ANNEX B1.4

Water Quality Monitoring

Grand Union Canal Transfer SRO

Affinity Water, Severn Trent Water, Canal & River Trust

Grand Union Canal Strategic Resource Option

Water Quality Monitoring Gate 2 Report

Severn Trent Water, Affinity Water and the Canal & River Trust

28 September 2022

5204564 / 1.5 / DG / 021

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Executive Summary

The Grand Union Canal (GUC) is a Strategic Resource Option (SRO) in which Affinity Water (AfW) and Severn Trent Water (STWL) are working together alongside the Canal & River Trust (The Trust). The scheme looks to transfer water from STWL's Minworth Wastewater Treatment Works (WwTW) in the Midlands to AfW in the South East using the existing GUC network.

Objectives

The aim of the water quality monitoring programme is to obtain a baseline dataset to allow characterisation of different study reaches in terms of drinking water safety risks (particularly with respect to current and future regulated parameters), Water Framework Directive determinands, and Environment Agency Surface Water Pollution Risk Assessment Parameters, to characterise the baseline risk and to inform modelling. The key drivers for monitoring water quality for this SRO include:

- Drinking Water Safety Planning – the scheme involves utilisation of a new source for public drinking water supply. As such, assessment of the risks to human health from this new source, and development of control measures sufficient to reduce these risks to an acceptable level, is critical to ensuring compliance with the legislative requirements for drinking water quality and safeguarding public health while meeting demand for public water supply of future generations.
- An All Company Working Group (ACWG) treatment water methodology for drinking water risk assessment and water safety planning of all SROs has been developed, which will require water quality data to inform judgements of drinking water risk. This ACWG methodology was updated for the transfer scheme at the end of Phase 1 and has been updated as part of Phase 3 using the available monitoring data.
- Environmental water quality – the scheme would result in changes to the sources of water entering the canal and therefore may impact on the ecological and environmental health of the water body and local environment. Water quality data are key to identifying and mitigating potential environmental impacts of the scheme. In particular, the requirements of the Water Framework Directive determinands, and Environmental Quality Standards Directive have been referred to in the development of this monitoring programme.
- Lastly, this monitoring programme will help inform treatment design at both selected discharge and abstraction locations.

Data collected between May 2020 and March 2022 (Phases 1 – 3) has been reported as part of this Water Quality Monitoring Gate 2 Report. Data collected from April 2022 onwards will be presented as part of the Gate 3 report.

Methodology

Under the Phase 1 water quality monitoring programme (May 2020 - March 2021), conducted by ALS analytical testing services, samples were taken at 15 monitoring locations in the upper and lower sections of the canal to characterise baseline water quality at the potential discharge and abstraction locations. Subsequent phases, Phase 2 (April and September 2021) and Phase 3 (October 2021 – March 2022) have been conducted by Atkins and RPS, a fully accredited laboratory (UK Accreditation Service ISO 17025) based in Bedford. At the onset of Phase 2, a number of discharge sub-route options and abstraction point sub-options were no longer being progressed as part of the scheme, so it was necessary to adapt the monitoring programme accordingly. For Phase 2 and 3, monitoring is being conducted at a total of nine monitoring locations across the GUC Transfer scheme. Water quality monitoring and analysis is being conducted at these Sites where there is a key legislative or design driver. As a result, the water quality analysis suites break down into the following components

- **Environmental risks as required by the Water Framework Directive (WFD)** – which cover analysis of samples for 83 determinands as previously agreed to be suitable as part of Phase 1, and, set out in the 2015 WFD Directions[1]

[1] The Water Framework (Standards and Classification) Directive (England and Wales) 2015 accessed via: The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 (legislation.gov.uk)

- **Environmental permitting risks as required by the EQSD** – which cover analysis of samples for the 95 determinands set out in the surface water pollution risk assessment for environmental permits[2], at Sites that may require permitting.
- **Drinking Water** – an appropriate list of 263 determinands to characterise the expected raw water quality to be abstracted from the GUC, to inform a water safety planning approach to control measures as required by DWI.

The first four sampling rounds took place at three weekly intervals (20/04/21 – 22/06/21 inclusive), however, following consultation with the Environment Agency and the DWI, all samples collected from the start of July were collected at monthly intervals.

In addition to spot sampling, continuous monitoring sondes were installed on 17/05/21 at three of the four abstraction sub-option locations (Sites 7, 8, and 9) in order to assess whether point or diffuse sources are likely to be affecting the water quality at these potential abstraction points. An additional sonde was installed at Site 6 on 25/11/21 following its identification as a potential abstraction location. Determinands monitored at these Sites include temperature, conductivity, dissolved oxygen, ammonium, pH, chlorophyll, and turbidity.

Conclusions

In total 86 environmental quality standard exceedances were observed spanning all sampling sites. At present, the following parameters demonstrated the greatest number of exceedances across all Sites: acid neutralisation capacity, benzo(a)pyrene and fluoranthene (polycyclic aromatic hydrocarbons), biological oxygen demand (a measure of organic pollution), perfluorooctanesulfonic acid (a synthetic chemical with a number of waterproofing applications), and soluble reactive phosphorus (a key limiting nutrient). A number of environmental quality standard exceedances were observed at Minworth WwTW discharges that were not seen at instream potential discharge locations, including chlorothalonil (an organic fungicide) and cypermethrin (a synthetic pyrethroid). As a result, if Minworth WwTW discharge were diverted into any of the proposed sub discharge routes without additional treatment applied, additional instream exceedances may occur, resulting in a future WFD compliance risk if the new discharge prevented the receiving body from achieving Good water quality status. Minworth WwTW treatment engineers should be engaged as part of that process to understand the feasibility of designing treatment for any of these 'high risk' compounds. Equally, further work is needed to understand if there are any WFD compliant substances which have a permittability risk (e.g., due to within class deterioration).

Drinking water safety parameters, assessed through their comparison to Prescribed Concentration or Values (PCVs) are only required to characterise the source water at Minworth WwTW (Site 1) and the 4 potential downstream abstraction locations (Sites 6-9). Across all 5 Sites where drinking water PCVs apply, to date (covering a 12-month period with an additional 11 months of data reported for Site 1 and Site 7 due to the addition of Phase 1 data) there have been a total of 475 instances of PCV exceedance. A number of determinands routinely exceed these targets including Coliform (total), *Clostridium perfringens* veg & spores, *Escherichia coli,* turbidity, nitrite, and iron (total). It should be noted, however, that drinking water safety thresholds apply only to treated drinking water, and not raw source waters, and as such these are included only as guidance to inform treatment options.

Data from wet weather sampling resulted in a number of additional exceedances not observed during low flow conditions. These exceedances included a number of polycyclic aromatic hydrocarbons, aluminium (dissolved), and iron (dissolved), nitrate, and ammonium. Of particular interest were the presence of tebuconazole, an agricultural triazole fungicide used to treat plant pathogenic fungi, and metribuzin, a synthetic herbicide applied both pre- and post-emergence of vegetable crops, which suggests an agricultural origin and the mobilisation of a larger number of potential pollutants under wet weather conditions. It is therefore recommended that AfW update their Drinking Water Safety Plan (DWSP) and complete a review of planned mitigations to factor in these additional compounds of concern.

Lastly, a large autumn algal bloom, which poses a risk to water abstraction, was observed in sonde data between 26/08/21 and 01/10/21 at all Sites, with the highest chlorophyll concentrations observed at Site 7. The installation and maintenance of the sensor network has been extended as part of the Phase 3 extension and Phase 4 monitoring (April 2022 onwards) to capture initial spring blooms which were missed in 2021 due to the timing of the installation. Algae blooms could have an impact on water storage as well as within the canal itself, and as such, mitigation for algae blooms should be considered in any treatment designs.

[2] Accessed via: https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit

1. Introduction

1.1. Background

The Grand Union Canal (GUC) is a Strategic Resource Option (SRO) in which Affinity Water (AfW) and Severn Trent Water (STWL) are working together alongside the Canal & River Trust (The Trust). The scheme looks to transfer water from STWL's Minworth Wastewater Treatment Works (WwTW) in the Midlands to AfW in the South East using the existing GUC network. Under the GUC SRO, there are multiple work packages covering the different scheme elements. A schematic diagram conceptualising the different scheme elements and associated work packages is shown in Figure 1-1. There are clear linkages between the scheme and other SROs, for example, the Minworth SRO and the Severn to Thames Transfer (STT) SRO. The purpose of this report is to present the results from the water quality monitoring work package. This work package will feed into other work packages, the results of which will be reported elsewhere.

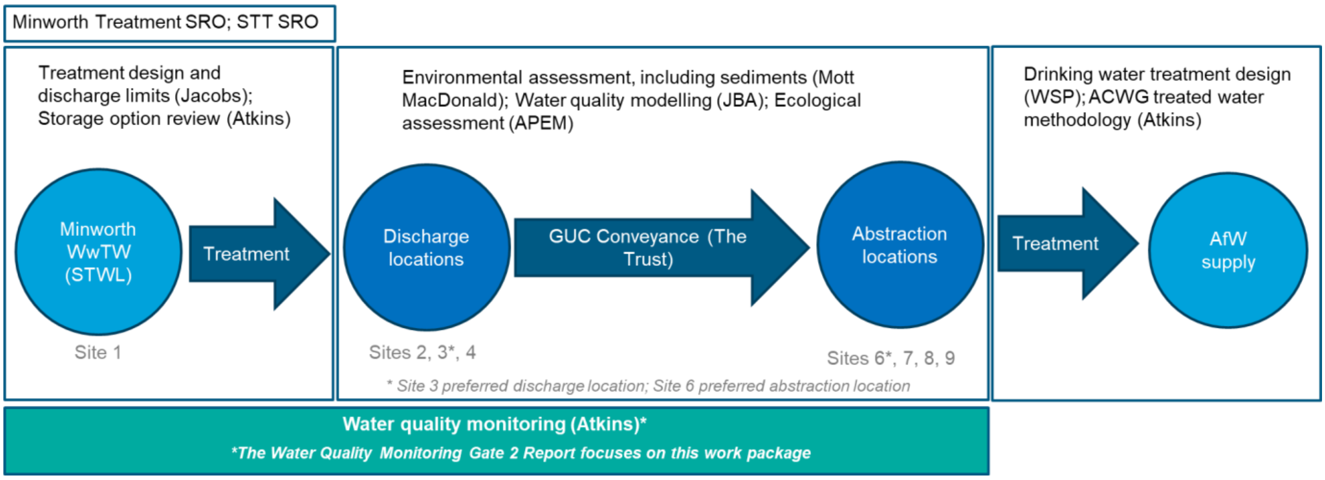

Figure 1-1 - Conceptualisation of the GUC scheme and work packages

Phase 1 water quality monitoring was undertaken by ALS between May 2020 and March 2021 at 15 locations along the transfer route. The sampling programme for Phase 1 involved spot water sampling on a monthly basis. Phase 2, undertaken by Atkins and RPS, was commissioned for the 6-month period between April and September 2021, with the view to further investigate changes in water quality along the transfer route and includes a more in-depth investigation into water quality at the abstraction locations to drinking water requirements. The programme included a more in-depth suite of determinands and continuous monitoring sondes. Phase 3 was commissioned (October 2021 – March 2022) to continue the Phase 2 monitoring programme. An additional Phase 3 extension was commissioned to run between April 2022 – June 2022. The GUC project phases are summarised in Figure 1-2 below.

Figure 1-2 – Schematic diagram showing the GUC monitoring Phases.

The key drivers for monitoring water quality for this SRO are:

- Drinking Water Safety Planning – the scheme involves utilisation of a new source for public drinking water supply. As such, assessment of the risks to human health from this new source, and development of control measures sufficient to reduce these risks to an acceptable level, is critical to ensuring compliance with the legislative requirements for drinking water quality and safeguarding public health while meeting demand for public water supply of future generations.

- An All Company Working Group (ACWG) treatment water methodology for drinking water risk assessment and water safety planning of all SROs has been developed, which will require water quality data to inform judgements of drinking water risk. This ACWG methodology was updated for the GUC transfer scheme at the end of Phase 1 and will be revisited as part of Phase 3 using updated monitoring data.
- Environmental water quality – the scheme would result in changes to the sources of water entering the canal and therefore may impact on the ecological and environmental health of the water body and local environment. Water quality data is key to identifying and mitigating potential environmental impacts of the scheme. In particular, the requirements of the Water Framework Directive (WFD) determinands, and Environmental Quality Standards Directive (EQSD) have been referred to in the development of this monitoring programme.
- Lastly, this monitoring programme will help inform treatment design at both selected discharge and abstraction location.

The aim of the water quality monitoring programme is to obtain a recent baseline dataset to allow characterisation of different study reaches in terms of drinking water safety risks (particularly with respect to current and future regulated parameters), the WFD determinands, and Environment Agency Surface Water Pollution Risk Assessment Parameters (referred to as EQSD parameters in this note) to characterise the baseline risk and inform modelling. The Phase 2, Phase 3, and Phase 3 extension monitoring programme included both water quality spot sampling and continuous monitoring (30-minute resolution data for dissolved oxygen, ammonium, temperature, conductivity, pH, and turbidity).

In Gate 2, the data collected will be used alongside existing datasets (e.g., the Environment Agency water quality archive, GUC water quality monitoring Phase 1, and other water company datasets) to inform Drinking Water risk assessment and management (for discussion with the Drinking Water Inspectorate (DWI)) and to inform water quality modelling to ascertain WFD compliance (for discussion with the Environment Agency).

1.2. Purpose of this document

The purpose of this document is to present initial results covering a 12-month data period between April 2021 and March 2022 (including 13 sampling rounds due to two samples being collected during June 2021). The data included in this report were sampled between 20/04/2021 and 08/03/2022 and this report compares the data collected to relevant chemical targets, where available. In addition, data from Phase 1 are also included for selected Sites, where Phase 1 Sites have been continued into Phase 2 & 3. Data collection is ongoing, and this report provides interested parties with a look at all data collected thus far in the monitoring programme. Data collected from April 2022 will be included in the Gate 3 water quality monitoring report.

The water quality data and analysis presented in this document will subsequently be used in the water quality modelling work package to assess the likely changes along the canal if this scheme goes ahead. This work package will also strengthen our understanding on whether any changes will pose future WFD compliance deterioration. The water quality data will also be used in another work package to inform the treatment design process.

2. Methodology

2.1. Site locations

Under the Phase 1 water quality monitoring programme, samples were taken at 15 monitoring locations in the upper and lower sections of the canal to characterise baseline water quality at the potential discharge and abstraction locations. At the onset of Phase 2, a number of discharge sub-route options and abstraction point sub-options were no longer being progressed as part of the scheme, so it was necessary to adapt the monitoring programme accordingly. For Phase 2 and 3, monitoring is being conducted at a total of nine locations across the GUC Transfer scheme. This can be seen summarised in Figure 2-1. These monitoring locations are summarised in Table 2-1. The monitoring plan was determined in line with the requirements set out in the GUC Gate 1 submission paper dated 05/07/2021.

