - IMT 4 December 2017 – Bundle in relation to Water PPP – Page 821, in which it was noted that the replacement of the trough sinks had not yet occurred.
[263] A37989601 – 06.06.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 106; Minutes of 3 July 2018 [A37990970 – 03.07.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 144] recorded that this was to be followed-up.
[264] A37991121 – 06.07.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 146.
[265] A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1369.

17.9. The use of trough sinks in locations where they posed a risk of splashing or were likely to be underused is a potentially deficient feature for the purposes of Glasgow III.

18. Showers, flexible hoses, particularities of single-occupancy rooms

Flexible hoses

18.1. The use of flexible hoses is identified as a potentially deficient feature of the hospital water system. Unlike fixed piping, their flexibility requires the use of a material the presence of which may of itself create a risk factor. The flexible lining of such hoses may be made of a material which could form a location for contamination.

18.2. In relation to flexible hoses, SHTM 04-01 advises:

> "Flexible hoses (also known as "tails") have become a convenient method of connecting between hard pipework and sanitary fittings or equipment. They typically comprise a steel braided outer sheath with a synthetic rubber inner lining. Reports have been received intimating that high levels of Pseudomonas and Legionella bacteria have been found in water samples taken from outlets fed by flexible hoses lined with ethylene propylene diene monomer (EPDM) due to colonisation of the lining, although it is possible that other lining materials and washers within couplings could be similarly affected.
>
> "…In view of this, it is recommended that the use of flexible hoses in potable water supplies should be identified and risk assessed, taking account of areas of highest risk involving persons vulnerable to infection…In new-build projects flexible hoses should not be specified in such situations
>
> "…All flexible hoses must be WRAS approved."[266]

18.3. In relation to the particularities of single-use rooms discussed later in this section, SHTM 04-01 advises:

> "Where taps or water outlets are not, or are unlikely to be, in regular daily use, Management Team Duty Holders and their staff should be alerted and reminded to flush these through and purge to drain, or purge to drain immediately before use, without release of aerosols."[267]
> "Local flushing regimes must be ongoing and continuous at all times, in

[266] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Pages 327 and 328. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[267] A33103411 - SHTM 04-01 Part G, July 2015 – Bundle in relation to Water PPP – Page 550.

order to prevent critical increases in Legionella growth"[268]

18.4. At the QEUH, almost all patients are accommodated in ensuite single side rooms. This provided at least four water outlets for every patient when the hospital opened.

18.5. DMA's 2015 report advised:

> "Flexible hoses have been noted in Kitchen/Pantry areas where there are flexible connections to dishwashers (not all fitted at present), in Facilities rooms (connections to double level sinks), in Dirty Utility rooms (connections to sluice machines) with the only patient areas DMA have noted as having flexible hoses being the connection to Arjo baths (both connections to the hot/cold system and internally within the actual bath). Wherever possible DMA would recommend all flexi hoses are removed and connections hard piped. Where flexible hoses cannot be removed then replacing with alternative WRAS approved hoses with linings other than EPDM should be considered…Flexible hoses have also been noted on the boosted bulk water system on pressure reducing valves. If possible these should be hard piped (stainless steel) or WRAS approved hoses with linings other than EPDM should be considered. Should these not be available for these types of units/connections then a regular inspection and replacement schedule should be implemented for these. DMA were advised by Mercury Engineering and Estates that all materials fitted during the construction are WRAs approved and therefore do not support bacterial growth… The use of EPDM flexible hoses in some areas may contradict this statement and their use should be reviewed to ensure compliance."[269]

18.6. GGC have advised the Inquiry that the exchange of flexible hoses commenced in January 2017, in response to DMA's 2015 report.[270]

18.7. However the DMA reports of 25 April 2018 and January 2019 noted similar concerns regarding flexible hoses:

> "EPDM flexible hoses have been installed in a small number of non-clinical areas with the only patient areas DMA have noted as having flexible hoses being the connection to Arjo baths…Flexible hoses have also been noted on the boosted bulk water system on pressure reducing valves."[271]

18.8. GGC reviewed the recommendations from DMA's 2018 assessment on 29

[268] A33103411 - SHTM 04-01 Part G, July 2015 – Bundle in relation to Water PPP – Page 573.
[269] A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 232.
[270] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 980.
[271] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 426; A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1374.

January 2019. It was noted in response to this concern:

> "Arjo bath flexible hoses were changed out for WRAS hoses and are replaced on a rolling 2 year program. Regarding flexible hoses on the boosted bulk water system, it was confirmed by AP Water (Jim Guthrie) that the whole valve as an assembly with the hoses is WRAS approved."[272]

18.9. It is not known if this resolved the concern.

18.10. The use of flexible hoses in potable water supplies until removed is a potentially deficient feature for the purposes of Glasgow III,

Organism growth in shower heads

18.11. The shower heads are also identified as potentially deficient features. In much the same way as 'deadlegs', shower heads may see infrequent use such that water may persist for a time within them, carrying the risk of stagnancy and organic growth.

18.12. The Scottish Ministers have advised the Inquiry that, in January 2018:

> "testing yielded positive results for various gram negative organisms and fungal growth in…shower heads (including wards 2A, 2B and 4B)"[273]

18.13. Showerhead components were removed and sent to a microbiology lab for testing on 2 March, revealing the presence of Cupriavidus.[274]

18.14. GGC have advised the Inquiry that from 1-12 March 2018 all shower heads in RHC Ward 2A were replaced.[275] However GGC have also advised that, on 12 March 2018, shower heads tested positive for Cupriavidus and Stenotrophomonas. Further positive results were noted on 21 March despite chemical dosing.[276]

18.15. GGC have advised that disposable shower heads were fitted initially before POU [Point Of Use] heads were fitted in late March.[277]

18.16. A report produced for an GGC Acute Infection Control Committee meeting of

[272] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 98.
[273] A44411439 - Scottish Ministers Response to s.21 Notice number 8 – Bundle in relation to Water PPP – Page 690.
[274] A44411439 - Scottish Ministers Response to s.21 Notice number 8 – Bundle in relation to Water PPP – Page 692.
[275] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 981.
[276] A44311391 - Part 1(i) of GGC response to s.21 Notice number 8 – Bundle in relation to Water PPP – Pages 948 and 949.
[277] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 981.

30 September 2020 stated:

> "Both showers with ICE [Imaging Centre of Excellence] Building returned out of spec's for legionella including LP1 in one shower. Full maintenance of these taps and TMV's have been carried out. However out of spec results retuned [sic]. Further investigates [sic] are being carried out by the team on site including Estates/DMA (Water Service Provider)."[278]

18.17. It appears from this report that the relevant shower heads were replaced for 'Dupal fixed head showers' and that these would be exchanged every 3 months. It is not clear if this resolved the concern.

