Annex B: Drinking Water Safety Plan - Strategic Water Quality Risk Assessment (SWQRA) for London Water Recycling Gate 3

J698-AJ-C01X-ZZZZ-RP-PE-100001

Standard Gate three submission for London Water Recycling SRO

Notice – Position Statement

This report has been produced as part of the process set out by RAPID for the development of the Strategic Resource Options (SROs). This is a regulatory gated process allowing there to be control and appropriate scrutiny on the activities that are undertaken by the water companies to investigate and develop efficient solutions on behalf of customers to meet future drought resilience challenges.

This report forms part of a suite of documents that make up the 'Gate 3 submission'. Gate 3 of the RAPID programme represents a checkpoint on the way to solutions being prepared for consent applications. The intention at this stage is to provide RAPID with an update on activities being undertaken in preparation for consent application submission; activities' progress including programme through to completion; and consideration of specific activities to address particular risks or issues associated with a solution. The regulatory gated process does not form part of the consenting process and will not determine whether an SRO is granted planning consent.

Given the stage of the SROs in the planning process, the information presented in the Gate 3 submission includes material or data which is still in the course of completion, pending further engagement, consultation, design development and technical / environmental assessment. Final proposals will be presented as part of consent applications in due course.

Disclaimer

This document has been written in line with the requirements of the RAPID Gate 3 Guidance and to comply with the regulatory process pursuant to Thames Water's statutory duties. The information presented relates to material or data which is still in the course of completion. Should the solutions presented in this document be taken forward, Thames Water will be subject to the statutory duties pursuant to the necessary consenting process, including environmental assessment and consultation as required. This document should be read with those duties in mind.

Contents

List of Figures

List of Tables

1 Executive Summary

1.1.1 This document provides a summary of the Strategic Water Quality Risk Assessment (SWQRA) undertaken for the London Water Recycling (LWR) Strategic Resource Option (SRO).

1.1.2 The SWQRA provides a high-level risk assessment based on a drinking water safety approach to identify limiting hazards and assessing their risks across the water supply system for SROs. At each stage from catchment to consumer (i.e. catchment, abstraction, conveyance, treatment, storage, distribution, and consumer) pre-mitigated risks are assessed using a 5x5 risk matrix, mitigation measures proposed, and resultant post mitigated residual risks assessed.

1.1.3 The framework methodology for this was developed by the All Company Working Group (ACWG)[1] and this report provides a summary of the outcome from the risk assessment framework approach.

1.1.4 This document summarises the changes to the SWQRA for LWR SRO between Gate 2 and Gate 3 which are as follows:

- Review of new and updated information since Gate 2
- Additional Limiting Hazards at Gate 3
- SWQRA risk scoring methodology
- Completion of the SWQRA
- Gate 3 Risk Assessment outcome

1.1.5 The methodologies and results of the SWQRA have been discussed with the company drinking water quality teams.

Risk Assessment Scenarios

1.1.6 The following risk assessment (RA) scenarios have been undertaken considering a catchment through to consumer's tap approach, described above, aligned with the Drinking Water Safety Plan (DWSP) methodology:

- Teddington Direct River Abstraction (DRA)
- Mogden Water Recycling
- Beckton Water Recycling

1.1.7 These RAs were undertaken in Gate 1 and Gate 2, and are updated in this Gate 3 work. The Mogden South Sewer scheme was officially removed as a LWR SRO Option at Gate 2 and therefore not continued in this stage.

Limiting Hazards at Gate 3

1.1.8 Gate 2 limiting hazards were reassessed at Gate 3 as well as any additional limiting hazards included in the Gate 3 SWQRA based on the new or updated information: Water quality (WQ) data, Drinking Water Safety Plans (DWSP), and process flow diagrams (PFD).

1.2 Teddington DRA

1.2.1 The following hazards were retained from Gate 2 work for Gate 3 assessment

- Escherichia coli (E.coli), Cryptosporidium, Iron, Nitrate, Nitrite, Total Pesticides, Cyanide, Polycyclic Aromatic Hydrocarbons (PAH), Benzo(a)pyrene, Corrosivity, Change in Source Type,1,4–Dioxane, Pathogens (bacteria, viruses, protozoa), N-Nitrosodimethylamine (NDMA), Total Organic Carbon (TOC), Ammonium, Chloride, Chromium, Perfluorooctanesulfonic acid (PFOS), Perfluorooctanoic acid (PFOA), Turbidity, Metaldehyde, Aluminium.

1.2.2 Additional limiting hazards at Gate 3 were identified:

- Acrylamide, Alpha Radioactivity, Manganese.

1.3 Mogden Water Recycling

1.3.1 The following hazards were retained from Gate 2 work for Gate 3 assessment

- E.coli, Cryptosporidium, Iron, Manganese, Sodium, Nickel, Nitrate, Nitrite, Pesticides Total, Mercury, Benzo(a)pyrene, Corrosivity, Change in hardness/alkalinity, Change in source type, 1,4-Dioxane, Pathogens (bacteria, viruses, protozoa), NDMA, TOC, Chloride, Chromium, Lead, PFOS, PFOA, Turbidity, Metaldehyde, Aluminium.

1.3.2 Additional limiting hazards at Gate 3 were identified:

- Ammonium

1.4 Beckton Water Recycling

1.4.1 The following hazards were retained from Gate 2 work for Gate 3 assessment

- E.coli, Cryptosporidium, Iron, Nitrate, Nitrite, Total Pesticides, PAH, Benzo(a)pyrene, Corrosivity, Change in hardness/alkalinity, Change in source type, 1,4-Dioxane, Pathogens (bacteria, viruses, protozoa), NDMA, TOC, Ammonium, Chloride, Chromium, PFOS, PFOA, Turbidity, Metaldehyde, Aluminium.

1.4.2 Additional limiting hazards at Gate 3 were identified:

- Beta Radioactivity

1.5 Conclusions

1.5.1 Three of the four SRO options considered at Gate 2 (Teddington DRA, Mogden Water Recycling, and Beckton Water Recycling schemes) have been reassessed at Gate 3. Mogden South Sewer was officially removed at Gate 2. An overall summary of key conclusions for all three options evaluated from the Gate 3 assessment are provided below however specific scheme hazards and scores are provided within the relevant sections of the Annex:

- The Gate 2 SWQRA has been updated considering new water quality data from the SRO monitoring programme. As a result, some of the risk scores have changed between Gate 2 and Gate 3.
- New limiting hazards have been included at Gate 3 based on new water quality data and DWSPs.
- The Gate 2 methodology has been revised based on the updated data used to allow for consistency. Due to this, Gate 2 and Gate 3 scores are not directly comparable. This has been documented and clearly described where applicable within the RA.