This monitoring programme was discussed with the Environment Agency and DWI at workshops held on 23/04/2021 and 21/05/2021. They were offered the opportunity to comment on the programme so any required amendments could be incorporated into the programme. We have subsequently engaged with them on a quarterly basis throughout Gate 2.

For the purpose of conceptualising the monitoring programme, the GUC system has been split into three main geographical sections, an overview of which can be seen in Figure 2-2 with specific reach maps found in Appendix A, these are summarised below:

- ‘Upper section’: Covering the discharge from Minworth via sub-routes (Birmingham & Fazeley Canal, Coventry Canal, North Oxford Canal, and GUC) from Birmingham to the Braunston Junction where all routes converge.
- ‘Middle section’: GUC from the Braunston Junction to the Aylesbury Arm (Marsworth, North of Tring). This section includes one potential abstraction location monitoring Site at Grove Lock, Leighton Buzzard.
- ‘Lower section’: GUC from the Aylesbury Arm to Hanwell, London. This section includes three of the four potential abstraction location monitoring Sites.

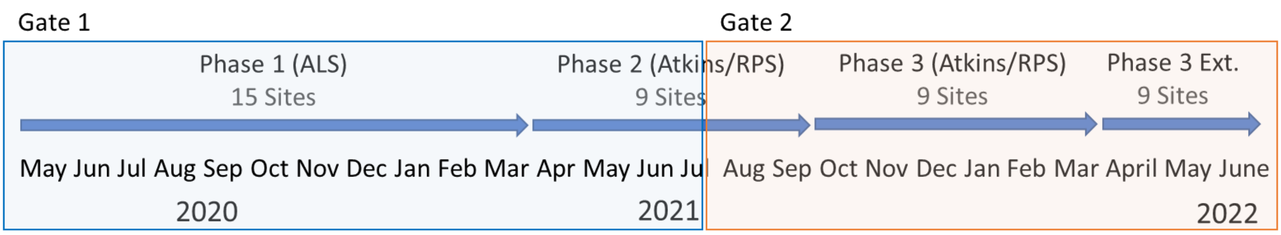

Figure 2-1 - Schematic diagram showing the GUC monitoring Phases and Site numbers.

Grid references for continued monitoring locations redacted

Table 2-1 - Monitoring locations

Section	Site no.	Location description	NGR	Rationale	Sampling	Land access
GUC: Upper Section	1.	Minworth WwTW Final Effluent	[redacted]	Official Minworth WwTW final effluent sampling point. To characterise potential future influence on the GUC prior to additional treatment which is likely to be deemed necessary. ***This Site is being sampled as part of the Severn to Thames Transfer Scheme (STT) SRO monitoring programme scheme. These data can be used to inform the water quality monitoring programme for the GUC, and thus duplicate sampling is not required. However, a small sub-set of parameters not currently monitored have been added to this suite to ensure that the full Drinking Water suite described for GUC is still sampled. This consists of 39 different parameters.***	Spot sampling + continuous monitoring	STWL
	2.	Birmingham & Fazeley Canal at Minworth		A single Site to characterise the reach and understand baseline water quality around sub-route 1 discharge point. This Site is aligned with the Phase 1 water quality monitoring point for consistency. Phase 1 data available for analysis.	Spot sampling	The Trust
	3.	Coventry Canal at Atherstone		A Site to characterise the reach and understand baseline water quality around sub-route 3 discharge point. This Site is aligned with the Phase 1 water quality monitoring point for consistency. Phase 1 data available for analysis.	Spot sampling	The Trust
	4.	GUC at Leamington Trough Pound		A Site to characterise the reach and understand baseline water quality around sub-route 6 discharge point**Error! Bookmark not defined.**. This Site is aligned with the Phase 1 water quality monitoring point for consistency. Phase 1 data available for analysis.	Spot sampling	The Trust
GUC: Middle Section	5.	GUC at Welton Lane, Daventry		Site on the GUC east of the point where the GUC and Oxford Canal interlink and before the Leicester Line at Norton Junction to characterise water quality at the upper end of the middle section and to understand baseline of water being ‘passed forward’ within the middle section. This is a new water quality monitoring location aligned with previous APEM ecological monitoring location in this reach.	Spot sampling	The Trust
	6.	GUC at Grove Lock, Leighton Buzzard		A Site to characterise and understand water quality at the lower end of the middle section after interactions with other watercourses. This is a new water quality monitoring location upstream of Tring before the Aylesbury and Wendover Arms converge with the GUC.	Spot sampling + continuous monitoring*	The Trust

Grid references for continued monitoring locations redacted

Section	Site no.	Location description	NGR	Rationale	Sampling	Land access
			[redacted]	Continuous monitoring sondes are installed at all proposed abstraction locations (Sites 6-9) to give an indication of sub-daily water quality variability, be this as a result of biological activity discharges and/or tributaries*.		
GUC: Lower Section	7.	GUC at Beggars Lane, Tring		Site located on the GUC downstream of the Aylesbury and Wendover Arm and downstream of Tring WwTW (Thames Water) to capture baseline water quality conditions around the proposed Tring abstraction location. This is a new water quality monitoring location upstream of the interaction with the River Bulbourne. Phase 1 data available for analysis.	Spot sampling + continuous monitoring	The Trust
	8.	GUC at Little Heath Lane Bridge, Hemel Hempstead		Site located on the GUC downstream of Berkhamsted WwTW (Thames Water) to capture baseline water quality conditions around the proposed Hemel Hempstead abstraction location. This reach will include the River Bulbourne interactions but is upstream of the River Gade. This is a new water quality monitoring location. An existing Phase 1 monitoring Site located approximately 3 km south-east of this location is not appropriate to characterise water quality at the abstraction point owing to the Canal Boat Mooring at Chaulden and the urban influences around Hemel Hempstead. This new Site is located before these influences.	Spot sampling + continuous monitoring	The Trust
	9.	GUC at The Grove, Hunton Bridge		Site located on the GUC before the interaction with the River Colne to capture baseline water quality conditions around the proposed 'The Grove' abstraction location. This is a new water quality monitoring location.	Spot sampling + continuous monitoring	The Trust

** Continuous monitoring commenced at Site 6 on 25th November 2021 as a result of this Site being proposed as a potential abstraction location.*

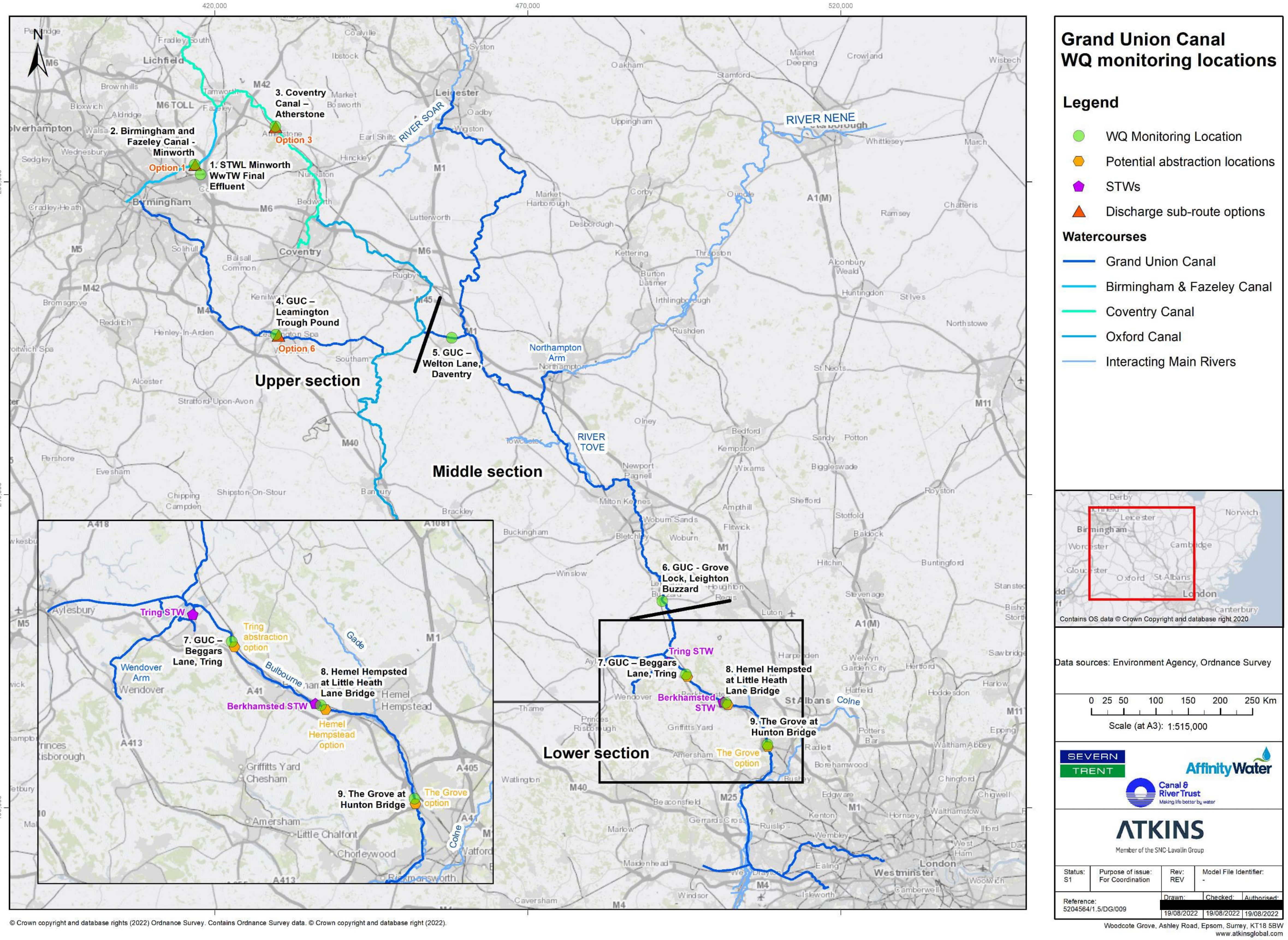

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Figure 2-2 - Key elements/ reaches of the GUC scheme.

2.2. Analysis suites

Water quality monitoring and analysis is being conducted where there is a key legislative or design driver. As a result, the water quality analysis suites break down into the following components:

- **Environmental risks as required by WFD** – which cover analysis of samples for 83 determinands as previously agreed to be suitable as part of Phase 1, and, set out in the 2015 WFD Directions[3]; including supporting parameters such as hardness, alkalinity, dissolved inorganic carbon and acid neutralising capacity (these are required to do WFD specific calculations such as bioavailable fractions).
- **Environmental permitting risks as required by the EQSD** – which cover analysis of samples for the 95 determinands set out in the surface water pollution risk assessment for environmental permits[4], at Sites that may require permitting.
- **Drinking Water** – the following have been reviewed to establish an appropriate list of 263 determinands to characterise the expected raw water quality to be abstracted from the GUC and to inform a water safety planning approach to control measures as required by DWI:
    - Existing regulations (The Water Supply (Water Quality) Regulations 2016 (England) (with 2018 amendments consolidated))[5].
    - Future legislation – notably the revised EU Drinking Water Directive (DWD).
    - Determinands identified as posing a potential risk to human health by the recent UK Water Industry Research (UKWIR) review of the Chemical Investigations Programme (CIP) data[6].
    - DWI feedback and agreements on other SRO water quality monitoring programmes.
    - Determinands contained in appropriate Drinking Water Safety Plans (DWSPs) – including comparable source type DWSPs (e.g., canal sources and industrially contaminated surface water sources), and existing receptor Site DWSPs (to enable any change in the scale of existing risks to be evaluated).
    - The ACWG methodology for drinking water risk assessment for all SROs.

Most Sites include two or more analysis suites (e.g., WFD and EQSD or WFD and Drinking Water). Where there are overlaps between the different analytical suites (e.g., because of a recurring parameter, or sampling is already being undertaken by another SRO for the same parameter, at the same point, and at the same frequency), the analysis is only undertaken once. Now that 12-months of monitoring has been conducted across all sites, we will review all analysis suites and, following discussions with both the Environment Agency and DWI, determinands that have fallen consistently below the laboratory Limit of Detection (LoD) may no longer be analysed.

2.2.1. WFD suite

The 2015 WFD Directions include 118 different parameters comprising of 'physico-chemical parameters', 'specific pollutants', 'priority substances', 'priority hazardous substances' and 'other pollutants'. These parameters are often the starting point for any monitoring programme to allow a characterisation of environmental risk. During Phase 1 of the GUC water quality investigation (2020-21) a condensed list of 74 parameters were agreed between STWL, AfW and the Environment Agency to cover determinands of relevance and to allow a characterisation of environmental risk. Therefore, the Phase 2 and Phase 3 (including Phase 3 extension) monitoring programme have continued to include these 74 parameters as part of the WFD suite.

Atkins have recommended that, where missing from this list, the following core environmental suites comprising determinands that pose a risk to WFD status deterioration were also included:

- Supporting parameters required to do WFD specific calculations such as bioavailable fractions; and,
- The Minworth final effluent permitted determinands (point source emissions to water) for secondary treated sewage effluent with nutrient removal.

[3] The Water Framework (Standards and Classification) Directive (England and Wales) 2015 accessed via: The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 (legislation.gov.uk)
[4] Accessed via: https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit
[5] The Water Supply (Water Quality) Regulations 2018 https://www.legislation.gov.uk/wsi/2018/647/contents/made
[6] UKWIR DW13S204: Risk Assessment of CIP Data with Respect to Implications for Drinking Water Sources 2019

As a result, we included a further nine parameters in this suite: acid neutralising capacity, dissolved inorganic carbon, hardness, organic nitrogen, total nitrogen (oxidised), nitrite as NO_2, ammonia, salinity (conductivity) and trichloroethylene.

This 'WFD suite' therefore consists of a total of 83 different compounds (see Appendix B). This analysis suite was used for all Sites to characterise environmental risks. At the end of 12 months (March 2022), we will investigate if any parameters can be removed, e.g., where parameters were consistently below the LoD.

2.2.2. EQSD suite

The Environment Agency surface pollution risk assessment list includes a total of 95 different parameters which have been set out in Appendix C. For the requirements of discharge permitting, these determinands are included only at Sites where discharges are proposed as part of the scheme. Removing duplication of WFD parameters, this results in an additional 87 different compounds to be analysed.

It is noted that due to the GUC being classed as an artificial waterbody, clarity needs to be sought from the Environment Agency on the permitting options and expectations for water quality discharge risk assessments. There may be a view that environmental risks are covered sufficiently by the WFD suite, and this may subsequently reduce the expectations for additional monitoring under EQSD. We will review after sufficient data are collected (we advocate that a full review is based on a minimum of 12 months of data).