18.18. The same report advised:

> "**QEUH Ward 6A (FILTRED [sic] TAPS)**
>
> A number of out of specs from various FILTRED [sic] TAPS AND SHOWERS including:-
>
> High TVC's
>
> Sphingomonas Paucimobilis
>
> Micro bacterium Flavsecens
>
> Acidetbacter Iwoffii
>
> Stenotrophomonas Maltophilia
>
> M Sterilla
>
> H.Hyhomcete
>
> Discussions have taken place with Infection Control, Microbiology regarding these. Additionally liaised with Facilities to review cleaning regime as per agreed procedures. Facilities Management are carrying out refresher training.
>
> In all cases the filters are changed and Estates have arranged for 11 of the filters to be sent to PAL for integrity testing which was agreed with Infection Control and Microbiology. Further analysis and possible caused [sic] should be discussed at the Water Technical Group."[279]

18.19. It is not clear what if any further remedial actions were taken in respect of this concern. The uses of shower heads in en suite facilities that see infrequent use is a potentially deficient feature for the purposes of Glasgow III.

[278] A32700430 - AICC paper 30 September 2020 – Bundle in relation to Water PPP – Page 911.
[279] A32700430 - AICC paper 30 September 2020 – Bundle in relation to Water PPP – Page 913.

Cleaning and disinfection of shower units

18.20. Separately, a concern arose regarding the cleaning of shower heads and the related issue of the need to replace them. A lack of records meant that it was difficult or impossible to be sure that these had been adequately maintained.

18.21. DMA's report of 25 April 2018 stated:

> "NHS Estates are unable to confirm the service history of the [shower] units and cleaning and disinfection of shower heads we would advise consideration is given to changing all heads and hoses with new WRAS approved heads and hoses."[280]

18.22. SHTM 04-01 recommends that shower heads are disinfected quarterly or as necessary.[281]

18.23. GGC have advised the Inquiry that non filtered shower heads and hoses were replaced with recyclable alternatives in May 2019.[282] It is not clear if this was in response to DMA's 2018 report. Pro Lp Consulting Ltd's Authorising Engineer Management and Compliance Audit dated 28 February and 1 March 2022 advised:

> "Showers are replaced on a quarterly basis. This is the case on any parts of the building where POU shower filters are not used. Where POU filters are used they are replaced as required and the shower hose is replaced at the same time or at least quarterly."[283]

18.24. A repeat audit of 11 January 2023 advised that shower heads and hoses are renewed every three months by DMA Canyon Ltd and the records can be found in the Teams system.[284]

18.25. It appears to be the case that GGC are now replacing shower heads frequently. However for some time after occupation of the hospital it is not clear that showerheads were being properly cleaned and disinfected. These are potentially deficient features for the purposes of Glasgow III.

Overprovision of outlets

18.26. A particularity of QEUH is in its provision of single-occupancy rooms throughout the hospitals. This arrangement means that, each room having individual taps, showers, toilets, etc., there are considerably more outlets than

[280] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 426.
[281] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 292. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[282] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 986.
[283] A44312654 - Pro Lp Consulting Ltd Audit 2022 – Bundle in relation to Water PPP – Page 1414.
[284] A44312832 - Pro Lp Consulting Ltd Audit 2023 – Bundle in relation to Water PPP – Page 1438.

would be present in a hospital following multiple-occupancy ward design. The potential deficiency arising from this is that consequently there were more points of risk.

18.27. The draft meeting report of 25 April 2018 produced by Leegionella Ltd noted:

> *"It was felt that there was overprovision of outlets which contributes to low flow* in parts of the system; particularly patient ensuite bathrooms. There are several reasons why designers overprovide on the number of washhand basins:- Sadly the formula for working out the number of outlets has not changed for decades and does not take into account the reduced need for WHBs [Wash Hand Basins] in modern healthcare because: less handwashing is carried out as a result of the increased use of alcohol gels. Patient stays are much shorter and when in hospital; patients are generally much sicker so they do not use outlets as frequently as previously (if at all). The move to single en suite facilities with showers compounds the problem; consideration should be given to providing en suites with a toilet and a wash hand basin but communal showers to reduce the risk of stagnation"[285]

18.28. Leegionella Ltd recommended:

> "review the numbers and placement of washhand basins and remove those deemed unnecessary. The installation of flow sensors may indicate where there is a lack of use and the potential for stagnation. The WSG [Water Safety Group] in consultation with the users should agree where washhand basins should be retained and if a flushing regime needs to be implemented. Self-flushing outlets installation, based on local risk assessment, may reduce the risk of the human factor especially where there are access problems such as in isolation rooms"[286]

18.29. It is not known what if any remedial action was taken to address this concern.

18.30. It is recognized that this potentially deficient feature arises at a particularly fundamental level of the concept of a hospital with 100% en suite single rooms, but it is a potentially deficient feature for the purposes of Glasgow III

Mould in shower areas

18.31. Concerns arose around the visual identification of mould within shower areas. Mould indicates the presence of organic material.

18.32. The Scottish Ministers have advised the Inquiry that, on 17 January 2019, two

[285] A40732034 – Draft meeting report - Bundle 8 for Oral hearing commencing 12 June 2023 – Pages 138 and 139.
[286] A40732034 – Draft meeting report - Bundle 8 for Oral hearing commencing 12 June 2023 – Page 139.

rooms in Ward 6A were taken out of use due to evidence of mould in the shower areas.[287]

18.33. An IMT Minute of 25 January 2019 stated:

> "the contractor in charge of the shower work…informed…that 80% of the showers were affected by mould. The contractor said that if there is a break in the shower sealant then the gyprock behind the sealant was not water resistant, but informed them this has been rectified. As an extra precaution the water seals have been raised further up the wall from the flooring. The whole ward will be finished by Monday 28th January where a member of the IPCT will carry out a walk round with estates before an HPV clean is carried out."[288]

18.34. In relation to this concern a timeline of incidents produced by the GGC Oversight Board noted:

> "there was a large volume of black mould in all the bathrooms which posed risk of fungal infections to patients and which was caused by water hitting a defective join and water damage to the surrounding areas (these were supposed to be waterproof but were not)."[289]

18.35. A Case Note Review Overview Report commissioned in 2020 by the Cabinet Secretary for Health and Sport advised that patients transferred out of the ward due to these concerns were returned on 11 February 2019.[290] The Inquiry team therefore understand the concern to have been resolved.

18.36. Whilst this particular concern was resolved the fact that black mould grew in around fourth fifths of showers is a potentially deficient feature for the purposes of Glasgow III.

Insufficient backflow protection

18.37. Insufficient backflow protection on shower heads was also noted as a potentially deficient feature, representing a risk that contaminated water might flow in a direction unintended by the purpose of the shower unit.

18.38. Scottish Water Byelaws Inspection Reports of 28 February 2020 and 10 March 2023 identified numerous instances of insufficient backflow protection in shower heads across the QEUH site.[291] It is not known what remedial

[287] A44411439 - Scottish Ministers Response to s.21 Notice number 8 – Bundle in relation to Water PPP – Page 700.
[288] A36690577 – 25.01.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 292.
[289] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 949.
[290] A33448007 – Case Note Review Overview Report –Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 995.
[291] A43262538 - Scottish Water Byelaws Inspection Report, 28 February 2020 – Bundle in relation to

actions if any have been taken to address those concerns. The lack of backflow protection in shower heads is a potentially deficient feature for the purposes of Glasgow III.