1.5.2 For several of the limiting hazards the residual risks posed to consumer are low (green). There are however a number of limiting hazards for which the residual risks to consumer remain high (red) or medium (amber). These are:

- Limiting hazards which pose a risk that consumers could experience a change in perception of their water. These are generally related to change in source and include change in source type assessed as high risk (red) and change in alkalinity/hardness and corrosivity assessed as medium risk (amber). Corrosivity has been assessed for two aspects: the impact on network corrosion for which the mitigation is treatment/blending to minimise corrosion, and also the potential impact to taste and consumer perception for which the mitigation is ongoing customer engagement and information sharing.

- Limiting hazards related to Contaminants of Emerging Concern (CECs) - PFOS, PFOA, 1,4-Dioxane and NDMA. These are mainly found in wastewater effluent and generally are difficult to treat with conventional treatment technologies employed for water and wastewater treatment. Advanced water treatment at Mogden and Beckton is to be provided to mitigate risk and reduce these CEC levels to within acceptable limits.

- In August 2024 DWI issued new guidance on PFAS[2] which now requires monitoring of 48 PFAS compounds, from January 2025, adding 6:2 FTAB to the previous list issued in July 2022. Additionally, the guidance now requires reporting of Total PFAS concentration for all individual PFAS with concentrations above the limit of detection. Although the reporting tiers have not been altered from the previous guidance, it is expected that the above change will result in many more sources moving into a higher tier. This latest guidance was not received in time to be included in the Gate 3 SWQRA; however, this will be done in the Gate 4 update.

- Based on available WQ data from the SRO monitoring programme the risk is considered low from PFOS and PFOA. However, information in TW and E&S DWSPs indicates the PFAS risk to be medium. Based on above PFAS risk has been assessed as medium in the SWQRA.

- There is no current DWI guidance or drinking water standards for 1,4-dioxane and NDMA. The risk from 1,4-dioxane is assessed as high and from NDMA as medium, in both cases based on very limited monitoring data available for these parameters. The assigned risk scores reflect the uncertainty resulting from lack of data. It is recommended to carry out further water quality sampling for these parameters at monitoring points relevant to these schemes.

- It is, however, recognised that global health advisories continue to change with regard to contaminants of emerging concern. In June 2022, the US Environmental Protection Agency (EPA) announced the release of health advisories for four perfluoroalkyl substances with extremely low concentration limits in drinking water of 0.004 parts per trillion (ppt) for PFOA and 0.02 ppt for PFOS. Compliance with these new US limits, if applied in the UK, will be very challenging for most water treatment works. The WHO guidelines for drinking water quality chemical working group water are expected to report on PFAS in drinking water in 2027 and this may cause a change in the regulations; further, the UK Committee on Toxicology is currently reviewing the evidence for PFAS though the timeline for its opinion to be published is less clear.

- **Limiting hazards have been assessed as a red or amber residual risk based on information in the DWSPs.** These include Escherichia coli (E.coli), Cryptosporidium, Iron, Manganese, Total Pesticides, Pathogens, – bacteria, viruses and protozoa, TOC, Ammonium, Alpha Radioactivity, Lead, Turbidity, and Metaldehyde – These risks are already being mitigated via the current Thames Water DWSP process and are therefore not considered a risk to these schemes going forward. However, it is noted that the treatment risk should be reviewed at Gate 4 as part of this scheme, based on the future water quality data, to ensure no impact to consumers going forward.

2 Introduction

2.1.1 The Strategic Water Quality Risk Assessment (SWQRA) provides a high-level risk assessment based on a drinking water safety approach to identify limiting hazards and assess their risks across the water supply system for Strategic Resource Options (SRO).

2.1.2 The framework methodology for this was developed by the All Company Working Group (ACWG)[3] and the key SWQRA outputs are a workshop providing overview and agreement on the Risk Assessment (RA) which are completed in excel form and used to provide summary information to Gate 3 reports and associated documents.

2.1.3 This document summarises the changes to the SWQRA for London Water Recycling SRO (LWR) between Gate 2 and Gate 3 which are as follows:

- Review of new and updated information
- Additional Limiting Hazards at Gate 3
- SWQRA risk scoring methodology
- Completion of the SWQRA template
- Revised Risk Scores

2.1.4 In the development of the Gate 3 SWQRA, relevant existing DWSPs, which will incorporate the components of schemes in the future, were reviewed to identify existing risks to the consumer and considered alongside any new risks introduced. DWSPs were also referred to in carrying out high-level assessments of the treatment process available to determine their suitability to meet the risks identified in the SWQRA. Where appropriate additional treatment process have been proposed to mitigate these risk

2.1.5 The methodologies and results of the SWQRA have been discussed with the company drinking water quality teams and Drinking Water Inspectorate (DWI).

2.1.6 Three SWQRAs have been undertaken to cover the LWR options:

- Teddington Direct River Abstraction (DRA)
- Mogden Water Recycling
- Beckton Water Recycling

2.1.7 These RAs were undertaken in Gate 1 and Gate 2, and have subsequently been updated for Gate 3 utilising the latest water quality data.

3 Limiting Hazards at Gate 3

3.1.1 The limiting hazards at Gate 3 included all the Gate 2 hazards plus additional hazards. These additional hazards were included based on new water quality data, which became available at Gate 3, as well as the Thames Water (TWUL) and Essex and Suffolk (E&S) Drinking Water Safety Plans (DWSP).

3.2 Limiting Hazards for Teddington DRA

Gate 2 hazards reconsidered at Gate 3

3.2.1 The following hazards were retained from Gate 2 work for Gate 3 assessment:

- Escherichia coli (E.coli), Cryptosporidium, Iron, Nitrate, Nitrite, Total Pesticides, Cyanide, Polycyclic Aromatic Hydrocarbons (PAH), Benzo(a)pyrene, Corrosivity, Change in Source Type,1,4–Dioxane, Pathogens (bacteria, viruses, protozoa), N-Nitrosodimethylamine (NDMA), Total Organic Carbon (TOC), Ammonium, Chloride, Chromium, Perfluorooctanesulfonic acid (PFOS), Perfluorooctanoic acid (PFOA), Turbidity, Metaldehyde, Aluminium.