2.2.3. Drinking water suite

The 263 different compounds making up the Drinking Water suite have been set out in Appendix D for the source water and the proposed intake / abstraction locations. Removing duplication with WFD / EQSD parameters, this results in a total of 239 additional parameters to be analysed. These will be compared against Permitted Concentration or Values (PCV) obtained following consultation with DWI. It should be noted that PCV's only apply to treated drinking water and not raw water values and have been compared solely as an indicator as to which determinands may be of concern following abstraction. This is discussed further in Section 3.2.

While the Drinking Water suite may appear large, it is important to note that:

- The sampling programme must be comprehensive to secure confidence that the solutions and proposed mitigation will not present a risk to human health – this is particularly important for reuse schemes from both a regulatory and public perspective.
- Monthly sampling to characterise expected parameter envelopes which may be presented to treatment is critical to appropriate sizing of treatment and other control measures, which in turn ensures fulfilment of the two key responsibilities of the water company – the effectiveness of risk management and the availability of water resources when required ('always on and good to drink').
- A targeted approach is recommended – to restrict use of this suite to relevant locations only (proposed abstraction points and discharge from Minworth to allow quantification of new sources / any change to risk in the canal catchment).

2.3. Sampling and analysis procedures

2.3.1. Continuous sondes

Continuous monitoring sondes were installed on 17/05/21 at three of the four abstraction sub-option locations (Sites 7, 8 and 9) in order to assess whether point or diffuse sources are likely to be affecting the water quality at these potential abstraction points. An additional abstraction sub-option location was identified for the scheme in October 2021 and as a result, a continuous monitoring sonde was installed at this Site (Site 6) on 25/11/21. A sonde has also already been installed to characterise the source water (Minworth WwTW treated discharge) as part of the STT SRO monitoring programme. Each continuous monitoring location includes:

- A modular system complete with a MCE-ESNET2 telemetry unit and a Xylem EXO2 multiparameter sonde, deployed at approximately 1 metre depth and sensors for temperature, conductivity, dissolved oxygen, ammonium, pH, chlorophyll, and turbidity. A limited sensor suite (dissolved oxygen, pH, and temperature) is included for the final effluent at Minworth WwTW. This sonde was installed under the STT scheme hence the different sensor suite.
- 20 W solar panel kit allowing autonomous year-round operation.

- 30-minute resolution telemetered data with secure web portal access via the Cloud, using a Tier III secure data centre.
- Daily data integrity checks undertaken via the Cloud.

Dedicated maintenance Site visits occur around every four to six weeks to proactively clean and calibrate the sensors and check equipment. So far, these have been undertaken on 22/06/2021, 13/08/2021, 22/09/2021, 21/10/2021, and 25/11/2021, 20/01/2022, 10/02/2022, and 16/03/2022. When sensors experience drift or fail in between that time, reactive repair and maintenance of the sondes has been undertaken.

2.3.2. Spot water quality sampling

It is noted that many of the WFD, EQSD and DWSP parameters have low Environmental Quality Standard (EQS) limits and will therefore require laboratory analysis to a very low level. Appropriate sampling and analysis methods have been used, along with suitably experienced staff, to achieve the required LoD and prevent risk of cross-contamination. Water quality samples have been collected monthly using project-specific Sampling Operating Procedure (SOP), which follows the approach outlined in the Environment Agency Operational Instruction 19-09[7]. Samples have been taken from a Site representative of the bulk of water being assessed (the volume of sample taken at each Site has been determined by the laboratory to cover the required analysis). In addition to the Environment Agency Operational Instruction, we also adhere to 'best practice' guidance for organic contaminant sampling set out by the US Environment Protection Agency (EPA)[8]. It is very important that cross contamination of samples is avoided to make sure no 'false positives' are seen in the data analysis. This is especially important owing to the very low EQS levels for WFD and PCV for DWSP parameters. These additional measures include:

- A sampling pole and food grade stainless steel and plastic sampling buckets have been used to collect water to fill the sampling bottles. These buckets are also used by the Environment Agency and prevent metal leaching. Each bucket will be thoroughly rinsed out downstream or slightly further away from the sampling location before any samples are taken to avoid any cross-contamination issues. One set will be dedicated to each scheme and not used for other projects, keeping all sampling containers in a dedicated 'clean' bag until used.
- Use of clean / sterile sampling bottles for any sampling round, including discarding any bottles inadvertently opened during transit.
- Use of specialist sampling containers for different analytes, some of which contain preservatives, for which indirect sampling will be used.
- Use of vinyl sampling gloves. Use new clean gloves for each new sample and dirty gloves (and other dirty PPE) stored in a designated 'dirty' bag.
- With regard to Perfluorooctanesulfonic acid (PFOS), avoiding PFOS-containing PPE and equipment (e.g., Gore-Tex jackets and boots, waterproof notepads), unless required for Health & Safety purposes (e.g., life jackets).
- In addition to taking spot water samples for laboratory analysis, the following water quality parameters were measured *in-situ* using a calibrated YSI handheld multiparameter probe:
    - Dissolved Oxygen (% saturation and mg/l)
    - Temperature
    - Conductivity
    - pH

Samples are maintained at a cool temperature during transit by using refrigerated vehicles. The laboratory (RPS) provides temperature data loggers and temperature blanks to record temperature during transit to ensure that the samples have not been exposed to environmental conditions that may adversely affect any analytical test for which they are scheduled. The samples are dropped off at the laboratory's nearest pick up

[7] Environment Agency Operational Instruction 19_09: Chemical and microbiological sampling of water. Issued 03/02/10
[8] See www.epa.gov, https://www.epa.gov/quality and https://www.epa.gov/quality/procedures-collecting-wastewatersamples. For example, https://www.epa.gov/sites/production/files/2019-02/documents/pfas_methods_tech_brief_28feb19_update.pdf for PFOS

point or collected directly from Site by RPS on the same day of collection and delivered to the laboratory overnight, thus maintaining compliance with the UK Accreditation Service (UKAS) Policy on Deviating Samples[9] (e.g., 24 hours for microbiological parameters and Biochemical Oxygen Demand (BOD)).

2.3.3. Laboratory analysis suites

Sample analysis was undertaken by RPS laboratories, with the main laboratory located in Bedford. RPS is fully accredited (UKAS ISO 17025) and highly experienced in both WFD and DWSP analysis suites, including through (but not limited to) previous projects involving extensive water company investigation work, as well as the CIP. As a result of this work, which included extensive final effluent as well as main river sampling, RPS offers all WFD and almost all EQSD determinands at or below the associated EQS. The very small number of exceptions, which include 3,4-dichloroaniline, cyfluthrin, doramectin, formaldehyde, hydrogen sulphide and methiocarb are identified in red text in Appendix C.

Table 2-2 below sets out the analysis suite for each of the nine monitoring Sites. Appendix B-D contains detail on the parameters, EQS and LoD which can be achieved by RPS[10] against the WFD EQS set out in the 2015 Directions and non-statutory EQS for the EQSD parameters. A database has been developed to hold all environmental data.

Table 2-2 - Overview of analysis suites

Section	Sites	Continuous Monitoring Sonde	WFD (Appendix B)	EQSD** (Appendix C)	DWSP*** (Appendix D)
GUC: Upper Section	1. Minworth WwTW Final Effluent*	✓	✓	✓	✓
	2. Birmingham and Fazeley Canal at Minworth	×	✓	✓	×
	3. Coventry Canal at Atherstone	×	✓	✓	×
	4. GUC at Leamington Trough Pound	×	✓	✓	×
GUC: Middle Section	5. GUC at Welton Lane, Daventry	×	✓	×	×
	6. GUC at Grove Lock, Leighton Buzzard	✓****	✓	×	✓****
GUC: Lower Section	7. GUC at Beggars Lane, Tring	✓	✓	×	✓
	8. GUC at Little Heath Lane Bridge. Hemel Hempstead	✓	✓	×	✓
	9. GUC at The Grove, Hunton Bridge	✓	✓	×	✓

** Minworth WwTW final effluent already being sampled as part of the STT SRO monitoring programme. Only parameters identified in the Drinking Water suite (Appendix D) that are not already being sampled as part of this programme will need to be sampled.*
*** EQSD parameters are only required to be sampled at discharge Sites.*
**** Drinking Water parameters are only required to characterise the source water and to understand baseline conditions at the potential abstriction locations.*
***** DWSP parameters were added to the analysis suite at Site 6 in October 2021 and a continuous monitoring sonde was added in November 2021 as a result of this Site being proposed as a potential abstraction location (previous analysis suite consisted of WFD parameters only April-September 2021).*

[9] TPS 63 UKAS Policy on Deviating Samples
[10] https://www.rpsgroup.com/services/laboratories/

2.4. Monitoring frequency

The first three sampling rounds took place at three weekly intervals (20/04/21 – 02/06/21 inclusive), however, following consultation with the Environment Agency and the DWI, all samples collected from the start of July were collected at monthly intervals. All results are reviewed quarterly to inform future monitoring frequency, and suites will be amended where necessary after sufficient data (i.e., 12 months) have been collected. Sessions will be set up with the Environment Agency and DWI on a quarterly basis to discuss findings and get agreement to amend suites where appropriate.

2.5. Data analysis

Following data compilation and the completion of standard data quality assurance procedures, descriptive statistical analyses were conducted on data from all Sites, including the generation of mean, maximum, minimum and percentile values (95th, 90th, and 10th percentiles). Relevant EQS (relating to both WFD[11] and EQSD[12]) were then obtained following consultation with the Environment Agency against which running mean data have been compared. Sites with potential abstraction applications have been compared against additional drinking water PCVs obtained from the UK's Water Supply (Water Quality) Regulations (2016) Schedule 1[13] with some determinands defined as indicator parameters being found in Schedule 2[14]. Additionally, many of the parameters included are not named within the regulations but fall under the category of 'other pesticides' and so were given a PCV of 0.10 µg/l. All raw data, descriptive statistical analyses and, where available, both EQS and PCVs are provided in Appendix E. In addition, high-resolution sensor data collected from all four Sites have been rigorously checked for sensor drop out, instrument drift, and anomalous readings that may impact interpretation. Raw sensor data are provided in Appendix F.

2.6. Rainfall data

Rainfall data were available from the Environment Agency for the entire monitoring period for a single location along the GUC (Dancers End Reservoir, Environment Agency Satiation Number: 261602). This site was selected for data interpretation as Dancers End Reservoir is situated between Sites 6-9 (abstraction locations) and coincides with the locations of the continuous monitoring sondes. The use of this dataset to infer catchment processes was therefore deemed sufficient for this interpretation. These data are presented in Figure 2-3. There was some notable weather over the monitoring period. Rainfall experienced across the GUC during 2020 peaked in October (212 mm) with the UK experiencing high rainfall totals as a result a number of large storms, namely storm Alex (02/10/2020). May recorded the lowest rainfall totals in 2020 (3.6 mm). In 2021, the UK experienced the 4th highest rainfall totals on record for the month of May, as a result, this month experienced the highest rainfall totals (121 mm). April was the driest month of 2021 (lower = 5.7 mm), mirroring a national picture of a predominantly dry and sunny weather. The rainfall total for England and Wales up to January 2022 reached 34mm, less than 40% of the average for this time of year. This national picture is reflected in the data observed in Figure 2-3 with rainfall totals equalling 21.1 mm in 2022 compared with 127 mm in 2021. These data will be used to analyse high frequency sonde and water quality spot sampling data, providing context for shifts in determinand concentrations as a result of weather patterns.

[11] The Water Framework (Standards and Classification) Directive (England and Wales) 2015 accessed via: *The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 (legislation.gov.uk)*
[12] Environment Agency statutory and operational EQS accessed via *https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit*
[13] https://www.legislation.gov.uk/uksi/2016/614/schedule/1
[14] https://www.legislation.gov.uk/uksi/2016/614/schedule/2

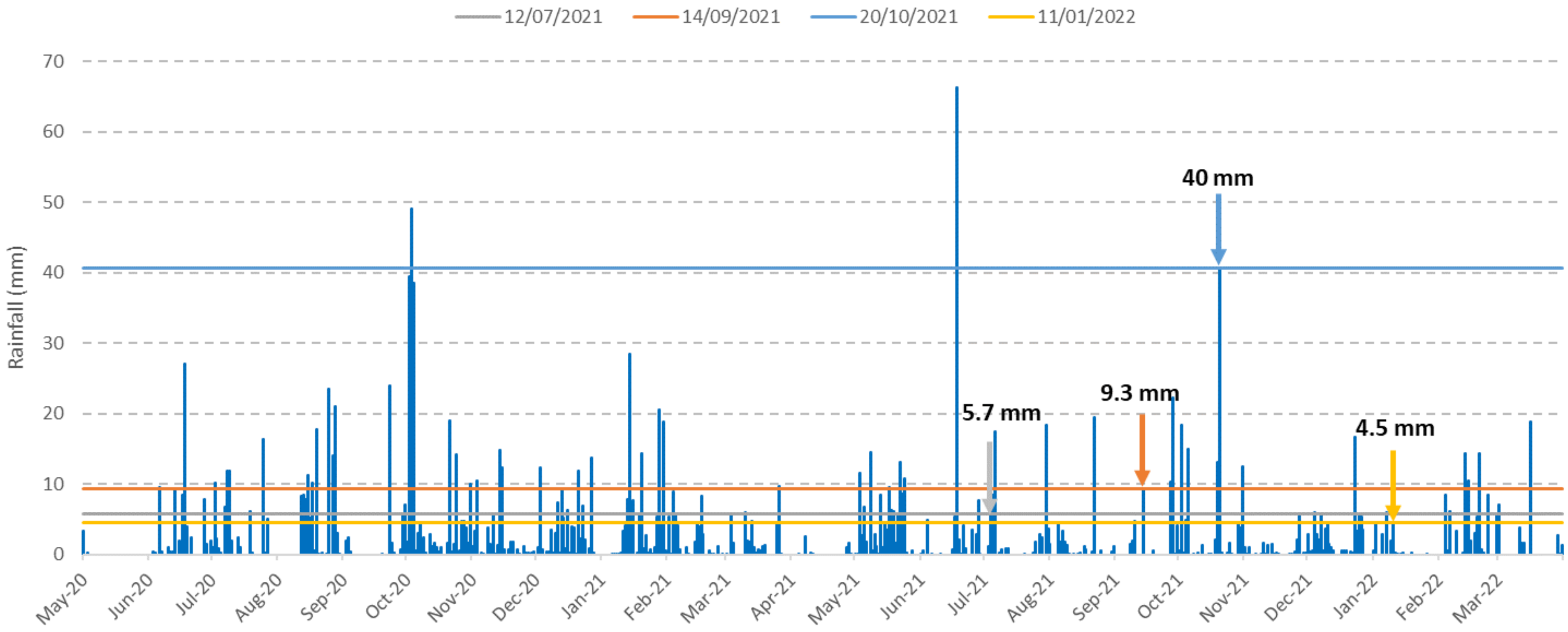

Figure 2-3 – Daily rainfall totals observed at Dancers End Reservoir (Environment Agency Station Number: 261602) for selected location to be used in the analysis of GUC sonde and chemical data series[15].