19. ARJO Baths

Hoses serving Arjo baths

19.1. Arjo baths are specialist bathing apparatus which take a number of forms, being medically-adapted to facilitate bathing for those with particular mobility needs. They are present throughout QEUH. They were identified as a potentially deficient feature due to the method of their connection to the water system, which was generally by means of flexible hoses (for which see above). They were also identified as a potentially deficient feature due their lack of sufficient backflow protection, which reduces the risk that contaminated water might flow in a direction unintended by the purpose of the bath.

19.2. On 25 April 2018 QEUH received an L8 Risk Assessment from DMA Canyon, which noted a concern in relation to Arjo baths in 'Various locations throughout the hospital (Wards)'. DMA were unable to confirm the extent of the use of these facilities. DMA observed that connections to the Arjo baths from the hot/cold water systems were by means of flexible hoses, the presence of which might pose a high legionella risk, if used infrequently. DMA recommended that the baths be maintained:

> "in accordance with manufacturers/installers instructions. Where flexible hoses (i.e. internal to bath unit) cannot be removed then replacing with alternative WRAS approved hoses with linings other than EPDM should be considered."[292]

19.3. DMA also recommended that some shower hoses were sufficiently long as to be able to reach into adjacent areas, and recommended:

> "Consider shortening shower hoses as it was noted that these can in some areas reach into adjacent WCs and WHBs"[293]

19.4. The recommendation in respect of flexible hoses and their linings was repeated by DMA Canyon in January 2019 in their 'Water System Risk Assessment':

> "EPDM flexible hoses have been installed in a small number of non-

Water PPP – Page 1390; A43262488 - Scottish Water Byelaws Inspection Report, 10 March 2023 – Bundle in relation to Water PPP – Page 1446.

[292] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 583.

[293] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 583.

> clinical areas with the only patient areas DMA have noted as having flexible hoses being the connection to Arjo baths (both connections to the hot/cold system and internally within the actual bath). Wherever practicable DMA would recommend all flexi hoses are removed and connections hard piped. Where flexible hoses cannot be removed then replacing with alternative WRAS approved hoses with linings other than EPDM should be considered. In healthcare premises additional guidance on the replacement and use of flexible hoses is provided in the "safety action notice SAN(SC)09/03". [294]

19.5. A Review of DMA's recommendations dated 29 January 2019 reported that Arjo bath flexible hoses had been changed out for WRAS hoses, to be replaced on a rolling 2 year program.[295] The review advised that the shower hoses could not be shortened while maintaining clinical bath functionality; point-of-use filters were fitted instead.[296] However GGC have advised the Inquiry that the shower hoses were shortened in 2021.[297]

19.6. The IMT minutes of 3 July 2019 raised a concern about the lack of a filter in the Arjo bath in ward 6A[298]. This arose in the context of the sink outlet in that room testing positive for Mycobacteria, with its filter being thought to be defective. By way of remedial action:

> "It was agreed to take the ARJO bath out of Ward 6A. Estates will remove the bath and cap off the water outlet to the bath. This will enable the bath to be reinstated once the Paediatric ward moves out of the ward and control of it is given back to the adult sector. Karen Connelly will contact Anne Harkness to seek approval for the removal of the ARJO bath."

19.7. The water pipes were reported as capped on or around 16 September 2019.[299]

19.8. The use of Arjo baths in the hospital is a potentially deficient feature for the purposes of Glasgow III.

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[294] A33870454 - DMA Canyon Water System Risk Assessment, January 2019 – Bundle in relation to Water PPP – Page 1374.
[295] A33869445 – GGC Review of DMA Recommendations, 29 January 2019 – Bundle 8 for Oral hearing commencing 12 June 2023 – Page 98.
[296] A33872975 - GGC Review of DMA Recommendations, 16 December 2018 – Bundle in relation to Water PPP – Page 852.
[297] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 987.
[298] A36591628 – 03.07.2019 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 331.
[299] A37854452 - Briefing paper: Ward 6a (Haematology/Oncology) – Bundle in relation to Water PPP – Page 902; this being a draft of A37854558 - SBAR in relation to Ward 6a, 2 October 2019 – Bundle in relation to Water PPP – Page 904.

Insufficient backflow protection

19.9. Scottish Water Byelaws Inspection Reports of 28 February 2020 and 10 March 2023 insufficient backflow protection for Arjo baths across the QEUH site.[300] It is not known what remedial actions if any have been taken to address those concerns. The lack of backflow protection in Arjo baths is a potentially deficient feature for the purposes of Glasgow III.

20. Water coolers

20.1. Water coolers were supplied by third parties and installed at locations throughout QEUH. These machines supplied drinking water either via connection to the mains cold water system, or via standalone water bottles. They were identified as potentially deficient features due to concerns around the quality of water from them, which differed for each type of water cooler.

20.2. SHTM 04-01 para 8.26 advises, in respect of *'Vending, chilled water and ice-making machines'* that:

> "The water supply to this equipment should be taken from a potable supply via a double check valve to prevent backflow and be upstream of a regularly used outlet with the minimum of intervening pipe-run, that is, less than 3m. The supply should not be softened. Additionally, it should be established that the usage is sufficient to avoid deterioration in water quality, for example that the inlet water temperature does not exceed 20ºC" [301]

20.3. Water coolers were supplied by third parties and installed at locations throughout QEUH. These machines supplied drinking water either via connection to the mains cold water system, or via standalone water bottles.

20.4. On 2 March 2017 Dr Inkster issued an SBAR raising concerns about the water coolers in the following terms[302]:

> "The microbiological quality of water from coolers may be of a poor standard and therefore pose a risk to patients, particularly those who are immunosuppressed. Historically there have been concerns over maintenance and cleaning of water coolers and over who has responsibility for them"

20.5. Dr Inkster observed that draft HFS Guidance SUP 05 (Provision of drinking

[300] A43262538 - Scottish Water Byelaws Inspection Report, 28 February 2020 – Bundle in relation to Water PPP – Page 1390; A43262488 - Scottish Water Byelaws Inspection Report, 10 March 2023 – Bundle in relation to Water PPP – Page 1446.
[301] A32354164 - SHTM 04-01 Part A, July 2014 – Bundle in relation to Water PPP – Page 306. The same provision is in v1 of that guidance from August 2011 (archived July 2014).
[302] A38694868 – SBAR 2 March 2017 water coolers and risk to patients – Bundle for Oral hearing commencing 12 June 2023 – Bundle 4 – Page 93.

water) highlights NHS responsibility to protect from waterborne bacteria in drinking water and water dispensers, and advises against free standing bottled water coolers due to infection risk. The low water flow risks stagnation and proliferation of bacteria. Positioning of coolers and poor stock control may also contribute. Mains-fed coolers and standalone coolers (fed from commercially-available bottles) were both present in QEUH. Mains-fed coolers are of higher quality. Sanitisation and maintenance of those should be undertaken at least every three months.[303]