Additional limiting hazards included at Gate 3

3.2.2 The following limiting hazards were included in the Gate 3 SWQRA based on the above new or updated information. In particular, the new water quality monitoring data.

3.2.3 Additional limiting hazards added in at Gate 3:

- Acrylamide
- Alpha Radioactivity
- Manganese

3.3 Limiting Hazards for Mogden Water Recycling

Gate 2 hazards reconsidered at Gate 3

3.3.1 The following hazards were retained from Gate 2 work for Gate 3 assessment:

- E.coli, Cryptosporidium, Iron, Manganese, Sodium, Nickel, Nitrate, Nitrite, Pesticides Total, Mercury, Benzo(a)pyrene, Corrosivity, Change in hardness/alkalinity, Change in source type, 1,4-Dioxane, Pathogens (bacteria, viruses, protozoa), NDMA, TOC, Chloride, Chromium, Lead, PFOS, PFOA, Turbidity, Metaldehyde, Aluminium.

Additional limiting hazards included at Gate 3

3.3.2 Additional limiting hazards included at Gate 3 based on new information, as above, were:

- Ammonium

3.4 Limiting Hazards for Beckton Water Recycling

Gate 2 hazards reconsidered at Gate 3

3.4.1 The following hazards were retained from Gate 2 work for Gate 3 assessment:

- E.coli, Cryptosporidium, Iron, Nitrate, Nitrite, Total Pesticides, PAH, Benzo(a)pyrene, Corrosivity, Change in hardness/alkalinity, Change in source type, 1,4-Dioxane, Pathogens (bacteria, viruses, protozoa), NDMA, TOC, Ammonium, Chloride, Chromium, PFOS, PFOA, Turbidity, Metaldehyde, Aluminium.

Additional limiting hazards included at Gate 3

3.4.2 Additional limiting hazards included at Gate 3 based on new information, as above, were:

- Beta Radioactivity

4 Review of new and updated information for Gate 3

4.1 New Water quality Sampling Data

4.1.1 The newest Water Quality Data was used at time of the Gate 3 SWQRA analysis being carried out. This utilised data obtained from the SRO monitoring programme. Specific reference was made to the following sites:

- Site 21 – TWUL Beckton STW Final Effluent (For Beckton Water Recycling)
- Site 11 – River Thames at Teddington Weir (For Teddington DRA)
- Site 12 – TWUL Mogden STW Final Effluent (For Mogden Water Recycling)
- Site 15 – River Lee upstream KGV Reservoir Intake
- Site 9 – TWUL Hampton Intake

4.2 Drinking Water Safety Plans (DWSP)

4.2.1 Updated DWSPs were obtained and reviewed. This included the appropriate Thames Water DWSPs as used at Gate 2 and the relevant WTW from Essex & Suffolk. These included:

- Teddington DRA – Lockwood Shaft, Surbiton, Lockwood Reservoir, Coppermills WTW, Chigwell WTW.
- Mogden Water Recycling – Walton-on-Thames, Lockwood Shaft, Lockwood Reservoir, Walton WTW, Hampton WTW, Coppermills WTW, Chigwell WTW.
- Beckton Water Recycling – River Lee and New Gauge Intake, Girling Lee Intake, King George V Reservoir, William Girling Reservoir, Lockwood Reservoir, Coppermills WTW, Chingford WTW, Chigwell WTW.

4.3 Process Flow Diagrams (PFD)

4.3.1 PFDs were reviewed to understand if the existing treatment processes at the water treatment works supplied by the LWR SRO are suitable to address the risks posed by the limiting hazards identified in the SWQRA.

- Walton WTW, Hampton WTW, Coppermills WTW, Chingford WTW, Chigwell WTW.

5 SWQRA Gate 2 Risk Scoring Methodology

5.1 General Approach

5.1.1 The general approach used for Gate 3 SWQRA risk scoring was as follows, which has been slightly updated since Gate 2 to ensure no artificial increase or decrease in overall risk when compared to the existing risk scores in company DWSPs. The template and RA methodology developed by the ACWG was applied which also provided general guidance for scoring of risk.

5.1.2 An independent assessment of the risks was carried out by using a methodology developed by Jacobs for SROs at Gate 2 SWQRA (see below), including determination of likelihood (table 5-1) and consequence (table 5-2) scores for each parameter. These scores were then compared with the risk scores in the water company's DWSPs to determine the highest overall risk score. A likelihood was then assigned to ensure the overall risk score given for the Gate 3 assessment did not decrease below the DWSP or artificially increase the risk banding.

5.1.3 This scoring assessment was carried out at Catchment, Abstraction, and Treatment stages for both pre-mitigated and post-mitigated risks. Due to this some risks fluctuate as the RA progresses from Catchment through to Consumer depending on the worst-case risk from available sources. Additionally, as the scores from Treatment DWSPs were utilised, a higher number of parameters remain amber or red risks at consumer than was the case at Gate 2 which were assessed using previous methodology. Where these higher risks relate to DWSPs it has been noted.

5.1.4 This procedure allowed for consistency with the water companies DWSP risk scores and is documented in the SWQRA.

5.2 Gate 2 SWQRA Risk Scoring Methodology

5.2.1 ACWG methodology on SWQRA provides on overall framework of risk scores based on a 5X5 risk matrix using likelihood and consequence of risks as shown below in Figure 5.1.