[15] Coloured lines represent rainfall totals of days corresponding with sample collection. Corresponding sample collection days are highlighted with corresponding coloured arrows. Rainfall total on sample collection days are also given.

3. Results

3.1. WFD and EQSD Environmental Quality Standards (EQS)

In order to determine parameters of risk, values have been compared against the relevant EQS as detailed by the 2015 WFD Directions and the Environment Agency Surface Water Pollution Risk Assessment Parameters EQSD, these include:

- Freshwater specific pollutants and operational environmental quality standards
- Freshwater priority hazardous substances
- Priority substances and other pollutants

It is important to note that standards or condition limits for certain parameters under the WFD (e.g., dissolved oxygen, biochemical oxygen demand (BOD), ammoniacal nitrogen, and acid neutralising capacity (ANC)), are determined by categorising the water body by type, dependent on its altitude and alkalinity. ANC standards are determined by annual mean dissolved organic carbon concentrations. In addition, soluble reactive phosphorus (SRP) standards are determined by the water body's altitude and alkalinity, cadmium standards are determined by categorising the water body, by type, dependent on the hardness of the water, and zinc standards are determined by the ambient background concentration (ABC) of dissolved zinc. Table 3-1 shows the categorisation of each monitoring Site in order to determine water body type, and Table 3-2 details the resultant Site-specific EQS which were used as part of our analysis. Whilst we have used Site-specific EQS or WFD Good standards for the Minworth WwTW final effluent for indicative purposes, it is important to note that these standards should not be routinely applied to final effluent samples as they are in-river standards.

Water quality monitoring data collected by ALS during Phase 1 of this monitoring programme have been included in this report. These extra data cover 11 months between May 2020 and March 2021 encompassing five of the sample locations included in Phase 3 bringing the total number of sampling rounds for the following Sites to 21:

- Site 1 (Minworth WwTW final effluent)
- Site 2 (Birmingham and Fazeley Canal at Minworth)
- Site 3 (Coventry Canal at Atherstone)
- Site 4 (GUC at Leamington Trough Pond)
- Site 7 (GUC at Beggars Lane, Tring)

These data were not collected by Atkins staff or analysed at laboratories recommended by Atkins and as such have been included at face value, under the assumption that the data are of good quality and have been previously quality assured following appropriate protocols.

This report presents data from Phase 1 and the additional 12 months of sampling in Phase 2 and Phase 3 (which includes 13 sampling rounds due to two samples being collected during June 2021). Where there is Phase 1 data available at sites, the data set includes 24 sampling rounds. All raw data and statistics are available in Appendix E. For the purpose of this analysis, it should be noted that we have compared data collected in the first 10 months of sampling to annual EQS values, often expressed as either annual averages, 10^{th}, 90^{th} or 95^{th} percentiles or maximum allowable concentrations (MAC). As such these exceedances are likely to change as the data set expands. The same is true for the Site-specific EQS, which uses water quality data gathered as part of this monitoring programme. Based on the data collected thus far, with metal concentrations (copper, zinc, manganese, and nickel) converted to bioavailable concentrations using the M-BAT tool, across all Sites there were 86 EQS exceedances. The distribution of these EQS exceedances is shown is Figure 3-1.

Table 3-1 - Categorisation of each monitoring Site to determine water body type

Site	Elevation (m)	Average alkalinity as $CaCO_3$ (mg/l)	Type (for dissolved oxygen, BOD and ammoniacal nitrogen standards)	Average dissolved organic carbon (mg/l)	Average water hardness as $CaCO_3$ (mg/l)	Cadmium class	ABC for dissolved zinc (catchment / group of catchments)	ABC for dissolved zinc (ug/l)
1. Minworth WwTW final effluent*	85	95	4	7.8	175	4	Humber	2.9
2. Birmingham & Fazeley Canal at Minworth	85	154	6	3.6	248	5	Humber	2.9
3. Coventry Canal at Atherstone	74	133	5	3.9	538	5	Humber	2.9
4. GUC at Leamington Trough Pound	62	151	5	4.1	203	5	Other	1.4
5. GUC at Welton Lane, Daventry	137	136	6	3.4	212	5	Nene	4.0
6. GUC at Grove Lock, Leighton Buzzard	95	174	6	3.8	228	5	Great Ouse	3.1
7. GUC at Beggars Lane, Tring	181	209	7	2.9	231	5	Thames	2.0
8. GUC at Little Heath Lane Bridge, Hemel Hempstead	147	229	7	2.4	261	5	Thames	2.0
9. GUC at The Grove, Hunton Bridge	87	243	7	1.0	263	5	Thames	2.0

** Waterbody types should not be applied to final effluent. We have used these for indicative purposes only in order to determine and understand the potential effects on the receiving waterbodies.*

Table 3-2 - Site specific EQS or WFD Good Status values used

Site	Dissolved Oxygen (% saturation) (10 percentile) WFD Good status	BOD (mg/l) (90 percentile) WFD Good status	Ammoniacal Nitrogen (mg/l) (90 percentile) WFD Good status	ANC (annual average) WFD Good status	SRP (mg/l) (annual average) WFD Good status	Cadmium (µg/l) (annual average) EQS	Cadmium (µg/l) (maximum allowable concentration) EQS	Zinc bioavailable plus ABC dissolved (µg/l) EQS
1. Minworth WwTW final effluent*	75	4	0.3	40	0.054	0.15	0.9	13.8
2. Birmingham & Fazeley Canal at Minworth	75	4	0.3	40	0.065	0.25	1.5	13.8
3. Coventry Canal at Atherstone	60	5	0.6	40	0.064	0.25	1.5	13.8
4. GUC at Leamington Trough Pound	60	5	0.6	40	0.069	0.25	1.5	12.3
5. GUC at Welton Lane, Daventry	75	4	0.3	40	0.052	0.25	1.5	14.9
6. GUC at Grove Lock, Leighton Buzzard	75	4	0.3	40	0.065	0.25	1.5	14.0
7. GUC at Beggars Lane, Tring	60	5	0.6	40	0.053	0.25	1.5	12.9
8. GUC at Little Heath Lane Bridge, Hemel Hempstead	60	5	0.6	40	0.061	0.25	1.5	12.9
9. GUC at The Grove, Hunton Bridge	60	5	0.6	40	0.075	0.25	1.5	12.9

** River EQS or WFD Good Status standards should not be routinely applied to final effluent. We have used these for indicative purposes only in order to determine and understand the potential effects on the receiving waterbodies.*

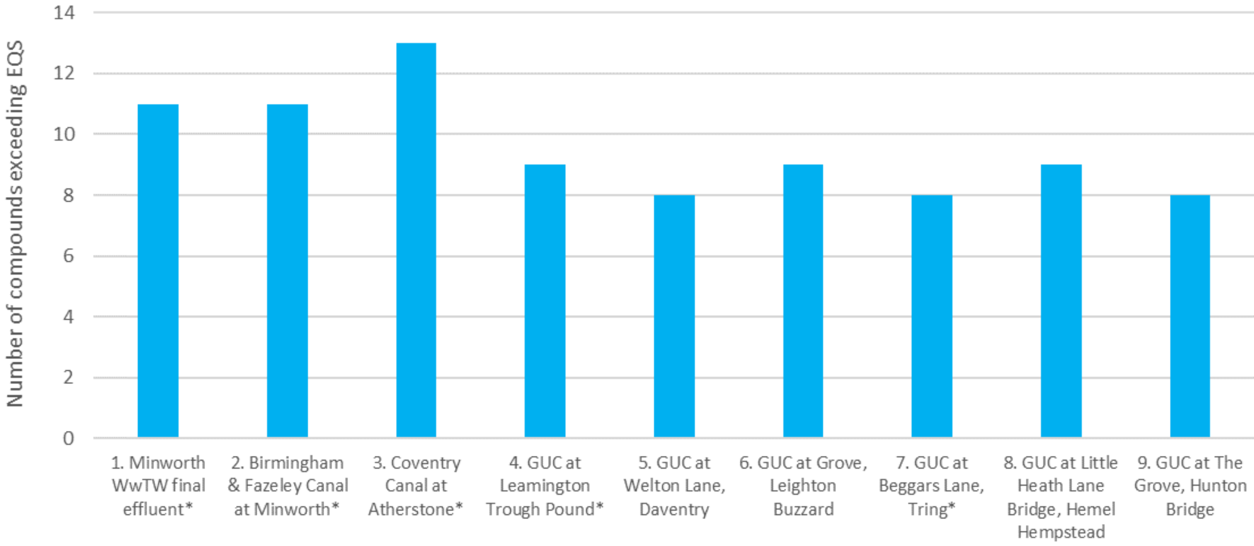

Figure 3-1 - Number of compounds exceeding EQS split by site location[16].

A list of all compounds that exceeded the quoted EQS split by Site is presented in Table 3-3. Of these compounds, those that exceeded the EQS at most Sites included two polycyclic aromatic hydrocarbons (PAH) benzo(a)pyrene and fluoranthene. As per the WFD, benzo(a)pyrene is considered as a marker for the other PAHs, hence only benzo(a)pyrene must be monitored for comparison with the biota EQS or the corresponding AA-EQS in water. Benzo(a)pyrene is classed as a priority hazardous substance under both the WFD[17] and EQSD[18] as it has carcinogenic and mutagenic properties, persists in the environment, accumulates in biota and food chains, and has adverse toxic effects on both aquatic and human life. PAHs released to the atmosphere, mainly through emissions from (road) transport and domestic consumption may reach terrestrial and aquatic environments through both wet and dry deposition. Once deposited, for example in terrestrial environments, PAHs can accumulate over long-time scales and also can be transported into adjacent waterbodies, along with other contaminants, following periods of heavy rainfall[19].

Biochemical oxygen demand (BOD) levels resulted in exceedances across all Sites. BOD (5-day) is an analytical technique which quantifies the oxygen demand exerted by biochemical processes, typically associated with the presence of organic material that may originate from either point or diffuse sources. As a result of microbial decomposition of organic matter, higher biochemical or chemical oxygen demand values are commonly associated with lower dissolved oxygen levels in the water column.

Elevated PFOS, concentrations also resulted in EQS exceedances at all nine Sites. PFOS is primarily used as a flame retardant, however, has also been used in pesticides and as a surface coating for fabrics such as carpets and waterproof apparel and is becoming increasingly found in a range of aquatic environments[20].

SRP also exceeded EQS values at 8 Sites including Minworth WwTW. Standards for SRP are Site specific, derived as a function of altitude and alkalinity, and can be seen in Table 3-2.

Bromine (total residual oxidant) resulted in EQS exceedances at 4 Sites. Bromine has been used in the production of fire retardants, hand sanitiser, and also used in agriculture as an insecticide, and as such may enter aquatic environments through point source discharges or through diffuse agricultural pathways. Bromine can occur in a number of oxidation states from -1 to +7 and is oxidised during drinking water treatment, using either ozone or chlorine dioxide, forming bromate, a suspected carcinogen[21].

Lastly, low 10th percentile dissolved oxygen saturation values resulted in EQS exceedances at five Sites. However, it should be noted that exceedance at Site 2 was driven by two low values of 37% and 72%

[16] Asterisks indicate inclusion of Phase 1 monitoring data. Mean values for Sites 1 – 4 and Site 7 cover a 23-month period (May 20 – March 22), whereas Sites 5-6 and 8-9 cover a 12-month period (April 21 – March 22).
[17] The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 (legislation.gov.uk)
[18] Surface water pollution risk assessment for your environmental permit - GOV.UK (www.gov.uk)
[19] Microsoft Word - UKSHS 9 final.doc (publishing.service.gov.uk)
[20] perfluorooctane-sulfonate-and-related-substances-pressure-rbmp-2021.pdf (environment-agency.gov.uk)
[21] Neal_bromide.pmd (copernicus.org)

saturation compared with a mean of 120%. On 21/06/2021 (where at Site 2 dissolved oxygen dropped to 37%) values were low at all Sites, suggesting this result may have been driven by a one-off proximal catchment source being delivered into the canal system.

Table 3-4 shows the values corresponding to test statistic for all compounds in exceedance of the EQS. This table highlights compounds that, while not currently exceeding EQS, may, if final effluent from Minworth WwTW were discharged into the GUC without additional treatment, be at risk of exceeding these WFD EQS values in the receiving waterbodies. This may result in a future WFD compliance risk as the new discharge would prevent the water quality of the receiving body from achieving Good Status in the future. These compounds include chlorothalonil (organic fungicide), cypermethrin (synthetic pyrethroid), permethrin (insecticide), and zinc (bioavailable).

Maximum allowable concentration (MAC) values were examined separately and have been applied to individual results and not mean or percentile data. In total there are 246 instances of MAC exceedances across all Sites. Overall, four PAH (benzo(g,h,i)perylene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene) accounted for 33% of these exceedances. As discussed above, benzo(a)pyrene can be considered as a marker for the other PAHs and hence only benzo(a)pyrene must be monitored for comparison with the biota EQS or the corresponding AA-EQS in water. The three additional hydrocarbons do, however, have a MAC value under WFD. Bromine (total residual oxidant) accounted for 45 exceedances and was most prone to exceedance in the 'upper GUC' (instream Sites 2-4) and Site 1. Sulphate (or hydrogen sulphide) exceeded MAC values on 102 occasions, with tributyltin only experiencing 1 exceedance. A list of total exceedances split by compound can be seen in Table 3-5.

Table 3-3 - Compounds responsible for EQS (WFD and EQSD) exceedance[22].