20.6. She recommended that GGC apply the draft HFS Guidance SUP 05. Mains-fed coolers and standalone coolers were to be treated differently. Any mains-fed coolers presently in high-risk areas could remain, but "may be removed if deemed an infection control risk i.e. implicated in an outbreak", with no new mains-fed coolers to be installed in such areas (with IPCT and Estates to be alerted to any new purchases). She recommended practice on their use:

> "Mains coolers should be subject to regular quarterly maintenance and weekly cleaning. Users should ensure that water is not consumed directly from the cooler and that drip trays are kept clean and dry on a daily basis. Water should not be allowed to pool as this will create stagnant conditions."[304]

20.7. Dr Inkster recommended that standalone coolers were to be almost entirely removed:

> "Stand alone water bottle coolers should be removed. The only agreed exception should be maternity USS clinics or urology clinics where patients may be required to drink water pre procedure and no mains fed cooler is in the vicinity. These coolers should be identified and a cleaning regime should be agreed with the IPCT."[305]

20.8. Water coolers appear to have been taken out of use for patients in inpatient areas at a date before 28 March 2018 (with bottled water to be provided to patients for drinking and brushing teeth),[306] though they remained in use elsewhere in the hospital.

20.9. Water coolers were removed in RHC on 26 April 2018, with further concerns to be pursued:

> "IP withdrew all water coolers from RHC on Thursday and the provision of bottle water has been arranged for the wards. A decision on the long-

[303] A38694868 – SBAR 2 March 2017 water coolers and risk to patients – Bundle for Oral hearing commencing 12 June 2023 – Bundle 4 – Page 93.
[304] A38694868 – SBAR 2 March 2017 water coolers and risk to patients – Bundle for Oral hearing commencing 12 June 2023 – Bundle 4 – Page 94.
[305] A38694868 – SBAR 2 March 2017 water coolers and risk to patients – Bundle for Oral hearing commencing 12 June 2023 – Bundle 4 – Page 94.
[306] A39123928 - Water Incident, March 2018 Updated – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 5 – Page 135.

term reallocation of the water coolers and dispensers needs to be determined. It was noted that these are part of the water system of the hospitals but are not maintained by Estates staff, they are maintained by an outside contractor which includes a 6 monthly sanitisation and service. MAK noted her concerns on the results being returned from these dispensers and their continuing use within the hospital. It was agreed that TI will forward her SBAR for comment. SD noted that there were questions being asked by nursing staff on why the coolers had been removed and it was noted that appropriate communication had not been taken forward with staff and will be resolved. OPD removal of the water coolers – there was not thought to be any reason to back fill these with bottles of water as in the wards. It was agreed that with POUF in place and ice available on the wards it would be acceptable to use the tap water for drinking. The risk to patients overrides the requirement to provide drinking water and the decision to remove the water dispensers was agreed"[307]

20.10. Work to remove water coolers remained ongoing during 2019:

"in some locations the units had been isolated but not yet removed"[308]

…

"Guidance is being issued nationally that bottled water coolers should not be used in NHS Scotland healthcare premises. This is due to the fact that there is potential for bacteria in the nozzle and the water bottle if not routinely used, which could pose an infection risk to vulnerable patients. This guidance has been issued to all Boards in Scotland who have either removed or are in the process of removing all bottled water coolers. NHSGGC is complying with this. Patients and staff will have access to drinking water from ward kitchens or suitably assessed plumbed in water coolers."[309]

…

"Standalone Bottled Water Coolers ... Management at the local level of hygiene is the issue not the actual coolers themselves but as local cleaning and maintenance is not taking place routinely across the Board it was agreed on the basis of risk that these need to be removed. Eden will continue to supply bottled water until told otherwise … Under Counter Chillers – Concerns that some models of these have reservoirs and these are a concern … Water coolers currently in place will be given the same documentation to ensure that these are cleaned and maintained appropriately and documented. Risk assessments for standalone bottled water coolers will be carried out in the areas by

[307] A38668909 – Water Technical Group Meeting 27 April 2018 – Bundle in respect of the Water Technical Group / Water Review Group Minutes in relation to the Glasgow 3 Hearings – Page 19.
[308] A38675850 – NHSGGC Board Water Safety Group Meeting 25 April 2019 – Bundle of documents in respect of the Water Safety Group in relation to the Glasgow 3 Hearings - Page 104.
[309] A34380791 – Media Statement dated 16 August 2019 – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 5 – Page 340.

exception if a chiller or a plumbed in version cannot be provided as it may be the case that there is no alternative"[310]

…

"Any increase of people drinking bottled water at the QEUH may be due to the recent removal of bottled water coolers from the site due to risk of contamination. This was in response to the potential for bacteria to grow in the nozzle and the water bottle if not routinely used, which could pose an infection risk to vulnerable patients"[311]

20.11. Pro Lp Consulting Ltd's Authorising Engineer Management and Compliance Audit dated 11 January 2023 noted:

"Some of the required LUO [Little Used Outlet] flushing is completed by DMA Canyon Ltd. Specifically, DMA Canyon Ltd flush the following:- Three times per week flushing of supply pipes to unused or removed water coolers."[312]

20.12. The use of both stand-alone and mains connected water coolers is a potentially deficient feature for the purposes of Glasgow III.

21. Dishwashers

21.1. Dishwashers were identified as potentially deficient features. These were plumbed into ward areas and connected with flexible hoses. Concern over the installation of these items identified their potential as locations for organic growth.

21.2. Concern over dishwashers was raised on 22 September 2017 in an IMT meeting regarding 'Exophiala in Cystic Fibrosis Patients':

"over the last 11 months there has been an increase in the number of patients who had this organism isolated from clinical samples, with a peak identified in August …

[Adult wards] … An engineer reviewed two of the dishwashers and the following issues were identified:-

Found to have 2 rinse aid containers in use rather than one rinse and one detergent.

Bottom filter found to have build up of residue

Found to have correct containers fitted but hoses supplying machine

[310] A38675852 –NHSGGC Board Water Safety Group Meeting 3rd September 2019 – Bundle of documents in respect of the Water Safety Group in relation to the Glasgow 3 Hearings – Page 112.
[311] A39123887 – Media Statement dated 4 December 2019 – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 5 – Page 410.
[312] A44312832 - Pro Lp Consulting Ltd Audit 2023 – Bundle in relation to Water PPP – Page 1435.

from containers were wrong way round.ie rinse aid hose was in detergent and detergent hose was in rinse aid.