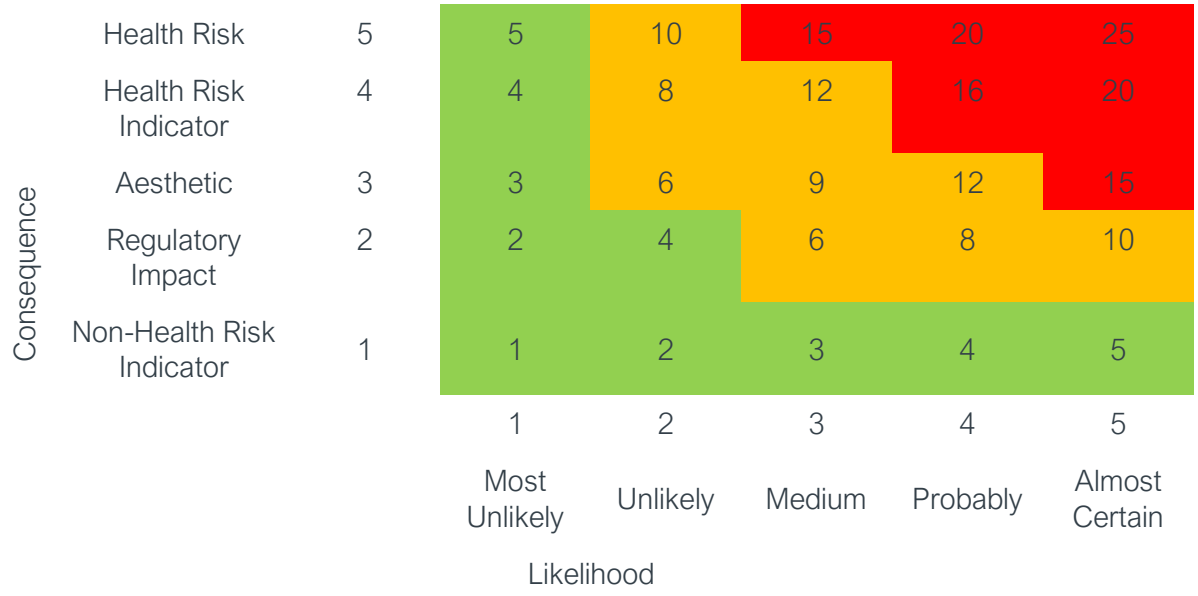


Figure 5.1 5x5 Risk Matrix.

5.2.3 Different companies and consultants use varying definitions for consequence and likelihood. In this report, the following definitions for the likelihood and consequence scores were applied, as seen in Table 5.1 and Table 5.2.

Table 5.1 Likelihood scores definitions.

Score	Likelihood	Occurrence	Probability range (Failures in 5 years)
1	Most unlikely	< Once in 10 years	0,1
2	Unlikely	Once in 10 years	2,3,4
3	Medium	Annually	5-14
4	Probable	Monthly	15-59
5	Almost Certain	Daily	≥60

5.2.4 The consequence scores were defined based on *parameter scores* for contaminants included in the DWI's Compliance Risk Index (CRI) methodology. It is noted that the full CRI methodology, which is used to assess the impact of water quality compliance failures, is **not** applied here and only the parameter scores are used to assign a consequence score as seen in Table 5.2.

Table 5.2 Consequence scores definitions.

Score	Consequence	CRI Parameter Score
5	Health Risk	5
4	Health Risk Indicator	4
3	Aesthetic	3

Score	Consequence	CRI Parameter Score
2	Regulatory Impact	2
1	Non-Health Risk Indicator	1

6 SWQRA Gate 3 Risk Scores and Changes from Gate 2

6.1.1 The following section provides a summary of post-mitigated consumer scores for completed Gate 3 SWQRAs as well as highlighting changes since Gate 2. It is important to note that the **Gate 2 scores are not directly comparable** due to **refinements made in the scoring and risk assessment methodology** to allow consistency. Risk scores are broken down and shown as likelihood x consequence = overall.

6.2 Teddington DRA

6.2.1 The post-mitigated risks to the consumer at Gate 3 for the Teddington DRA are shown in Table 6.1 as well as the main data source or assessment these are derived from. Despite an increase in some risk scores due to a change in methodology since Gate 2, only 4 parameters have increased a risk band. These are *E.coli*, Iron, Turbidity, and 1,4-dioxane.

Table 6.1 Teddington DRA Gate 3 risk scores showing change from gate 2 assessments.

Limiting Hazard	Gate 3	Change from Gate 2	Reasons
E.coli	2 x 5 = 10	Increase	Based on DWSPs
Cryptosporidium	4 x 5 = 20	Increase	Based on DWSPs
Iron	2 x 4 = 8	Increase	Based on DWSPs
Manganese	2 x 3 = 6	New at Gate 3	Based on DWSPs
Acrylamide	1 x 5 = 5	New at Gate 3	Based on DWSPs
Nitrate	1 x 5 = 5	No Change	Based on DWSPs
Nitrite	1 x 5 = 5	No Change	Based on DWSPs
Pesticide: Total	2 x 4 = 8	Decrease	Based on DWSPs
Cyanide	1 x 5 = 5	No Change	Based on DWSPs
PAH	5	Decrease	Based on DWSPs
Benzo(a)pyrene	1 x 5 = 5	Decrease	Based on DWSPs
Corrosivity	2 x 2 = 4	Decrease	Other assessment
Change in Source	5 x 2 = 10	Decrease	Other assessment
1,4-dioxane	3 x 5 = 15	Increase	Other assessment
Pathogens - Bacteria, Viruses, Protozoa	4 x 5 = 20	Increase	Other assessment
NDMA	2 x 5 = 10	No Change	Other assessment
TOC	2 x 5 = 10	No Change	Based on DWSPs

Limiting Hazard	Gate 3	Change from Gate 2	Reasons
Ammonium	2 x 4 = 8	No Change	Based on DWSPs
Chloride	2 x 2 = 4	Increase	Based on DWSPs
Alpha activity, total	2 x 5 = 10	New at Gate 3	Based on DWSPs
Chromium	1 x 5 = 5	No Change	Based on DWSPs
PFOA	12	Increase	Based on DWSPs
PFOS	12	Increase	Based on DWSPs
Turbidity	12	Increase	Based on DWSPs
Metaldehyde	2 x 4 = 8	Decrease	Based on DWSPs
Aluminium	1 x 4 = 4	Decrease	Based on DWSPs

6.3 Mogden Water Recycling and South Sewer

6.3.1 The post-mitigated risks to the consumer at Gate 3 for the Mogden Scheme are shown in Table 6.2 as well as the main data source or assessment these are derived from. Despite an increase in some risk scores due to a change in methodology since Gate 2, only 3 parameters have increased a risk band: *E.coli*, Manganese, and 1,4-dioxane.

Table 6.2 Mogden Water Recycling Gate 3 risk scores showing change from Gate 2 assessments.