				Upper GUC				Middle GUC		Lower GUC		
				Source	Discharge			-	Abstraction			
Compound	**Standard**	**Unit**	**Statistic**	**Site 1****	**Site 2****	**Site 3****	**Site 4****	**Site 5**	**Site 6**	**Site 7****	**Site 8**	**Site 9**
Acid neutralisation capacity	40	µg/l	AA	13[#]	13[#]	13[#]	13[#]	13	14	13[#]	13	13
Benzo(a)pyrene	0.00017	µg/l	AA	25	24	24	24	13	14	24	13	13
BOD (5 day)	*	mg/l	90^{th} Percentile	5	8	5	5	3	6	5	6	4
Bromine - total residual oxidant	0.002	mg/l	AA	12[#]	8[#]	12[#]	13[#]					
Chlorothalonil	0.035	µg/l	AA	1	0[#]	0[#]	0[#]					
Cobalt – dissolved	3	µg/l	AA	0[#]	0[#]	11[#]	0[#]		0[##]	0[#]	0	0
Dissolved Oxygen	*	%	10^{th} Percentile	7[#]	2[#]	0[#]	0[#]	4	1[#]	1[#]	0	0
Cypermethrin	0.00008	µg/l	AA	16	0	1	1	1	2	0	9	1
Fluoranthene	0.0063	µg/l	AA	0	18	23	22	4	13	19	13	12
Manganese - bioavailable***	123	µg/l	AA	0[#]	1[#]	24	0[#]		0[##]	0[#]	0	0
Nickel - bioavailable***	4	µg/l	AA	3	23	19	0	0	0	0	0	0
Perfluorooctane sulfonic acid	0.00065	µg/l	AA	24	24	24	24	13	11	22	13	12
Permethrin	0.001	µg/l	AA	7[#]	1[#]	1[#]	1[#]					
Soluble reactive phosphorus	*	mg/l	AA	19	3	4	18	5	11	11	13	13
Sulphide or hydrogen sulphide	0.25	µg/l	AA	5	16	15	16	6	9	19	9	7
Total anions	250	mg/l	AA	3[#]	1	11[#]	0		1	0[#]	0	0
Tributyltin compounds	0.0002	µg/l	AA	0	1	1	3	0	1	2	1	0
Zinc - bioavailable***	*	µg/l	AA	11	10	9	1	0	0	3	0	0
Total number of samples	**-**	**-**	**-**	**25**	**24**	**24**	**24**	**13**	**14**	**24**	**13**	**13**

[+] AA = Annual Average
[++] Numbers of failures are shown for illustrative purposes only and reflect individual samples being compared to an AA or percentile derived EQS.
** Site specific EQS determined, see Table 3-2 for details.*
*** Data at Sites 1 – 4 and Site 7 cover a 23-month period (May 20 – March 22), whereas Sites 5-6 and 8-9 cover a 12-month period (April 21 – March 22).*
**** Converted to bioavailable concentrations using the Metal Bioavailability Assessment Tool (M-BAT)[23].*
[#] Total number of samples collected = 13 (not included in Phase 1 dataset).
[##] Drinking water suite parameters added to this site in October 2021 so total number of samples = 6.

[22] Blue shading indicates EQS (WFD and EQSD) exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites. For further detail relating to analysis suites see Table 2-2. The count of individual EQS exceedances are also given[+].
[23] Rivers & Lakes - Metal Bioavailability Assessment Tool (M-BAT) | wfd uktag

Table 3-4 – Concentrations of compounds responsible for EQS (WFD and EQSD) exceedance[24].

				Upper GUC				Middle GUC		Lower GUC		
				Source	Discharge			-	Abstraction			
Compound	**Standard**	**Unit**	**Statistic⁺**	**Site 1****	**Site 2****	**Site 3****	**Site 4****	**Site 5**	**Site 6**	**Site 7****	**Site 8**	**Site 9**
Acid neutralisation capacity	40	µg/l	AA	1877	3100	2331	3269	2992	3571	4031	4088	4800
Benzo(a)pyrene	0.00017	µg/l	AA	0.00119	0.00898	0.0155	0.0235	0.0038	0.0198	0.0136	0.0271	0.0217
BOD (5 day)	*	mg/l	90th Percentile	4.75	6.61	5.93	8.29	5.28	11.8	9.02	19.0	5.84
Bromine - total residual oxidant	0.002	mg/l	AA	0.132	0.192	2.70	0.387					
Chlorothalonil	0.035	µg/l	AA	0.0592	0.0350	0.0337	0.0350					
Cobalt - dissolved	3	µg/l	AA	1.78	0.232	13.4	0.20		0.5450	0.1738	0.2069	0.1723
Dissolved Oxygen	*	%	10th Percentile	56.8	74.2	80.8	74.1	64.7	75.5	58.4	72.7	90.5
Cypermethrin	0.00008	µg/l	AA	0.000178	0.00005	0.00005	0.00005	0.000081	0.00008	0.00005	0.00018	0.00008
Fluoranthene	0.0063	µg/l	AA	0.00219	0.0104	0.0194	0.0222	0.00530	0.0186	0.0174	0.0315	0.0190
Manganese - bioavailable***	123	µg/l	AA	14.9	11.8	1517	21.8		14.8	3.64	5.46	3.83
Nickel - bioavailable ***	4	µg/l	AA	3.09	4.85	9.89	1.10	0.909	0.744	0.304	0.401	0.341
Perfluorooctane sulfonic acid	0.00065	µg/l	AA	0.0204	0.0316	0.00804	0.00593	0.0185	0.00176	0.00260	0.00216	0.00190
Permethrin	0.001	µg/l	AA	0.00262	0.00108	0.00104	0.00108					
Soluble reactive phosphorus	*	mg/l	AA	0.260	0.0254	0.158	0.0954	0.103	0.193	0.0654	0.510	0.111
Sulphide or hydrogen sulphide	0.25	µg/l	AA	6.78	16.3	16.5	19.7	13.5	28.8	33.1	14.0	12.5
Total anions	250	mg/l	AA	218	175	433	109		265	84.1	107	80.0
Tributyltin compounds	0.0002	µg/l	AA	0.000041	0.000090	0.000094	0.000125	0.000037	0.000165	0.000079	0.0240	0.000068
Zinc - bioavailable***	*	µg/l	AA	15.3	17.8	10.0	2.45	3.15	3.18	4.67	6.27	3.19

⁺ *AA = Annual Average*
** Site specific EQS determined, see Table 3-2 for details.*
*** Data at Sites 1 – 4 and Site 7 cover a 23-month period (May 20 – March 22), whereas Sites 5-6 and 8-9 cover a 12-month period (April 21 – March 22).*
**** Converted to bioavailable concentrations using the Metal Bioavailability Assessment Tool (M-BAT)[25].*

[24] Blue shading indicates EQS exceedance and grey shading indicates where failures relate to EQSD target compounds (not monitored at all sites, and as such not directly comparable across all sites). Concentrations corresponding to test statistic are also shown. For further detail relating to analysis suites see Table 2-2.
[25] Rivers & Lakes - Metal Bioavailability Assessment Tool (M-BAT) | wfd uktag

Table 3-5 - Compounds responsible for WFD and EQSD MAC exceedances[26].

				Upper GUC				Middle GUC	Lower GUC			
				Source	Discharge			-	Abstraction			
Compound	**Standard**	**Unit**	**Statistic**	**Site 1****	**Site 2****	**Site 3****	**Site 4****	**Site 5**	**Site 6**	**Site 7****	**Site 8**	**Site 9**
Benzo(a)pyrene	0.027	µg/l	MAC	0	1	4	7	0	2	3	5	3
Benzo(b)fluoranthene	0.017	µg/l	MAC	0#					2##	3#	5#	3#
Benzo(g,h,i)perylene	0.0082	µg/l	MAC	0#					5##	7#	10#	11#
Benzo(k)fluoranthene	0.017	µg/l	MAC	0#					1##	1#	5#	3#
Bromine - total residual oxidant	0.005	mg/l	MAC	12#	8#	12#	13#					
Cypermethrin	0.0006	µg/l	MAC	1	0	0	0	0	0	0	1	0
Endosulfan A	0.01	µg/l	MAC	0#					0##	0#	1#	0#
Heptachlor and heptachlor epoxide	0.0004	µg/l	MAC	0#					0##	0#	1#	0#
Nickel - dissolved	34	µg/l	MAC	2	0	11	0	0	0	0	0	0
Sulphide or hydrogen sulphide	1	µg/l	MAC	5	16	15	16	6	9	19	9	7
Tributyltin compounds	0.0015	µg/l	MAC	0	0	0	0	0	0	0	1	0
Total number of samples	**-**	**-**	**-**	**25**	**24**	**24**	**24**	**13**	**14**	**24**	**13**	**13**

** While these determinands have a MAC, as per the WFD there is no corresponding AA statistic as benzo(a)pyrene should be considered as a marker for the other PAHs, hence only benzo(a)pyrene must be monitored for comparison with the biota EQS or the corresponding AA-EQS in water.*
*** Data at Sites 1 – 4 and Site 7 cover a 23-month period (May 20 – March 22), whereas Sites 5-6 and 8-9 cover a 12-month period (April 21 – March 22).*
 # Total number of samples collected = 13 (not included in Phase 1 dataset).
Drinking water suite parameters added to this site in October 2021 so total number of samples = 6.

[26] Blue shading indicates MAC EQS exceedance, grey shading indicates where target compounds are not monitored at all sites, and as such not directly comparable across all sites. The count of exceedances also given

3.2. Drinking Water Quality Standards

Drinking water parameters, assessed through their comparison to PCVs are only required to characterise the source water at Minworth WwTW (Site 1) and the 4 potential downstream abstraction locations (Site 6 Grove Lock, Leighton Buzzard, Site 7 Tring, Site 8 Hemel Hempstead, and Site 9 The Grove) (Table 2-1). It is important to note, that drinking water parameters were only added to the analysis suite at Site 6 in October 2021, and as a result six months of DWSP parameters are reported for Site 6. Across all five Sites where drinking water PCVs apply, to date (covering a 12-month period with an additional 11 months of data reported for Site 1 and Site 7 due to the addition of Phase 1 data) there have been a total of 475 instances of PCV exceedances. The distribution of these exceedances across the five Sites can be seen in Figure 3-2, with a detailed breakdown in Table 3-6.

Site 1 recorded the highest number of exceedances (n = 137). Across the 4 potential abstraction locations (Sites 6-9), Site 8 recorded the highest number of exceedances (n = 110). There were a number of exceedances common to all abstraction locations, these are listed below ranked by their total number of exceedances across all sites:

- Coliform total (total exceedances across all sites = 58)
- *Clostridium perfringens* veg & spores, confirmed (total exceedances across all sites = 58)
- *Escherichia coli* (*E.coli*, total exceedances across all sites = 58)
- Turbidity (total exceedances all sites = 53)
- Nitrite (total exceedances all sites = 43)
- Iron - total (total exceedances all sites = 31)

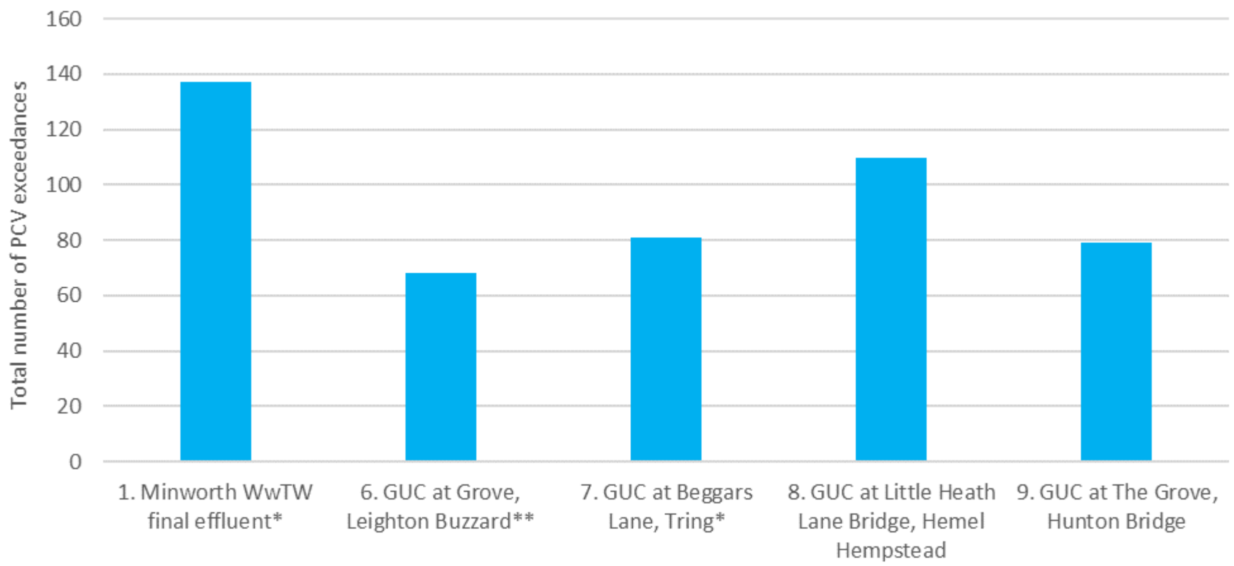

Figure 3-2 - Total number of PCV exceedances split by site location[27].

C. perfringens (a sulphite-reducing species commonly associated with faecal contamination) is widely distributed in the environment and is regularly evaluated with the aim of understanding the microbiological safety of drinking water supplies. *C. perfringens* is responsible for gastrointestinal disease, the spores of which persist longer than other indicators of contamination, such as Coliforms (which also demonstrated exceedances at all sites and is also an important indicator of faecal contamination). Sources of bacterial contamination can range from the input of animal manures from farmyard runoff and the discharge of untreated, and even treated, sewage effluent[28]. *Cryptosporidium* was not detected at any Site, however, given that *Cryptosporidium* events can be extremely short-lived *Cryptosporidium* monitoring should be continued going forward. Elevated turbidity values may be caused by storm event mobilisation of catchment sediment stores. However, as canal networks

[27] * (Sites 1 and 7) indicate inclusion of Phase 1 monitoring data covering a 23-month period (May 20 – March 22), **indicate the data covers a 6-month period (October 21 – March 22). Sites 8 and 9 cover a 12-month period (April 21 – March 22).
[28] final_jrc_tech_report_dwd___06.04.20_final_pdf(4).pdf

often has shallow depths (<6ft), short lived events may be a result of localised disturbance such as boats but also dogs and other wildlife swimming in the vicinity of the sensor location disturbing shallow sediment depositions.

A number of rainfall events were captured during the latter half of monitoring period. Rainfall events coincided with sampling on14/09/21 (daily rainfall total = 9.3 mm), 07/12/21 (daily rainfall total = 5.7 mm), and 11/01/22 (daily rainfall total = 4.5 mm). Additional exceedances in MAC concentrations of benzo(k)fluoranthene and PAHs (sum of benzo(b)fluoranthene, benzo(k)fluoranthene, Benzo(ghi)perylene, and indeno(1,2,3-c,d)-pyrene) were observed at Sites 8 and 9 on 14/09/21, along with elevated turbidity values, not regularly experienced under baseflow conditions. The reduced monitoring suite present at Site 6 prior to November 2021 means these determinands were not routinely monitored during this time. Additional exceedances were also observed in PCVs for iron (total) (Sites 6, 8, and 9) along with exceedances in nitrite (Sites 6 and 8).