In addition detergent container found to be crystallising in bottom of container resulting in uptake into hoses and on into machine. Hose intake usually sits at bottom of container." [313]

"incident from last year whereby we had noticed cystic fibrosis patients colonised with a fungus called Exophiala. It does not cause clinical infection but we decided to check dishwashers"[314]

""In 2017, Exophiala was identified in an environmental sample taken from a dishwasher. As a precaution dishwashers were removed from some areas in both the adult and children's hospital. No patients were affected."[315]

21.3. Dr Inkster and Dr Storrar addressed what further action was to be taken with respect to the dishwashers in an exchange on 7 June 2018, Exophiala having been discovered still to be present:

"… Is the plan to put on point of use filters?

yes we do … There were issues with cleaning and plumbing of these which was addressed and I reswabbed a few weeks back. The fungus is still there so I have requested online filters before swabbing again. At the moment these dishwashers are out of use in Cystic fibrosis wards until we get negative results."[316]

21.4. This is understood to be a reference to ongoing discussions in Water Review Meetings around the installation of point of use filters,[317] such as:

"**Dishwashers and Drinking Dispensers**

The question was raised at the last meeting about putting POUF on these. It was noted that these are proving difficult to locate but TI noted that there had been spores found in the dishwashers but it was unclear how this was happening. Due to the settings these are being run at with appropriate detergent there should be nothing being found. It was agreed that these should be run every day with the appropriate

[313] A41890305 – 22.09.2017 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Pages 50 and 51.
[314] A33820370 - Email from Dr Inkster to Dr Storrar 7 June 2018 – Bundle in relation to Water PPP – Page 842.
[315] A41501722 – Herald on Sunday article "Early fungal outbreaks at hospital revealed" – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 5 – Page 313.
[316] A33820370 - Email from Dr Inkster to Dr Storrar 7 June 2018 – Bundle in relation to Water PPP – Page 842.
[317] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 978.

> detergent by catering staff and a record kept of the units and testing continues. It was noted that a realignment of the machines was carried out last week and should prevent anything further but as a precaution in the high risk areas – 7A/7D/3A/3B/3C and high risk areas (in in total) should have POUF fitted."[318]

21.5. The Inquiry is unaware as to whether these actions were carried out.

21.6. The use of dishwashers – or at least the use of dishwashers without daily cleaning – in Cystic fibrosis wards is a potentially deficient feature for the purposes of Glasgow III.

22. Energy centre

Capacity of the energy centre

22.1. The performance of the Energy Centre against its theoretical capacity prompted concerns that it may be a potentially deficient feature of the water system at QEUH. The fundamental concern was that the centre may not be capable of operating to full capacity. The risk as a consequence would be that it would thereby be unable to reliably maintain the hot water system at the temperature at which it was supposed to operate, meaning an increased risk of growth of legionella.

22.2. In 2014 the 'New South Glasgow Hospitals Specification CHP Systems' states "The primary purpose of the CHP is to provide Medium Temperature Hot Water" and "The CHP Units shall be controlled by their own controls system to provide a constant 105 °C flow." [319]

22.3. In 2019 NSS Health Facilities Scotland described the purpose of the Energy Centre at QEUH as follows:

> "To provide an efficient source of heating and power for QEUH, RCH and other parts of the QEUH campus a new separate Energy Centre was built to house the Combined Heat and Power Unit (CHP) and boilers.
>
> Hot water is distributed to the building plant rooms from the energy centres via a Medium Temperature Hot Water (MTHW) heating system derived from seven MTHW dual fuel boilers and 3 gas fired CHP units. The CHP system is designed to be the lead system and provide a high portion of the campus heating requirement.\
>
> In the QEUH and RCH plant rooms there are plate heat exchangers which convert the MTHW to Domestic Hot water (DHW) and Low

[318] A38668902 – Water Technical Group Meeting 18 May 2018 – Bundle in respect of the Water Technical Group / Water Review Group Minutes in relation to the Glasgow 3 Hearings – Page 31.
[319] A34316123 - Specification CHP Systems – Bundle in relation to Water PPP – Page 1137.

> Temperature Hot Water (LTHW) to serve the hot water and heating circuits respectively, for the wards and ancillary spaces."[320]

22.4. Capita, in their Supervisor's Final Defects Certificate dated 26 January 2017, recorded a concern regarding the operation of the Energy Centre as having been identified to them on 28 October 2016:

> "CHP control is still set back at 80 percent heat output, based on higher than expected return temperatures ... this is combine with the heat dump valve being set at 50% minimum setting, therefore the CHP is continuously rejecting 50 percent of 1 CHP output (600 KW rejection)". as a result this system cannot be operating at optimum design efficiency…
>
> … advise from Schneider installation team is that they were instructed by H&V commissioning to set the value at a minimum 50% (5V) in order to achieve the required flow rates to balance the system. This cannot be correct? Please provide commission detail to justify the current configuration against the design control philosophy? detailed review of CHP control philosophy and performance is urgently required."[321]

22.5. Capita recorded that remedial action was envisaged in the near future:

> "Boiler flow temperature now reduced and system being monitored. Edina to be arranged w/c 06/02/17 to put CHP back into 100 percent performance."[322]

22.6. On 10 May 2018 Innovated Design Solutions produced an in depth 'Forensic Analysis Report' on the QEUH/RHC Energy Centre.

22.7. GGC requested Innovated Design Solutions to undertake a forensic analysis of record documentation contained within the Zutec electronic database pertaining to the medium temperature hot water installation, providing comments with regards to probable design intent, and identifying any potential inconsistencies relative to the same.[323]

22.8. Innovated Design Solutions were also asked to review and comment on possible variations undertaken to the system that appeared to deviate from the anticipated initial design intent, together with an opinion with respect to any anomalies in relation to the same.[324]

22.9. Where there was insufficient information made available to the Innovated Design Solutions, there was some speculation in relation to particular aspects of the system. Innovated Design Solutions accepted that inaccurate opinions

[320] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 140.
[321] A32402296 - Final Defects Certificate 26.01.2017 – Bundle in relation to Water PPP – Page 1225.
[322] A32402296 - Final Defects Certificate 26.01.2017 – Bundle in relation to Water PPP – Page 1225.
[323] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1270.
[324] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1270.

may have been arrived at.[325]

The concerns raised in the report were:

> "….it would appear there was likely to be inherent irregularities in terms of the original MTHW heating primary circulation design philosophy. These may have subsequently resulted in system temperature control instability, and consequently led to the CHP system underachieving intended desired level of performance."[326]
>
> "….post completion/commissioning alterations were primarily instigated with a view to enhancing probable CHP underperformance. However, the eventual influences of modifications on the MTHW heating system do not appear to have been thoroughly considered prior to implementation." [327]
>
> "Alterations to the control systems included several amendments to the presumed original design intent, including functional operation parameters pertaining to CHP system, boilers, primary MTHW circulation pumps, and automatic control valve sequencing."[328]
>
> "In relation to CHP system and boiler operation, the revised strategy appears to prioritise heat rejection to atmosphere over the presumed original intent of de-rating CHP unit outputs. On the presumption the CHP system was intended to operate on heat led basis, this does not appear to be an appropriate or efficient method of operation. Furthermore, temperature set point adjustments appear to have effectively resulted in an apparent **continued rejection of heat to atmosphere**, whilst up to three boilers are operational, and again raising concern with regards to efficiency from both energy and monetary perspectives."[329]
>
> "In terms of primary MTHW pump operational modifications….. we anticipate the revised control methodology to be ineffective, thereby resulting in a significant fundamental divergence from the intended system operation in respect of primary and secondary circulation. A particular consequential effect of these pump control modifications appears to have caused **lower secondary side temperatures (i.e. heating and domestic hot water services) than those originally proposed, adversely influencing thermal comfort and increasing the risks associated with legionella."**[330]
>
> "Circulation temperatures noted…. tend to indicate the incidence of a primary MTHW circulation short-circuit, which could be a consequence of automatic control valve adjustments undertaken…. there also