Limiting Hazard	Gate 3	Change from Gate 2	Reasons
E.coli	2 x 5 = 10	Increase	Based on DWSPs
Cryptosporidium	4 x 5 = 20	Increase	Based on DWSPs
Iron	2 x 4 = 8	No Change	Based on DWSPs
Manganese	2 x 3 = 6	Increase	Based on DWSPs
Sodium	4	Increase	Based on DWSPs
Nickel	1 x 5 = 5	No Change	Based on DWSPs
Nitrate	1 x 5 = 5	No Change	Based on DWSPs
Nitrite	1 x 5 = 5	No Change	Based on DWSPs
Pesticide: Total	2 x 4 = 8	Decrease	Based on DWSPs
Mercury	1 x 5 = 5	Decrease	Based on DWSPs
Benzo(a)pyrene	1 x 5 = 5	Decrease	Based on DWSPs
Corrosivity	2 x 4 = 8	Decrease	Other assessment
Change in hardness	2 x 4 = 8	Decrease	Other assessment

Limiting Hazard	Gate 3	Change from Gate 2	Reasons
Change in Source	5 x 3 = 15	No Change	Other assessment
1,4-dioxane	3 x 5 = 15	Increase	Other assessment
Pathogens - Bacteria, Viruses, Protozoa	4 x 5 = 20	Increase	Other assessment
NDMA	2 x 5 = 10	No Change	Other assessment
TOC	2 x 5 = 10	No Change	Based on DWSPs
Ammonium as NH4	2 x 4 = 8	New at Gate 3	Based on DWSPs
Chloride	2 x 2 = 4	Increase	Based on DWSPs
Chromium	1 x 5 = 5	Increase	Based on DWSPs
Lead	2 x 5 = 10	Decrease	Based on DWSPs
PFOS	12	Increase	Based on DWSPs
PFOA	12	Increase	Based on DWSPs
Turbidity	12	Decrease	Based on DWSPs
Metaldehyde	2 x 4 = 8	Decrease	Based on DWSPs
Aluminium	1 x 4 = 4	Decrease	Based on DWSPs

6.4 Beckton Water Recycling

6.4.1 The post-mitigated risks to the consumer at Gate 3 for the Beckton Scheme are shown in Table 6.3 as well as the main data source or assessment these are derived from. Despite an increase in some risk scores due to a change in methodology since Gate 2, only 4 parameters have increased a risk band: *E.coli*, Iron, 1,4-dioxane, and Turbidity.

Table 6.3 Beckton Gate 3 risk scores showing change from Gate 2 assessments.

Limiting Hazard	Gate 3	Change from Gate 2	Reasons
E.coli	2 x 5 = 10	Increase	Based on DWSPs
Cryptosporidium	4 x 5 = 20	Increase	Based on DWSPs
Iron	2 x 4 = 8	Increase	Based on DWSPs
Nitrate	1 x 5 = 5	No Change	Based on DWSPs
Nitrite	1 x 5 = 5	No Change	Based on DWSPs
Pesticide: Total	2 x 4 = 8	Decrease	Based on DWSPs
PAH	5	Decrease	Based on DWSPs
Benzo(a)pyrene	1 x 5 = 5	Decrease	Based on DWSPs

Limiting Hazard	Gate 3	Change from Gate 2	Reasons
Corrosivity	2 x 4 = 8	Decrease	Other assessment
Change in hardness/Alkalinity	2 x 4 = 8	Decrease	Other assessment
Change in Source	5 x 3 = 15	No Change	Other assessment
1,4-dioxane	4 x 5 = 20	Increase	Other assessment
Pathogens - Bacteria, Viruses, Protozoa	4 x 5 = 20	Increase	Other assessment
NDMA	2 x 5 = 10	No Change	Other assessment
TOC	2 x 5 = 10	No Change	Based on DWSPs
Ammonium	3 x 4 = 12	Increase	Based on DWSPs
Chloride	2 x 2 = 4	Increase	Based on DWSPs
Beta Activity	1 x 5 = 5	New at Gate 3	Based on DWSPs
Chromium	1 x 5 = 5	Increase	Based on DWSPs
PFOA	12	Increase	Based on DWSPs
PFOS	12	Increase	Based on DWSPs
Turbidity	12	Increase	Based on DWSPs
Metaldehyde	2 x 4 = 8	Decrease	Based on DWSPs
Aluminium	1 x 4 = 4	Decrease	Based on DWSPs

6.5 Contaminants of Emerging Concern (CEC)

6.5.1 It is noted that PFOS, PFOA, 1,4-dioxane and NDMA are CECs which are typically associated with wastewater.

PFAS

6.5.2 In August 2024 DWI issued new guidance on PFAS which now requires monitoring of 48 PFAS compounds, from January 2025, adding 6:2 FTAB to the previous list issued in July 2022. Additionally, the guidance now requires reporting of Total PFAS concentration for all individual PFAS with concentrations above the limit of detection. Although the reporting tiers have not been altered from the previous guidance, it is expected that the above change will result in many more sources moving into a higher tier. This latest guidance was not received in time to be included in the Gate 3 SWQRA; however, this will be done in the Gate 4 update.

6.5.3 Based on available WQ data from the SRO monitoring programme the risk is considered low from PFOS and PFOA. However, information in TW and E&S DWSPs indicates the PFAS risk to be medium. Based on above PFAS risk has been assessed as medium in the SWQRA.

6.5.4 It is also recognised that global health advisories continue to change with regards to contaminants of emerging concern and that the regulations regarding PFAS will continue to develop. In this context it is noted that:

- In June 2022, the US Environmental Protection Agency (EPA) announced the release of health advisories for four perfluoroalkyl substances with extremely low concentration limits in drinking water of 0.004 parts per trillion (ppt) for PFOA and 0.02 ppt for PFOS. Compliance with these new US limits, if applied in the UK, will be very challenging for most water treatment works.
- The WHO guidelines for drinking water quality chemical working group water are expected to report on PFAS in drinking water in 2027 and this may cause a change in the regulations, further the UK Committee on Toxicology are currently reviewing the evidence for PFAS though the timeline for their opinion to be published is less clear.

1,4-dioxane and NDMA

6.5.5 There is no current DWI guidance or drinking water standards for 1,4-dioxane and NDMA. The risk from 1,4-dioxane is assessed as high and from NDMA as medium, in both cases based on very limited monitoring data available for these parameters. The assigned risk scores reflect the uncertainty resulting from lack of data. It is recommended to carry out further water quality sampling for these parameters at monitoring points relevant to these schemes.

7 Post Mitigated Residual Risks in Water Supplied to the Consumers

7.1.1 The SWQRA process considers the risks to drinking water quality at all stages from catchment to the consumer. The risks are assessed at each stage of the process and mitigated where appropriate.