During the rainfall event sampled on 07/12/21 additional PCV exceedances in ammonium (Sites 6, 7, and 8) and nitrate (Sites 6 and 7) were observed. It should be noted that although nitrate didn't exceed the PCV at Site 8 during this event, concentrations were considerably elevated when compared to baseflow conditions (48 mg/l NO_3), 2 mg/l NO_3 shy of reaching the PCV (50 mg/l NO_3). The same is true for concentrations observed at Site 9, which were found to be elevated when compared to baseline conditions (nitrate = 27 mg/l).

A number of exceedances were observed at Site 6 (Grove Lock, Leighton Buzzard) for an additional sample collected on 20/10/2021 which coincided with a period of intense rainfall relative to the other storms captured (see Figure 2-3). October 2021 experienced 120 mm total rainfall compared to 55 mm in the preceding month with a daily total on 20/10/2021 of 40 mm (see Figure 2-3). Of the additional exceedances observed, of note are the presence of tebuconazole, an agricultural triazole fungicide used to treat plant pathogenic fungi, and metribuzin, a synthetic herbicide applied both pre- and post-emergence of vegetable crops. It is likely these are of agricultural origin, leached by the heavy rainfall experienced during the month, with each rainstorm increasing ground saturation and further facilitating additional losses. The Ledburn Book has its confluence with the GUC directly south (upstream) of Site 6. Ledburn Book is a heavily modified water body which lists poor agricultural land management as one of its contributing factors for not achieving good status under WFD. The presence of a ditch upstream of Site 6 was also observed with a visually elevated suspended sediment loading. It is therefore likely that these catchment areas may be responsible for the delivery of these additional compounds during periods of heavy rainfall. This storm event also resulted in additional exceedances of PAH, aluminium (dissolved), and iron (dissolved), which were not regularly experienced at any abstraction location under base flow conditions. A second sample collected from all locations under rainfall conditions on 11/01/22 (daily rainfall total = 4.5 mm) demonstrated no additional exceedances of tebuconazole or metribuzin. Antecedent conditions for this month, however, were considerably different from those experienced in October 2021. As discussed in Section 2.6, national rainfall totals for January 2022 were on average 40% lower than the preceding year (January 2022 = 21.2 mm, January 2021 = 127 mm). Reduced rainfall, leading to drier soil conditions may have resulted in a lower rate of pollutant transport, and as such, no additional exceedances of the agricultural biproducts observed during the last period of rainfall that coincided with sample collection.

While these determinands are useful indicators of compounds that may be of concern following abstraction (depending on their relative drinking water treatment removal efficiencies) PCVs apply only to treated drinking water, and not raw source waters, which helps to explain why these numbers are considerably higher than the number of EQS failures. They do however, aid in future planning helping to ensure treatment facilities are tailored towards the chemicals of concern.

Table 3-7 shows the maximum concentrations observed across four of the potential abstraction locations. Based on maximum concentrations discharged from Minworth WwTW, the following compounds have the potential to result in additional instream breaches of PCVs: colour, nitrate, and PAH (sum).

Table 3-6 - Compounds responsible for drinking water PCV exceedances[29].

			Source	Abstraction Sites			
Compound	**PCV**	**Unit**	**Site 1****	**Site 6****	**Site 7****	**Site 8**	**Site 9**
Aluminium - dissolved	200	µg/l	0	1	0	0	0
Aluminium - total	200	µg/l	0	4	2	1	0
Ammonium as NH_4	0.5	mg/l	1[#]	1[##]	1[#]	7	0
Benzo(a)pyrene	0.01	µg/l	0	6	12	10	7
Bisphenol A	2.5	µg/l	9[#]	0[##]	0[#]	4	1
C. perfringens veg & spores, confirmed	0	No/100 ml	13[#]	6[##]	13[#]	13	13
Chlorate	0.25	mg/l	4[#]	0[##]	1[#]	3	2
Chlorite	0.25	µg/l	0[#]	1[##]	0[#]	0	0
Chromium - total	50	µg/l	1	0	0	1	0
Coliform - total	0	No/100 ml	13	6[##]	13[#]	13	13
Colour	20	mg/lPt/Co	12[#]	2[##]	0[#]	0	0
E.coli	0	No/100 ml	13[#]	6[##]	13[#]	13	13
Iron - dissolved	200	µg/l	0	1	0	1	0
Iron - total	200	µg/l	4	11	3	11	2
Manganese - dissolved	50	µg/l	13[#]	1[##]	0[#]	0	0
Manganese - total	50	µg/l	13[#]	1[##]	0[#]	0	0
Metribuzin	0.1	µg/l	0[#]	1[##]	0	0	0
Nickel - dissolved	20	µg/l	4	0	0	0	0
Nickel - total	20	µg/l	4	0	0	0	0
Nitrate	50	mg/l	8	2	1	0	1
Nitrite	0.5	mg/l	13[#]	7	6[#]	8	8
PAHs (sum of Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene, Indeno(1,2,3-cd)-pyrene)	0.1	µg/l	0[#]	1[##]	0[#]	5	3
PAH sum*	0.1	µg/l	0[#]	2[##]	3[#]	7	4
Propyzamide	0.1	µg/l	1[#]	0[##]	0[#]	0	0
Sulphate	250	mg/l	0[#]	1[##]	0[#]	0	0
Tebuconazole	0.1	µg/l	0[#]	1[##]	0[#]	0	0
Turbidity	1	NTU	9[#]	6[##]	13[#]	13	12
Total number of samples	**-**	**-**	**25**	**14**	**24**	**13**	**13**

** Polyaromatic hydrocarbons (PAH) sum of 8 (naphthalene, fluoranthene, anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)-perylene, and indeno(1,2,3-cd)-pyrene).*
*** Data at Sites 1 and 7 cover a 23-month period (May 20 – March 22), Site 6 a 6-month period (Oct – March 22) and Sites 8-9 cover a 12-month period (April 21 – March 22).*
[#] Total number of samples collected = 13 (not included in Phase 1 dataset).
[##] Drinking water suite parameters added to this site in October 2021 so total number of samples = 6.

[29] Blue shading indicates PCV exceedance, with the number of exceedances provided.

Table 3-7 – Concentrations of compounds responsible for drinking water PCV exceedances[30].

			Source	Abstraction Sites			
Compound	**PCV**	**Unit**	**Site 1**	**Site 6**	**Site 7**	**Site 8**	**Site 9**
Aluminium - dissolved	200	µg/l	50	1000	67	56	21
Aluminium - total	200	µg/l	125	1800	230	270	130
Ammonium as NH_4	0.5	mg/l	1.40	1.88	0.94	1.79	0.19
Benzo(a)pyrene	0.01	µg/l	0.00302	0.134	0.0416	0.0693	0.078
Bisphenol A	2.5	µg/l	137	<10	<10	16.8	88.4
C. perfringens veg & spores, confirmed	0	No/100 ml	>100	>100	>100	>100	>100
Chlorate	0.25	mg/l	2.0	0.7	1.0	2.0	12.0
Chlorite	0.25	µg/l	<3	15.0	<3	<3	<3
Chromium - total	50	µg/l	140	8.6	9.4	65	2.4
Coliform - total	0	No/100 ml	>2420	>2420	>2420	>2420	>2420
Colour	20	mg/lPt/Co	40.0	26	18	17	17
E.coli	0	No/100 ml	>2420	>2420	866	>2420	>2420
Iron - dissolved	200	µg/l	92.0	1700	81	370	58
Iron - total	200	µg/l	310	2600	305	700	220
Manganese - dissolved	50	µg/l	130	120	35	21	9.3
Manganese - total	50	µg/l	160	150	37	25	19
Metribuzin	0.1	µg/l	<0.05	0.22	<0.05	<0.05	<0.05
Nickel - dissolved	20	µg/l	61.0	7.1	1.6	2.2	0.8
Nickel - total	20	µg/l	61	9.4	11	2.5	1.2
Nitrate	50	mg/l	120	100	54	48	54
Nitrite	0.5	mg/l	2.5	2.5	1.2	2.8	2
PAHs (sum of Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene, Indeno(1,2,3-cd)-pyrene)	0.1	µg/l	-	0.374	0.0951	0.227	0.211
PAH sum*	0.1	µg/l	<0.05	0.62	0.17	0.4	0.34
Propyzamide	0.1	µg/l	0.32	0.1	0.01	0.01	0.01
Sulphate	250	mg/l	180	690	42	38	26
Tebuconazole	0.1	µg/l	<0.05	0.2	<0.05	<0.05	<0.05
Turbidity	1	NTU	14	210	29	12	11

** Polyaromatic hydrocarbons (PAH) sum of 8 (naphthalene, fluoranthene, anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)-perylene, and indeno(1,2,3-cd)-pyrene).*

[30] Dark blue shading indicates PCV exceedance, light blue shading indicates this substance is of future concern as it is within 20% of the PCV. Maximum observed values are also given

3.2.1. Temporal patterns in long term data records

All sites now have data spanning a 12-month period. In addition, five Sites have instream data for longer than a 12-month period when Phase 1 data are included: Site 1 (Minworth WwTW final effluent), Site 2 (Birmingham and Fazeley Canal at Minworth), Site 3 (Coventry Canal at Atherstone), Site 4 (GUC at Leamington Trough Pound), and Site 7 (Tring at Beggars Lane). Temporal plots of the four most common determinands to breach EQS values (benzo(a)pyrene, PFOS, soluble reactive phosphorus, and BOD) all sites can be seen in Figure 3-3 to Figure 3-11. These determinands are discussed in turn below.

Benzo(a)pyrene

Benzo(a)pyrene concentrations span a similar range across all sites, exhibiting a similar temporal trend. Concentration maxima can be seen peaking in July-September (with the exception of an anomalously high value in June at Site 2). A rise in benzo(a)pyrene concentration through mid/late summer (across both years) may have been the result of an increase in fossil fuel combustion resulting from increasing usage of the canal network for transport and recreation during the summer months. A reduction in dilution capacity caused by a lower frequency of rainfall events may have acted to further exacerbate this trend. The slow decline observed following the late August – September peak (and minimal increase observed during December 2020/January 2021 e.g., as seen at Site 2 and Site 4) may have been the result of a sudden increase in the inefficient burning of fuel for heating (during the winter months) such as log burning stoves, common on house boats and barges, prevalent across the canal network. This trend of increasing PAH discharge in riverine system has been observed across the scientific literature[31]. Data from Minworth final effluent demonstrated no obvious seasonal trends, with peak concentrations occurring in December 2020 and October 2021. Benzo(a)pyrene concentration at Site 6 peaked in October 2021 in the sample collected to coincide with wet weather conditions. This peak in concentration (0.134 µg/l) is considerably higher than all other concentrations observed during this record and may be related to the flushing of land directly adjacent to the canal used predominantly for parking.

Soluble reactive phosphorus

Differences in concentration patterns between sites suggest a complex assortment of phosphorus source areas. No clear seasonal trend was evident from any abstraction site with data collected under Phase 1. Phosphorus is commonly leached from a number of sources (predominantly agricultural) under intense rainfall conditions due to a combination of its charge, and its affinity for sediment. As a result, it is likely that peaks in phosphorus concentrations outside any observable seasonal pattern were likely the result of catchment delivery from diffuse sources. The significant peak in phosphorus concentration that occurred at Site 3 in December 2020 did not correlate with a significant rainfall event, suggesting a more local, flow independent source may be responsible. Peak phosphorus concentrations at Site 6 were observed coinciding with a significant period of rainfall suggesting flushing of diffuse sources. Patterns in data from Minworth treated effluent were highly variable, peaking during Phase 1 between September and February 2020. This was a significant increase and may be related to operations issues/ changes taking place at the works as concentrations remain below 0.4 mg/l from March 2021 to the end of the monitoring period.

PFOS

At all sites with the exception of Site 2, seasonal patterns were observed in PFOS data with concentrations experiencing a maximum during the late summer months and a minimum during the winter months. This was likely due to the changing dilution capacity of the canal between seasons. As inputs from point sources e.g., WwTW or septic tanks are relatively consistent across the year, a seasonal signal is often superimposed on synthetic chemicals as winter dilution from higher baseflow input decreases instream concentrations. This has been found with a number of chemicals of emerging concern including PFOS and Hexabromocyclododecane (HBCDD)[32].

BOD

Results from the analysis of BOD were more variable and likely reflect local conditions and nutrient sources. Increases in BOD are commonly associated with increases in organic loading (due to the increased oxygen required to break down the organic material). Clear annual peaks can be seen at Site 2, with BOD peaking during the summer months. This pattern is consistent with instream bacterial breakdown of a point source input of organic matter, as instream dilution capacity drops during the summer months, increasing instream nutrient concentrations and BOD. A significant peak in BOD occurred at Site 7 on 11/05/2021. While this day did not experience significant rainfall (1.24 mm), it was preceded by a significant rainfall event on 08/05/21 (14.4 mm)

[31] Seasonal and long-term trends in atmospheric PAH concentrations: evidence and implications - ScienceDirect
[32] Seasonal variation of contaminant concentrations in wastewater treatment works effluents and river waters: Environmental Technology: Vol 41, No 21 (tandfonline.com)

and again on the 10/05/21 (2.94 mm). This likely resulting in saturated ground and conditions suitable for the mobilisation and transport of pollutants from a wider range of source areas than during a single storm event, suggesting a diffuse trigger for the elevated BOD measurements. As observed with the other determinands discussed above, no seasonality was evident in final effluent samples collected from Minworth.

3.2.2. Laboratory limits of detection

An updated list of compounds that fall consistently below the laboratory provided limit of detection (LoD), split by analysis suite, can be seen in Appendix G (total number of compounds = 140) for all data collected by RPS. We are constantly monitoring not only prevalent compounds that may result in water body EQS (and PCV) exceedances but also those which consistently fall below LoD values. Four sampling rounds coincided with periods of heavy rainfall, as discussed in Section 2.6. As rainfall events were captured, this compound list can be considered reflective of material mobilised under a wet weather conditions and as such, samples collected during these events are considered a ‘worst case scenario’ in terms of material delivered to the channel from the surrounding catchment.

Compounds less than the laboratory reported LoD reported over the 12-months of sampling can be investigated for their removal from future analysis suites, in discussion with the relevant regulatory bodies. A comprehensive analysis of the removal potential of these determinands is presented in Appendix H.