[325] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1270.
[326] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1268.
[327] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1268.
[328] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1268.
[329] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1268.
[330] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Pages 1268 and 1269.

appears to have been alterations made to lead plant sequence controls, and load diversion strategies, which may result **in insufficient heat generation** during periods of peak demand."[331]

'….the domestic hot water services appear to have been originally designed on the basis of direct heating utilising MTHW/DHWS plate heat exchangers, as to afford rapid recovery of domestic hot water temperatures, and minimise risks associated with legionella. Given the lower than originally intended operational temperatures observed during our investigation works, and temperatures indicated within the User Manual, the revised control strategy would appear to have resulted in the primary distribution operating on a low temperature hot water basis, and unlikely to afford rapid heat recovery.'[332]

"In conclusion…..there may well have been complications associated with the successful operation of the systems prior to implementation of system modifications. Post completion alterations do not seem to have successfully resolved recognised original system inadequacies, and appear to have created separate/additional detrimental operational problems."[333]

22.10. The 2019 Health Facilities Scotland report also records that there had been issues throughout with the Energy Centre, with the plant having been brought online late and never having been signed off as compliant with the specifications of the contract:

"The CHP plant was not commissioned within the original project timeline and was subject to contractual penalties.

A summary of the current situation (as at writing of Report) is as follows:

Intended project completion	January 2015.
Actual project completion	January 2016 All 3 CHP units were brought online, there was no sign off on the compliance of the CHP with the contract as Multiplex still required to prove the control strategy and energy performance, to date (July 2018) this has not been provided

[331] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1269.
[332] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1313.
[333] A33795394 - Forensic Analysis Report – Bundle in relation to Water PPP – Page 1269.

First indication not working as intended	January 2016
Date changes made to control software	These changes have been ongoing since January 2016 under the control and instruction of Multiplex, current configuration was implemented Aug 2017 by Multiplex (not proven or signed off as working).
Have all software changes been documented	No these software changes have not been documented despite requests for this documentation and sign off by the system control philosophy changes by the design engineers. Following pressure (from GGC Estates) a user guide was issued (by the Contractor) for use by the operational Estates Team

…

GGC have advised they have not been able to operate the plant as intended due to numerous failures of the system …"[334]

22.11. The HFS report also records that these issues were under discussion with the contractor, without agreement:

"The Contractor has indicated that they and their advisors can see no consistent issues with temperatures although there may be some control issues which were instigated in 2017 and it has been these changes which have caused the potential issues with the hot water temperatures at QEUH and RCH.

Temperature issues

GGC has advised that the main issue is that the MTHW flow and return temperatures are not as specified. This in turn means that on occasion that the DHW temperatures on the wards will fall below the specification and parameters set out in SHTM 04-01."[335]

22.12. The HFS report summarised the position as follows:

"As noted in DMA's reports there were issues reported at the time with the MTHW supply to QEUH and RCH from the Energy Centre. This may have contributed to the LTHW temperatures to the outlets dropping

[334] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 141.
[335] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 141.

below the minimum 50oC required and into the legionella growth zone (which would have also aided other organism growth). There is evidence from the BMS logs that the LTHW temperature is low. This situation has not been resolved at the time of writing (July 2018). Issues with Water Management Issues Technical Review Page 78 of 124 Version V1.0 the function of the CHP are being addressed directly by GGC to the Contractor."[336] [337]

22.13. Among the recommendations were that GCC should:

"2. Resolve outstanding issues with the Energy Centre."[338]

22.14. It is not clear whether further remedial action has been taken. In any event the question of whether the energy centre has sufficient capacity to operate the hot water system within a temperature range outside the legionella growth zone is a potentially deficient feature for the purposes of Glasgow III.

Insufficient backflow protection

22.15. Another potentially deficient feature identified in the Energy Centre was a lack of sufficient backflow protection on a filling loop and the incoming supply. Backflow protection reduces the risk of contaminated water flowing in an unintended direction through pipework.

22.16. Scottish Water Byelaws Inspection Reports of 28 February 2020 and 10 March 2023 identified instances of insufficient backflow protection on a filling loop and the incoming supply to the Energy Centre Building.[339] It is not known what remedial actions if any have been taken to address those concerns. The lack of backflow protection in the Energy Centre is a potentially deficient feature for the purposes of Glasgow III.

23. Irrigation system

23.1. The irrigation system operated as an external soakaway irrigation system in various courtyards and rooftop gardens at the QEUH site. This system was identified as a potentially deficient feature due to its less-frequent use, and

[336] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Pages 146 and 147.
[337] NB that the reference to the DMA Report may be a reference to DMA having recorded in its 2015 Report that: *"When DMA were on site on the 21st of April there was a significant drop on the temperatures of the calorifiers which we understand was caused by a failure on the heating system. Temperatures recorded on these calorifiers on this day were 40-45°C."* [A33870103 – DMA L8 Risk Assessment, 1 May 2015 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 220.]
[338] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 148.
[339] A43262538 - Scottish Water Byelaws Inspection Report, 28 February 2020 – Bundle in relation to Water PPP – Page 1390; A43262488 - Scottish Water Byelaws Inspection Report, 10 March 2023 – Bundle in relation to Water PPP – Page 1446.

distance from the rest of the system, posing a risk that it may function as a deadleg, with consequent risks of stagnancy and growth of organic material.

23.2. In its gap analysis of 8 March 2016, DMA Canyon raised the concern that, subsequent to earlier recommendations on flushing, the irrigation system had instead been disconnected, leaving the possibility of deadlegs:

> "**Irrigation System**
>
> Task
>
> Include in site flushing regime. Additional flushing may also be required (outlets run for extended periods) to bring temperatures on distribution system down particularly during periods of low use (e.g. in winter when irrigation system is not required to operate frequently). Maintain in accordance with manufacturers/installers instructions
>
> Minimum Frequency
>
> Twice weekly as part of site flushing regime
>
> In place or being carried at present?
>
> This is not being carried out at present. Allocation of responsibilities unclear at this time. These should be formally included in site flushing regime."[340]

23.3. Subsequent to the Gap Analysis, flushing was carried out though not on a twice-weekly basis. Ten flushing events were recorded from 3 May 2016 to 29 November 2019.[341]

23.4. GGC record that in February 2017 the disconnection/removal work was carried out:

> "Irrigation system for external vegetation/planting was isolated and disconnected and external bb taps removed [because] identified as an unnecessary risk"[342]

23.5. It is inferred that this was pursuant to an instruction made on 30 December 2016 to "Isolate outside taps in garden areas if possible", and marked completed by 24 February 2017.[343]

23.6. On 30 January 2018, DMA Canyon maintained its concern regarding the possible presence of deadlegs in the residual irrigation system:

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[340] A44312702 - DMA Gap Analysis, 8 March 2016 – Bundle in relation to Water PPP – Page 1215.
[341] A33869858 - 'Item 487 – Irrigation FM first tickets' – Bundle in relation to Water PPP – Page 1221.
[342] A44311369 - Parts 1(iii), 1(iv) & 2(i) of GGC response to s.21 Notice 8 – Bundle in relation to Water PPP – Page 980.
[343] A33869865 - 'Item 487 – Irrigation System comments' – Bundle in relation to Water PPP – Page 1363.