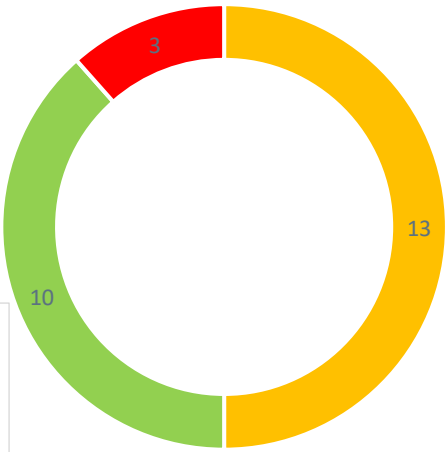
7.1.2 In the case of LWR several of the risks are mitigated at the treatment stage so that the residual risks posed to the consumer are low (green). There are however some limiting hazards for which the residual risks to consumer remain high (red) or medium (amber).

7.1.3 It is important to note that residual high risk scores are a product of two numbers: the worst case consequence score which remains unchanged progressing from catchment to consumer, and the likelihood score assigned to ensure risk is neither signfiicantly increased or decreased incomparison to the worst-case risk as found through analysis of available data. This methodology was chosen to ensure consistency. Therefore, a hazard marked as high residual risk to the consumer for the purposes of this SWQRA does not necessarily correspond to a high risk to the consumers in current TWUL DWSPs. Where high risk scores are taken from DWSPs, it is considered that these risks are already being mitigated via the current TWUL DWSP process and so are not considered a high risk to these schemes going forward. However further review must take place at Gate 4.

7.2 Teddington DRA Residual Risks

7.2.1 The chart below shows the number of limiting hazards with red (high), amber (medium) and green (low) residual risks for Teddington DRA.

High (Red) risks include 1,4-Dioxane , *Cryptosporidium* and Pathogens – bacteria, viruses, and protozoa.



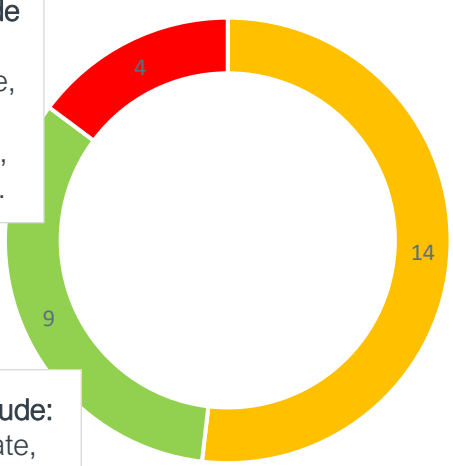
Medium (Amber) risks include: *E.coli*, Iron, Manganese, Pesticides total, Change in source type, NDMA, TOC, Ammonium, Alpha Radioactivity, PFOS, PFOA, Turbidity, and Metaldehyde.

Low (Green) risks include: Acrylamide, Nitrate, Nitrite, Cyanide, PAH, Benzo(a)pyrene, Corrosivity, Chloride, Chromium, and Aluminium.

7.3 Mogden Water Recycling Residual Risks

7.3.1 The chart below shows the number of limiting hazards with red (high), amber (medium) and green (low) residual risks for Teddington Mogden Water Recycling and Mogden South Sewer.

High (Red) risks include *Cryptosporidium*, Change in source type, 1,4-dioxane, and Pathogens – bacteria, viruses and protozoa.



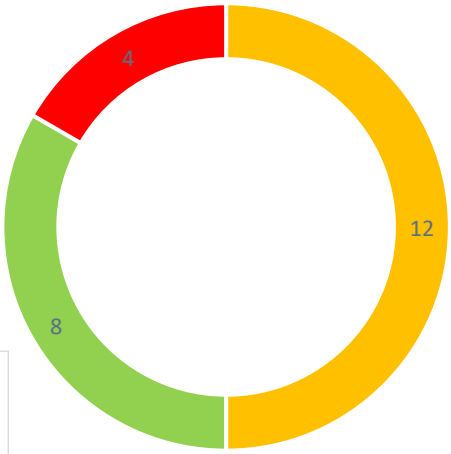
Medium (Amber) risks include: *E.coli*, Iron, Manganese, Pesticides total, Corrosivity, Change in hardness/Alkalinity, NDMA, TOC, Ammonium, Lead, PFOS, PFOA, Turbidity, and Metaldehyde.

Low (Green) risks include: Sodium, Nickel, Nitrate, Nitrite, Mercury, Benzo(a)pyrene, Chloride, Chromium, and Aluminium.

7.4 Beckton Water Recycling Residual Risks

7.4.1 The chart below shows the number of limiting hazards with red (high), amber (medium) and green (low) residual risks for Teddington Beckton Water Recycling.

High (Red) risks include Cryptosporidium, Change in source type, 1,4-dioxane, and Pathogens – bacteria, viruses and protozoa.



Medium (Amber) risks include: *E.coli*, Iron, Pesticides total, Corrosivity, Change in hardness/Alkalinity, NDMA, TOC, Ammonium, PFOS, PFOA, Turbidity, and Metaldehyde.

Low (Green) risks include: Nitrate, Nitrite, PAH, Benzo(a)pyrene, Chloride, Beta activity, Chromium, and Aluminium.

8 Additional Information and Assessments

8.1.1 Following Workshop 2 with representatives from water companies and the regulators, additional information and further analysis was requested which will be summarised in this section and Appendix 0.

8.1.2 Comparison of the water quality between Hampton and Teddington Weir was requested. Statistical analysis has been carried out on sampling data from the River Thames at both Hampton and Teddington Weir for all the limiting hazard relating to the Teddington DRA scheme. Two-tailed T-tests were utilised, with the results and more information found in Appendix A. The only three limiting hazards found to be statistically different between the two sites, showing lower water quality results at Teddington Weir, are Nitrates, Alkalinity, and E. coli. This may be explained by the discharge of Hogsmill FE making its way into the Thames between the Hampton and Teddington Weir sampling locations. The SWQRA takes into account the water quality at Teddington Weir, and therefore the assessment will not change.

8.1.3 A summary of minimum, maximum and average values for the applicable limiting hazards for Teddington DRA can be found in Appendix A.

8.1.4 Additional risks identified in the Teddington catchment compared to the Hampton catchment include:

- Hogsmill FE
- Risks associated with changing source

8.1.5 Confirmation of the inflows and arrangements of the Lee Valley Reservoir network was requested and is summarised in this section and Figure 8.1.

8.1.6 The TLT can supply water to two of the Lee Valley reservoirs under normal operation: Banbury and Lockwood reservoirs. The King George V and William Girling reservoirs are supplied via the River Lee Diversion.