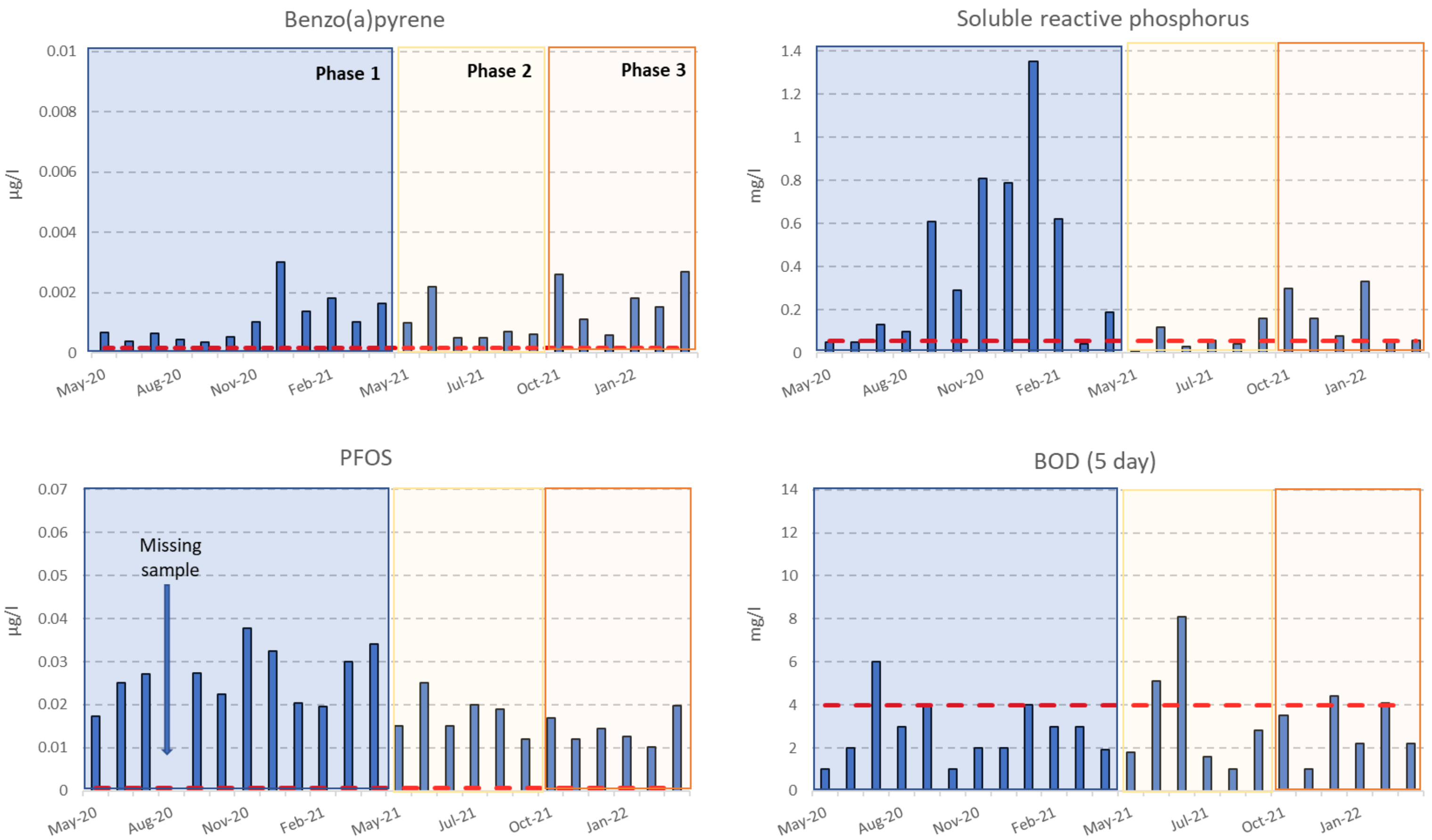

Figure 3-3 - Spatial trends in for key determinands at Site 1 Minworth WwTW final effluent (May 2020 - March 2022)[33].

[33] Red dashed line indicates the EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.065 mg/l, BOD = 4 mg/l). Note: this EQS is applicable to raw water samples and has been included as a visual guide only. Blue shading indicates Phase 1 data, yellow Phase 2, and orange Phase 3. Values <LoD have been plotted at the LoD. Note: a different y-axis is used at this site for benzo(a)pyrene and soluble reactive phosphorus as the data reflect treated final effluent and not canal water samples.

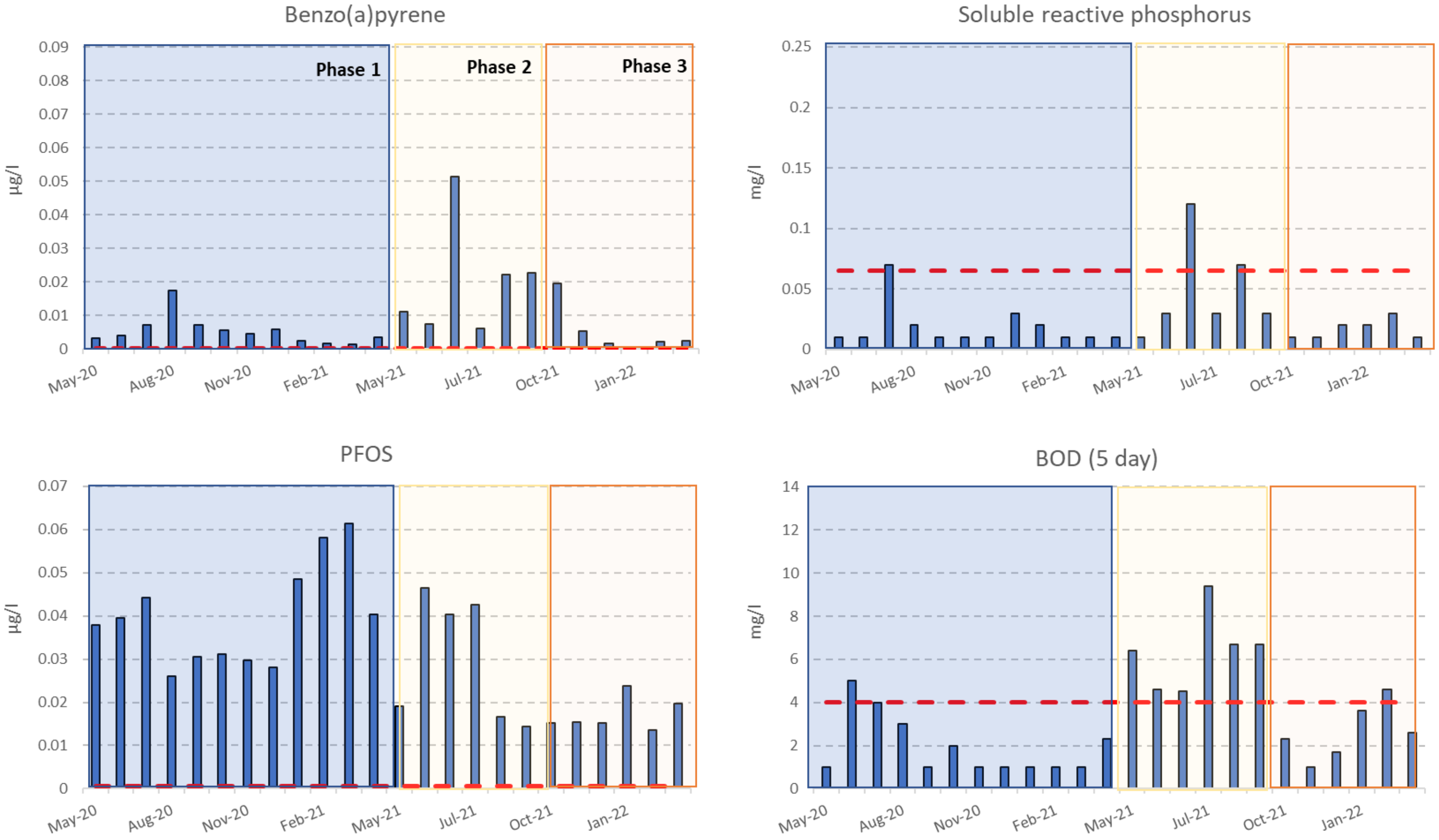

Figure 3-4 - Spatial trends in for key determinands at Site 2 Birmingham and Fazeley Canal at Minworth (May 2020 - March 2022)[34].

[34] Red dashed line indicates the EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.065 mg/l, BOD = 4 mg/l). Blue shading indicates Phase 1 data, yellow Phase 2, and orange Phase 3. Phase 1 analyses were conducted at a different analytical laboratory. Values <LoD have been plotted at the LoD.

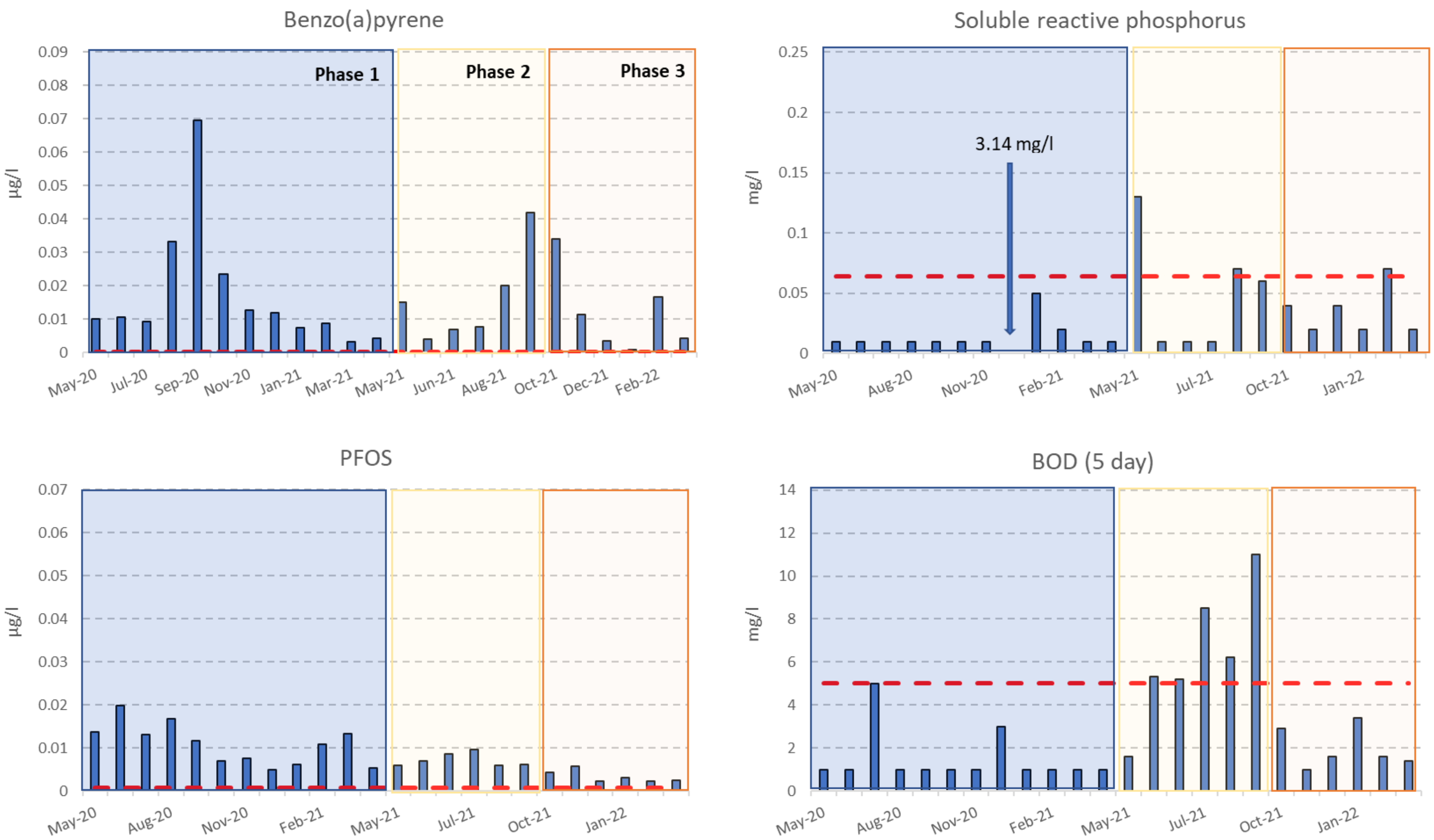

Figure 3-5 - Spatial trends in for key determinands at Site 3 Coventry Canal at Atherstone (May 2020 - March 2022)[35].

[35] Red dashed line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.064 mg/l, BOD = 5 mg/l). Blue shading indicates Phase 1 data, yellow Phase 2, and orange Phase 3. Phase 1 analyses were conducted at a different analytical laboratory. Values <LoD have been plotted at the LoD.

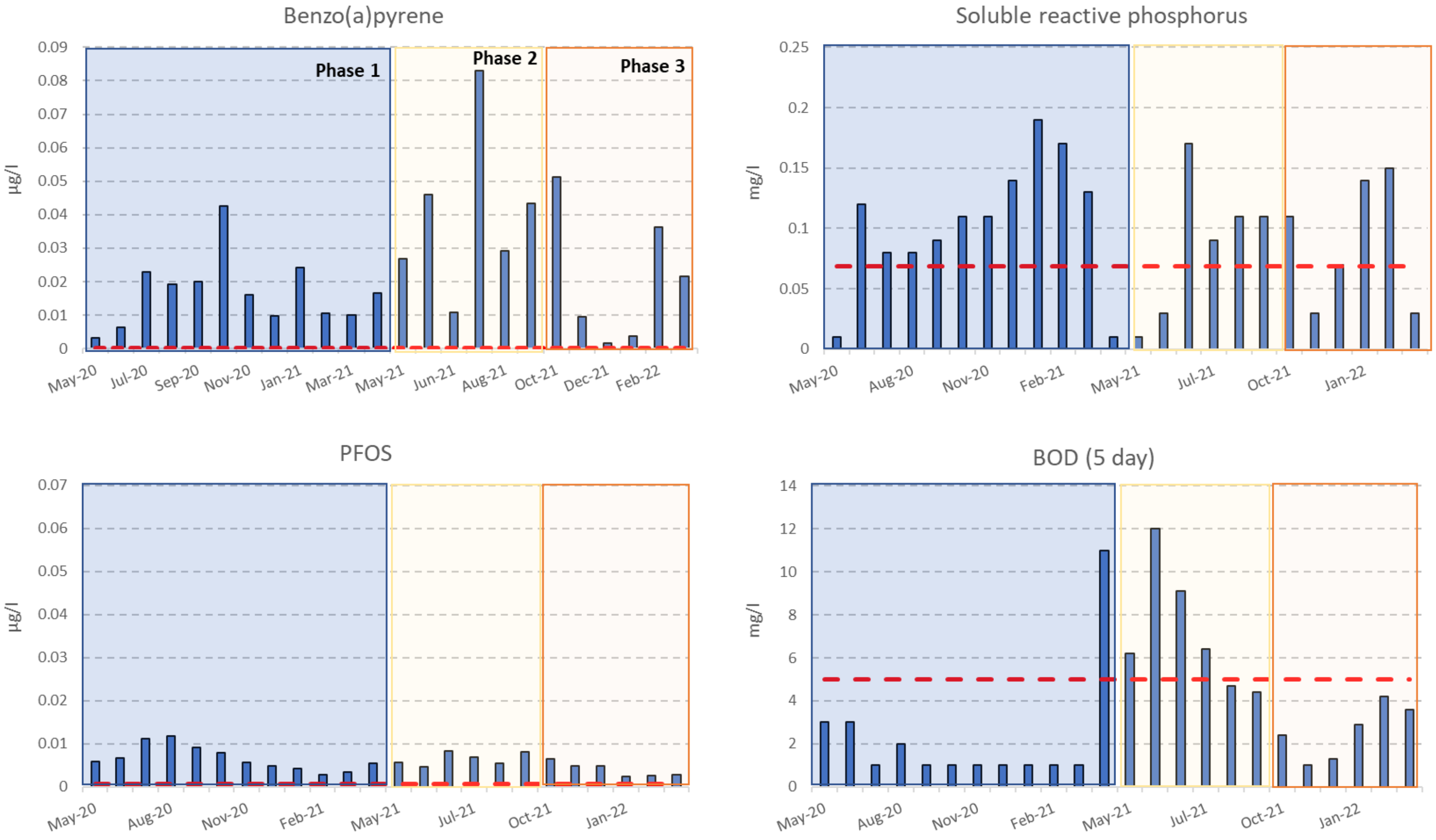

Figure 3-6 - Spatial trends in for key determinands at Site 4 GUC at Leamington Trough Pound (May 2020 - March 2022)[36].