> "Comments Very long runs to outlets through the building.
>
> Recommendations Ensure former connection points are included in site flushing regime or removed leaving no deadlegs with stored capacity reduced as required."[344]

23.7. The Water Management Issues Technical Review produced by HFS in March 2019 also stated that while outlets for the irrigation system had been removed, the pipe work serving them had not been completely removed.[345]

23.8. The inclusion of an Irrigation system for external vegetation/planting is a potentially deficient feature for the purposes of Glasgow III.

24. Waste system

24.1. The waste system at QEUH was a possible location of interest during an incident regarding the water system in 2018, where investigation was being made into the source of a series of infections in certain wards in RHC.

24.2. Multiplex have submitted to the Inquiry the document 'Description of Above Ground Drainage', which describes the drainage system within QEUH in the following terms:

> "This description relates to the above ground drainage system serving the Adult and Children's Hospitals at the time it was handed over to GGHB by MPX.
>
> …
>
> Above ground foul (soil and waste) drainage is collected from sanitary fittings, equipment and outlets, by a system of vertical and horizontal pipework distributed within the building, to connect to the below ground drainage system.
>
> …
>
> The drainage system operates under gravity with anti-siphon ventilation stacks to atmosphere for the ground floor upwards.
>
> …
>
> For the basement, the soil and waste feeds into a sump located in the pump room FMB-024 and is pumped into the ground floor and below

[344] A33870243 – DMA Canyon L8 Risk Assessment, Final Submission 25 April 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 585.
[345] A33448015 – HFS Water Management Issues Technical Review – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 7 - Page 84.

ground drainage system."[346]

24.3. During the series of IMT meetings on the 2018 Water System Incident concerns were raised regarding drains as a potential source of the Enterobacter clocae outbreak Healthcare Infection, Incident and Outbreak Reporting Template, 29 May 2018. Other potential sources, including cleanliness, large numbers of visitors, and presence of large amounts of patient and parent belongings, had been raised at previous meetings:

> "A PAG was held on 18.05.18 to assess 4 cases of Enterobacter cloace bacteraemia associated with wards 2A or 2B
>
> …
>
> Yesterday (28.05.18) a further Enterobacter cloacae bacteraemia was confirmed. This patient was non HAI by definition but she too had had contact with ward 2B. Typing of 2 cases also found both patients to have unique strains. Typing results are awaited for the others. An IMT was held today 29.05.18. All the above actions were reviewed and noted to have been completed. The following additional actions were agreed:
>
> Drains within clinical hand wash basins to be swabbed on ward 2A and 2B
>
> Request to be made to facilities to clean all drains in 2A and 2B following swabbing…"[347]

24.4. The swabs taken as a result of that meeting were analysed and the results addressed at a subsequent IMT meeting on 4 June 2018: Water System Incident Ward 2A & 2B.

> "A Problem Assessment group was held on the 18th May 2018 to discuss 4 new cases of E.cloacae bacteraemia and 3 cases of Stenotrophomonas maltophilia bacteraemia in patient's associated with ward 2A and/or 2B. A number of actions were generated from these PAGs including sampling of drains. Late on Friday, results of the drain swabs were reported. Various gram negative organisms were indentified including Enterobacter cloacae, Paeusomonas aeruginosa, Sphingomnas, Cupriavadis pauculus, Acinetobacter ursingii and Klebsiella oxytoca.
>
> …
>
> Dr Inkster expanded on the findings of the drain swabs … it is very likely that the Enterobacter cloacae bacteraemias are associated with contaminated drains … AR queried if concerns had been reported

[346] A44674683 - 'Description of the Above Ground Drainage' – Bundle in relation to Water PPP – Pages 1000 and 1001.
[347] A41967195 - HIIORT 29 May 2018 – Bundle in relation to Water PPP – Pages 840 and 841.

> relating to drains previously. AH and SD stated that black grime had been noted in the drains some weeks ago. AG confirmed that this had been reported and discussed at previous water IMTs. He stated that the opinion of both water experts consulted as part of the water incident was that drains should not be cleaned. AR advised that this advice is approached with caution."[348]

24.5. It was agreed that the drains should be cleaned:

> "IP reported that following a request for drains to be cleaned on Friday, he has notified Scottish water of the requirement to do so. IP informed the group that this is necessary before cleaning can be undertaken. He has also looked at appropriate products for use and circulated suggestions by email. Products include chlorine dioxide for the initial drain cleaning decontamination followed by acetic acid for ongoing rolling programme of drain cleaning. TI supported this. Ian Storrar also supported this. It was agreed that all outlet drains will be decontaminated within ward 2A and 2B."[349]

24.6. Measures to be taken in response included restricting patient access to wards 2A and 2B, undertaking drain cleaning imminently, and checking and increasing filtering[350]. Additional requirements were imposed regarding hand hygiene and antibiotic prophylaxis[351]. An infection timeline produced by the Oversight Board stated that drains were cleaned and then decontaminated with Hydrogen Peroxide Vapour in Wards 2A, 2B, 7A, 7D, PICU and elsewhere on site. The timeline also noted that, around this time, dissection of a sink waste pipe showed exposed metal parts with bio-film. All waste pipes were replaced in Wards 2A/4B with new plastic ones.[352] On Monday 4 June 2018 GGC issued a media statement containing the following:

> "Our facilities team is today carrying out treatment on the drains within Wards 2A/B after traces of bacteria were found during testing.
>
> …
>
> Our infection control experts believe the bacteria to be linked to an earlier issue with taps which have since been fitted with filters. The water supply is unaffected.
>
> Dr Teresa Inkster, NHSGGC Consultant Microbiologist, said: "As the

[348] A36690448 – 04.06.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Pages 94 and 95.
[349] A36690448 – 04.06.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 96.
[350] A36690448 – 04.06.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 96.
[351] A36690448 – 04.06.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 96.
[352] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 943.

wards affected treat patients whose immune system is compromised we have taken these immediate steps to apply a chemical disinfection to the drains and to inform the families of the situation.""[353]

24.7. On 11 July 2018 Intertek issued a report containing the following concerns in respect of wards 3A and 3C:

"Ward 3C … Rubber seal showed evidence of significant decomposition. Heavy biofilm presence … large piece of clear plastic (50mmX40mm) … large clumps of tangled hair present … gap between down pipe and bulb trap heavily soiled to 10mm depth