8.1.7 The SWQRA process is a collaborative process which involves continuing engagement and consultation with stakeholders. As this work progresses through Gate 4 and beyond, the SWQRA will be updated with new water quality data and other information and feed into the various existing DWSPs already in place. Engagement will continue with stakeholders as the Project progresses through planning and consent on a regular basis and as part of dedicated workshops established from Gate 1. More detail on stakeholder engagement can be found in Section 9 of the Gate 3 Report, including the statutory consulting due to commence in late spring 2025 which will include water quality.

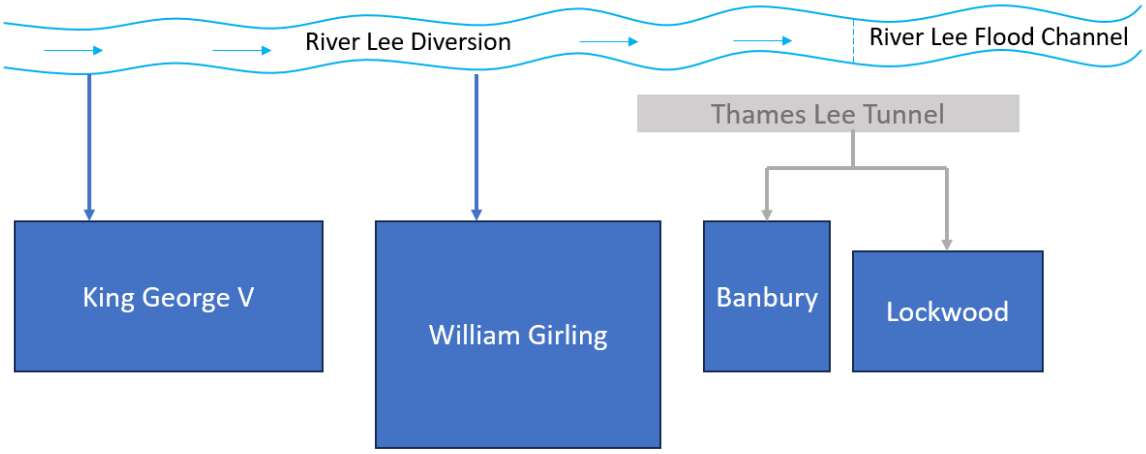


Figure 8.1 Schematic of the Lee Valley system under normal supply routes.

8.1.8 Remineralisation is relevant to the Mogden Recycling and Beckton Recycling schemes due to the use of Reverse Osmosis process. Remineralisation to some degree is expected and has therefore been included in the designs currently. However, the extent to which remineralisation will be required will be determined following confirmation of permitting.

9 Conclusions

9.1.1 Key conclusions from the Gate 3 assessment are:

- Three SRO options considered at Gate 2 (Teddington DRA, Mogden Water Recycling, and Beckton Water Recycling schemes) have been reassessed at Gate 3.
- Gate 2 SWQRA has been updated considering new water quality from SRO monitoring programme. As a result, some of the risk scores have changed between Gate 2 and Gate 3.
- New limiting hazards have been included at Gate 3 based on new water quality data and DWSPs.
- The Gate 2 methodology has been revised based on the updated data used to allow for consistency. Due to this, Gate 2 and Gate 3 scores are not directly comparable. This has been documented and clearly described where applicable within the RA.
- For several of the limiting hazards the residual risks posed to the consumer are low (green). There are however a number of limiting hazards for which the residual risks to the consumer remain high (red) or medium (amber). These are:

9.1.2 **Limiting hazards which pose a risk that consumers could experience a change in perception of their water.** These are generally related to change in source and include change in source type assessed as high risk (red) and change in alkalinity/hardness and corrosivity assessed as medium risk (amber). Corrosivity has been assessed for two aspects: the impact on network corrosion for which the mitigation is treatment/blending to minimise corrosion, and also the potential impact to taste and consumer perception for which the mitigation is ongoing customer engagement and information sharing.

9.1.3 **Limiting hazards related to CECs - PFOS, PFOA, 1,4-Dioxane and NDMA.** These are mainly found in wastewater effluent and generally are difficult to treat with conventional treatment technologies employed for water and wastewater treatment. Advanced water treatment at Mogden and Beckton is to be provided to mitigate risk and reduce these CEC levels to within acceptable limits.

9.1.4 In August 2024 DWI issued new guidance on PFAS which now requires monitoring of 48 PFAS compounds, from January 2025, adding 6:2 FTAB to the previous list issued in July 2022. Additionally, the guidance now requires reporting of Total PFAS concentration for all individual PFAS with concentrations above the limit of detection. Although the reporting tiers have not been altered from the previous guidance, it is expected that the above change will result in many more sources moving into a higher tier. This latest guidance was not received in time to be included in the Gate 3 SWQRA however this will be done in the Gate 4 update.

9.1.5 Based on available WQ data from the SRO monitoring programme the risk is considered low from PFOS and PFOA. However, information in TW and E&S

DWSPs indicates the PFAS risk to be medium. Based on above PFAS risk has been assessed as medium in the SWQRA.

9.1.6 It is, however, recognised that global health advisories continue to change with regards to contaminants of emerging concern. In June 2022, the US Environmental Protection Agency (EPA) announced the release of health advisories for four perfluoroalkyl substances with extremely low concentration limits in drinking water of 0.004 parts per trillion (ppt) for PFOA and 0.02 ppt for PFOS. Compliance with these new US limits, if applied in the UK, will be very challenging for most water treatment works. The WHO guidelines for drinking water quality chemical working group water are expected to report on PFAS in drinking water in 2027 and this may cause a change in the regulations, further the UK Committee on Toxicology are currently reviewing the evidence for PFAS though the timeline for their opinion to be published is less clear.

9.1.7 There is no current DWI guidance or drinking water standards for 1,4-dioxane and NDMA. The risk from 1,4-dioxane is assessed as high and from NDMA as medium, in both cases based on very limited monitoring data available for these parameters. The assigned risk scores reflect the uncertainty resulting from lack of data. It is recommended to carry out further water quality sampling for these parameters at monitoring points relevant to these schemes.

9.1.8 **Other limiting hazards have been assessed as a red or amber residual risk based on information in the DWSPs**. These include *Escherichia coli (E.coli)*, *Cryptosporidium*, Iron, Manganese, Total Pesticides, Pathogens, – bacteria, viruses and protozoa, TOC, Ammonium, Alpha Radioactivity, Lead, Turbidity, and Metaldehyde – These risks are already being mitigated via the current Thames Water DWSP process and are therefore not considered a risk to these schemes going forward. However, it is noted that the treatment risk should be reviewed at Gate 4 as part of this scheme, based on the future water quality data, to ensure no impact to consumers going forward.

Appendix A: Additional Assessments

A.1.1 Following Workshop 2 with representatives from water companies and the regulators, additional information and further analysis was requested which will be summarised in this Appendix.

A.1.2 Two-sample unequal variance two-tailed T-tests were carried out using Microsoft Excel to determine the similarity of the water quality at the Hampton and Teddington Weir sampling locations in the River Thames. These tests were carried out only on the limiting hazards applicable to the Teddington DRA scheme, as defined in the SWQRA.

Table A.1 below shows the results of this t-test.

Table A.1 T.Test results for Hampton and Teddington Weir Water Quality of limiting hazards for Teddington DRA SWQRA.

Limiting Hazard	T.Test Result	Significant Difference
E. coli	0.02	Yes
Cryptosporidium	0.33	No
Iron	0.92	No
Manganese	0.08	No
Sodium	0.14	No
Nickel	0.24	No
Acrylamide	0.32	No
Nitrate	0.04	Yes
Nitrite	0.23	No
Pesticides: Total	N/A	No
Mercury	0.54	No
Cyanide	0.72	No
PAH	0.51	No
Benzo(a)pyrene	0.64	No
Corrosivity	N/A	No
Change in hardness/alkalinity	0.02	Yes
Change in Source	N/A	No
1,4-dioxane	-	No
Pathogens	N/A	No
NDMA	0.70	No

Limiting Hazard	T.Test Result	Significant Difference
Total Organic Carbon	0.95	No
Ammonium/ammoniacal nitrogen	0.39	No
Chloride	0.18	No
Alpha activity	0.88	No
Chromium	0.17	No
Lead	0.90	No
PFOA	0.47	No
PFOS	0.29	No
Turbidity (21°C)	0.80	No
Metaldehyde	1	No
Aluminium	0.47	No

A.1.3 Maximum, Minimum and average sample values for the applicable limiting hazards for Teddington DRA are presented in Table A.2 below for Hampton and Teddington Weir sampling points.

Table A.2 Water Quality summary of Limiting hazards for Teddington DRA SWQRA at Hampton and Teddington Weir sampling sites.

Limiting Hazard	Units	Teddington Weir			Hampton		
		Minimum	Maximum	Average	Minimum	Maximum	Average
E. coli	MPN/100ml	118	2420	1073	31	2420	636
Cryptosporidium	no/litre	0	78	2	0	1	0
Iron	ug/l	16	1400	293	30	1500	300
Manganese	ug/l	2	76	23	3	70	28
Sodium	mg/l	15	48	29	14	44	27
Nickel	ug/l	0.7	5.5	2.6	0.7	5.5	2.4
Acrylamide	ug/l	0.1	0.1	0.1	0.1	0.1	0.1
Nitrate	mg/l NO3	3	50	33	2	39	29
Nitrite	mg/l NO2	0.10	1.40	0.49	0.10	1.20	0.38
Pesticides	N/A						
Mercury	ug/l	0.001	0.070	0.010	0.001	0.049	0.008
Cyanide	ug/l	0.60	40.00	36.55	0.50	40.00	35.51
PAH	ug/l	0.05	2.44	0.14	0.05	0.62	0.09
Benzo(a)pyrene	ug/l	0.0012	0.2970	0.0184	0.0009	0.1030	0.0138
Corrosivity	N/A						
Change in hardness/alkalinity	mg/l	44	250	172	140	270	190
Change in Source	N/A						
1,4-dioxane	ug/l	1.00	1.00	1.00	1.00	1.00	1.00
Pathogens	N/A						
NDMA	ug/l	0.001	0.001	0.001	0.001	0.002	0.001
TOC	mg/l	2.5	63.0	6.9	2.2	59.0	7.0
Ammonium/ ammoniacal nitrogen	mg/l	0.015	0.400	0.105	0.015	0.780	0.127
Chloride	mg/l	25	66	46	22	62	43
Alpha activity	Bq/l	0.02	0.31	0.10	0.02	0.28	0.10
Chromium	ug/l	0.25	3.90	0.92	0.25	20.00	1.86
Lead	ug/l	0.09	4.30	0.86	0.27	3.30	0.88
PFOA	ug/l	2.40	5.70	3.53	2.20	5.71	3.28

Limiting Hazard	Units	Teddington Weir			Hampton		
		Minimum	Maximum	Average	Minimum	Maximum	Average
PFOS	ug/l	3.00	7.40	5.29	3.17	7.13	4.81
Turbidity (21oC)	NTU	1	64	9	1	19	8
Metaldehyde	ug/l	0.02	0.02	0.02	0.02	0.02	0.02
Aluminium	ug/l	10	600	115	13	440	97

A.1.4 To conclude, the only three limiting hazards found to be statistically different between the two sites, showing lower water quality results at Teddington Weir, are Nitrates, Alkalinity, and E. coli.

Acronyms and Glossary

Term	Definition
ACWG	All Company Working Group
CEC	Contaminants of Emerging Concern
CRI	Compliance Risk Index
DRA	Direct River Abstraction
DWI	Drinking Water Inspectorate
DWSP	Drinking Water Safety Plans
E.coli	Escherichia coli
INNS	Invasive non-native species
LWR	London Water Recycling
NDMA	N-Nitrosodimethylamine
PAH	Polycyclic Aromatic Hydrocarbons
PFD	Process Flow Diagram
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
RA	Risk Assessment
SRO	Strategic Resource Option
SWQRA	Strategic Water Quality Risk Assessment
STT	Severn to Thames Transfer
STW	Sewage Treatment Works
TOC	Total Organic Carbon
TWUL	Thames Water Utilities Limited
WQ	Water Quality

[1] Strategic WQ Risk Framework – Report for All Company Working Group, Jacobs, 2021
[2] DWI, August 2024, Guidance on the Water Supply (Water Quality) Regulations 2016 (as amended) for England and Water Supply (Water Quality) Regulations 2018 for Wales specific to PFAS (per- and polyfluoroalkyl substances) in drinking water
[3] Strategic WQ Risk Framework – Report for All Company Working Group, Jacobs, 2021

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