…

Ward 3C … light staining inside the bulb trap … single piece of physical debris present in the trap (5p piece)"[354]

24.8. The difference between the two wards was apparent from the test results. In respect of Ward 3C:

"Microbiological assessment of this debris was not deemed possible due to the expected high levels it would not be possible to obtain a dilution high enough to produce a workable result and when dealing with waste water systems with high levels of contamination the associated risk to the lab from potential virus contamination would be to great … Due to the level of contamination a traditional swabbing method of the drain was not seen as practical. On assessment it was decided that due to the seal being in a failed condition that a swab would be taken from the metal fitting where the seal attaches. The tip of a swab was dabbed onto an area of 10mm2 to perform the test. The result for the swab test gave a result of 210cfu at 6 dilutions. This would give and estimated total organism count of 210x106 /cm2 of the metal fitting"[355]

24.9. And in respect of Ward 3A:

"The drain showed little or no evidence of contamination. All seals were intact and sound … A swab was taken from a sweep of the inside of the bowl trap the result for the swab test gave a result of 115cfu at 5 dilutions giving an estimated total count of 115x105. At this point it is worth noting the difference in organism levels between the two drain swab samples …"[356]

[353] A38661975 – GGC Media Statement 4 June 2018 – Bundle for Oral Hearing Commencing 12 June 2023 – Bundle 5 – Page 139.
[354] A33795375 – Intertek report 11 July 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 638.
[355] A33795375 – Intertek report 11 July 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Pages 643 and 644.
[356] A33795375 – Intertek report 11 July 2018 – Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Pages 644 and 645.

24.10. It is not known to the Inquiry whether any further action was taken.

24.11. In the IMT meeting of 13 September 2018, further concerns were raised in respect of ward 2A, regarding Gram Negative Bacteraemia:

> "the IMT are currently focussing on cases 18-22 and three patients have been discharged home. Case 22 has been added as the patient had a Serratia blood culture which was taken on 5th and the patient was in Ward 2A. Serratia has not been included in the list of organisms to date as it had not been identified in drains however after this patient had been admitted the drain in his room had been swabbed and was positive for Serratia, Teresa said we may be over reporting regarding this patient but the patient does now meet the agreed case definition. Teresa explained that is it not possible to determine what was contaminated first, patient or drain. She explained that drains are not sterile but that there should not be reflux back up into sinks.
>
> …
>
> there was a spike earlier in the year which related to the drains, then no cases were identified in June and July and then another spike now relating to the drains
>
> …
>
> It was noted that there were differences in the adult hospital compared to the children's hospital with no reflux materials found in any of the sinks in the adult hospital … alerted to a drain issue when nursing staff noticed black material coming up from the sink
>
> …
>
> we are not trying to sterilise the drains but to try and reduce the material coming up and figure out why this is happening"[357]

24.12. The timeline produced by the Oversight Board notes in addition for this period:

> "Drains swabbed in Ward 2A on 29 Aug as thick black and yellow grime visible after cleaning only 4-6 weeks ago - findings are that 2 of 3 cases match the patients. Tests show Coliforms, Delftia acidovarons, Chryseomonas indologenes, Cupriavadis, Pseiudomonas aeruginosa and Klebsiella oxytoca.
>
> "…IPCT conduct physical inspection of drains and sinks and note some appear to have sealant in the drain and black gunge is noted. Reported to F&E team who confirm sealant is a gasket in the drain that has become porous due to the use of hydrochloride cleaning products.
>
> "… Drain survey and ventilation survey are commissioned. The drain

[357] A36629307 – 13.09.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Pages 160 and 161.

survey did not find any issues."[358]

24.13. Investigations, cleaning and decanting of patients into other wards occurred over subsequent weeks.[359]

24.14. The timeline produced by the Oversight Board noted for November 2018:

> "Following a PAG held on 25 October an IMT was set up on 2 Nov to investigate 5 cases of PsA [Pseudomonas Aeruginosa] isolated from patients who had all had appendectomies in same theatre in October 2018…Sample of drains found PsA growth in the anaesthetic trough and this was sent for typing. Excessive amount of debris, including nail picks, found in u-bend traps of drains also. All drains throughout theatre have been cleaned. No further meetings were planned unless new cases identified."[360]

24.15. The Oversight Board timeline narrates further instances of drains harbouring concerning bacteria and excessive amounts of debris.[361] In all instances the drains were cleaned however the current state of the hospital's drainage is not known.

24.16. A report produced for a Clinical Care & Governance meeting of 5 December 2017 stated:

> "Plumbing in Neuro Surgical Block
>
> Dr Redding stated that there has been sewage leaking in the theatre suite since before 2015 and is still ongoing and not all incidents have been reported to ICDs [Infection Control Doctors]"[362]

24.17. An appended action plan noted for this concern:

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[358] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 945.
[359] A36629309 – 14.09.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 164.
A36629315 – 17.09.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 169.
A36629310 – 18.09.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 175.
A36629316 – 19.09.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 180.
A36629320 – 20.09.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 185.
A36629324 – 25.09.2018 IMT – Bundle for Oral hearing commencing 12 June 2023 – Bundle 1 – Page 190.
[360] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Page 947.
[361] A33448013 – Oversight Board Infection Timeline - Bundle for Oral hearing commencing 12 June 2023 – Bundle 6 – Pages 949, 951 and 956.
[362] A32347779 - Report on Concerns Raised re QEUH and RHC – Bundle in relation to Water PPP – Page 836.

"Ensure reporting is ongoing."[363]

24.18. It is not known what if any further action was taken.

24.19. It should be noted that drains are not sterile, that there is no systematic survey of the waste system and there is no analysis that answers the question of what was contaminated first during the investigations described in this section; patient or drain. However given the interest shown in the drains as part of those investigations, the waste system is a potentially deficient feature for the purposes of Glasgow III.

25. Conclusion

25.1. This Paper has identified many potentially deficient features for the purposes of Glasgow III. Notwithstanding the sources used to identify these features the question of whether system as a whole or in part (a) did or does not achieve the outcome or was capable of the function for which it was intended, or (b) did or does not conform to relevant statutory regulation and other applicable recommendations, guidance, and good practice will be determined after evidence is heard at the Glasgow III hearing. The same statement is also true for the key concept in the Key Questions of whether the whole or part of the water system (including drainage) was or remains in an unsafe condition, in the sense that that feature presented or presents an additional risk of avoidable infection to patients. These questions will require to be determined only after evidence has been led and submissions received in the Glasgow III hearing.

25.2. It seems clear to the Inquiry team that some of the potentially deficient features identified in this Paper appear to only apply to discrete parts of the system whilst others are potentially system wide. Some of these potentially deficient features are literal physical features of the system and some are aspects of its operation or, in some way, results of testing or investigation that appear to or could apply to all or a large part of the water in the system. The consideration of the effect of these potentially deficient features in Glasgow III must look at these features in isolation, in combination with others and also as a whole water and drainage system.

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