[36] Red dashed line indicated EQS value (see Table 3-2 for details). Blue shading indicates Phase 1 data, yellow Phase 2, and orange Phase 3. Phase 1 analyses were conducted at a different analytical laboratory. Values <LoD have been plotted at the LoD (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.069 mg/l, BOD = 5 mg/l).

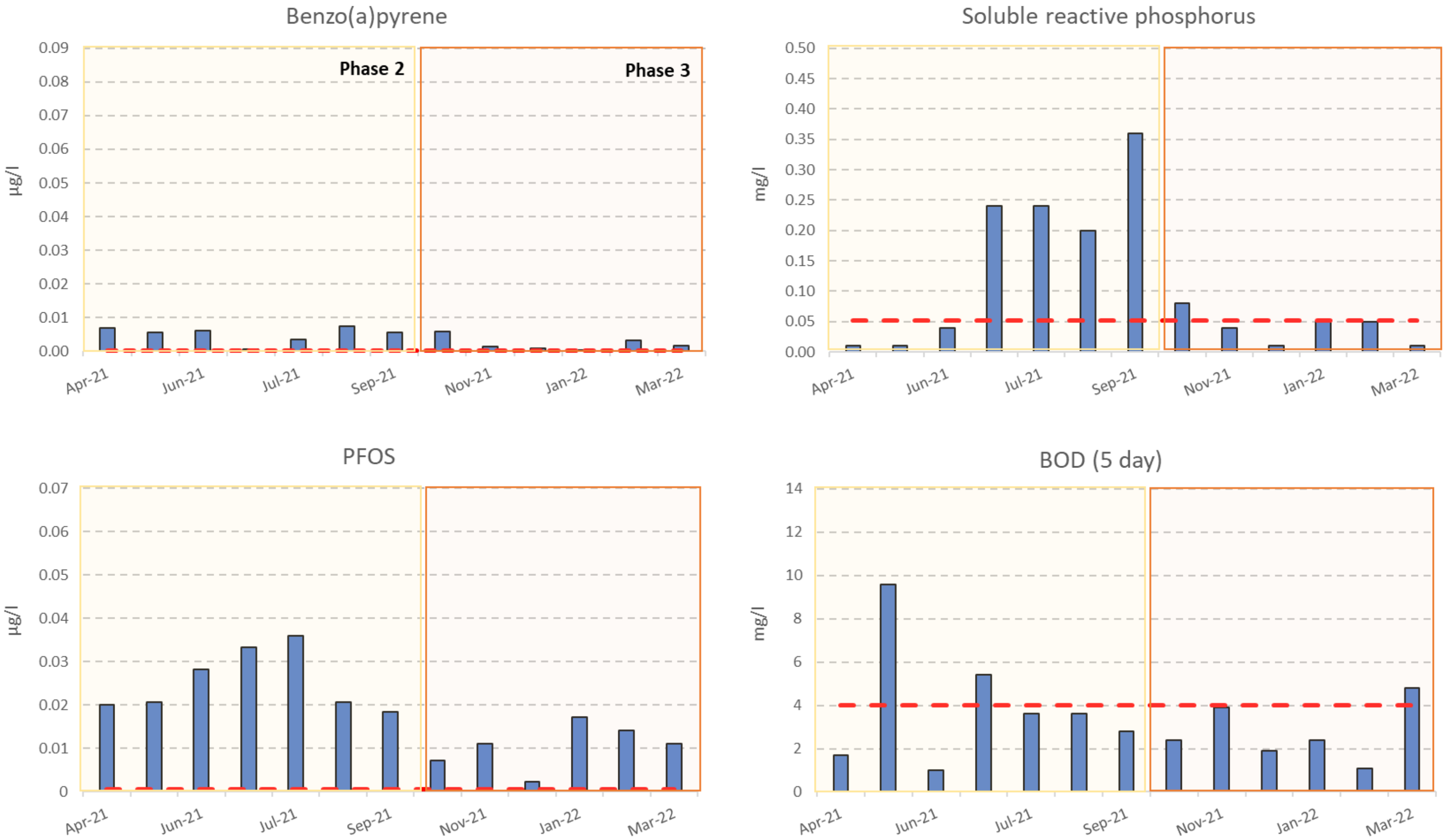

Figure 3-7 - Spatial trends in for key determinands at Site 5 GUC at Welton Lane, Daventry (April 2021 - March 2022)[37].

[37] Red dashed line indicated EQS value (see Table 3-2 for details). Yellow shading indicated Phase 2 data and orange Phase 3 data. Values <LoD have been plotted at the LoD (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.052 mg/l, BOD = 4 mg/l). Note: a different y-axis is used for soluble reactive phosphorus due to the range of values observed at this site.

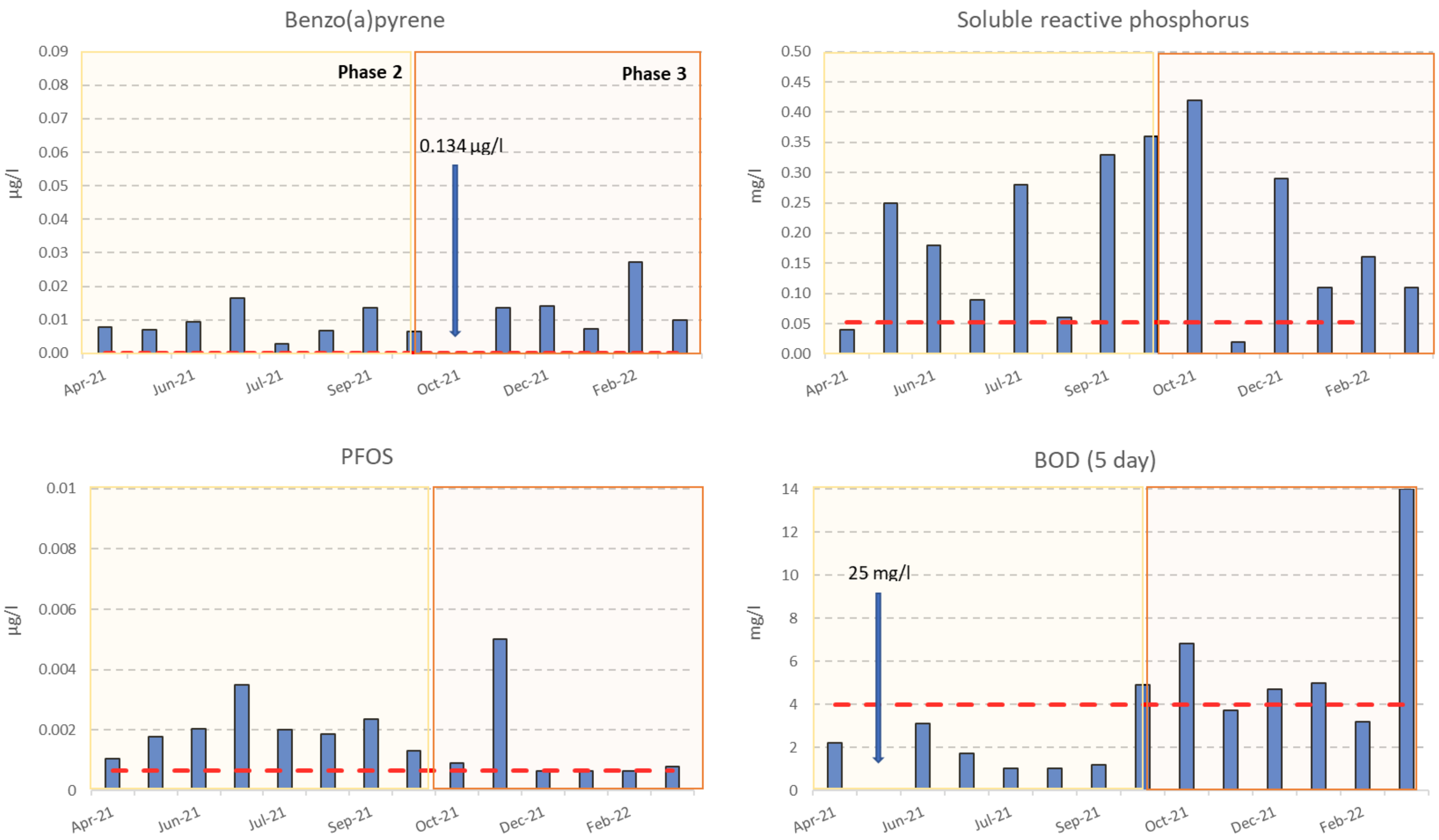

Figure 3-8 - Spatial trends in for key determinands at Site 6 Grove Lock, Leighton Buzzard (April 2021 - March 2022)[38].

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[38] Red dashed line indicated EQS value (see Table 3-2 for details). Yellow shading indicated Phase 2 data and orange Phase 3 data. Values <LoD have been plotted at the LoD (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.065 mg/l, BOD = 4 mg/l). Note: a different y-axis is used for soluble reactive phosphorus and PFOS due to the range of values observed at this site. Concentrations that exceeded the y-axis range are indicated by an arrow with their concentration also given.

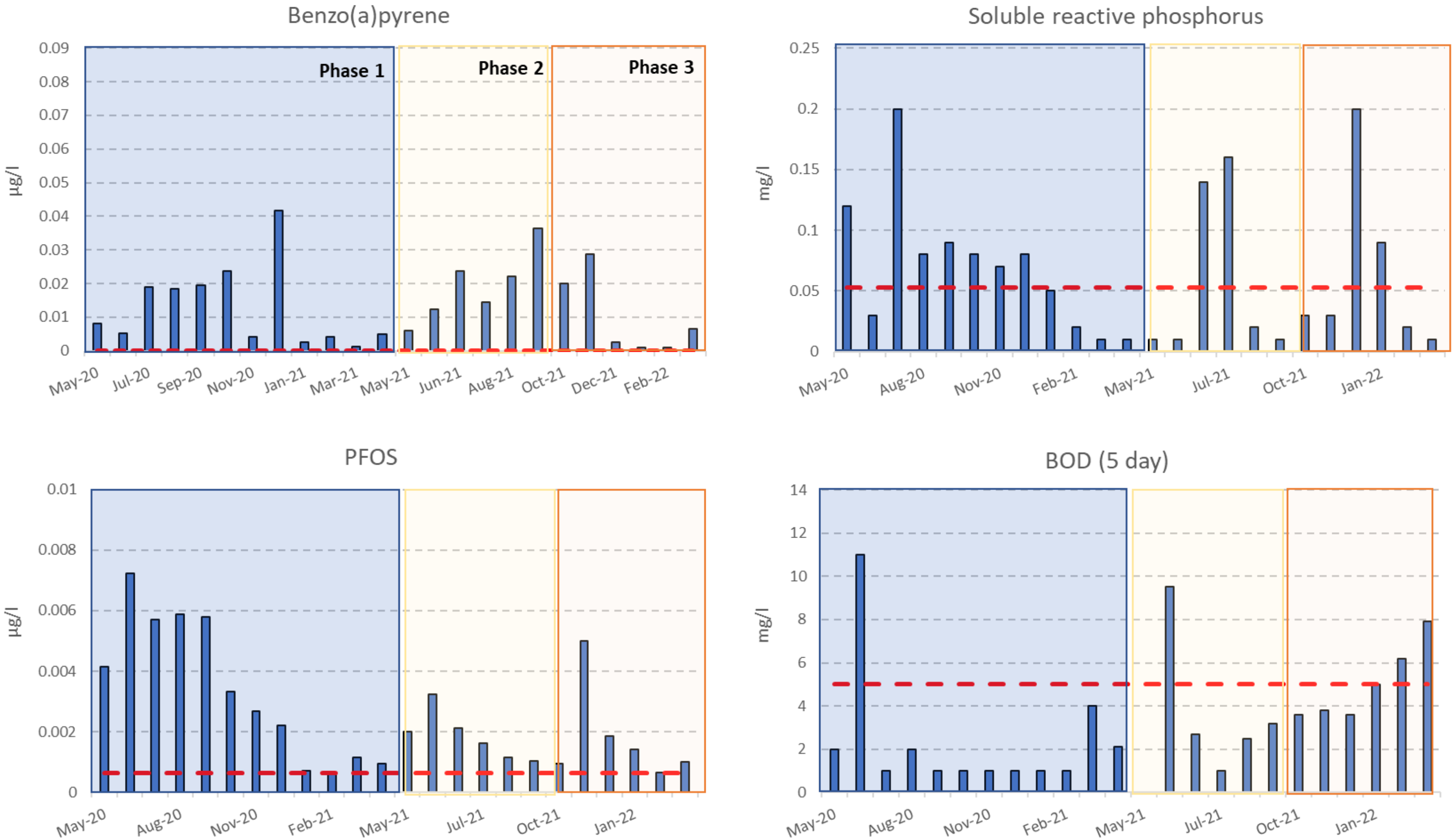


Figure 3-9 – Spatial trends in for key determinands at Site 7 GUC at Beggars Lane, Tring (May 2020 - March 2022)[39].

[39] Red dashed line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.053 mg/l, BOD = 5 mg/l). Blue shading indicates Phase 1 data, yellow Phase 2, and orange Phase 3. Phase 1 analyses were conducted at a different analytical laboratory. Values <LoD have been plotted at the LoD. Note: a different y-axis is used for PFOS due to the range of values observed at this site

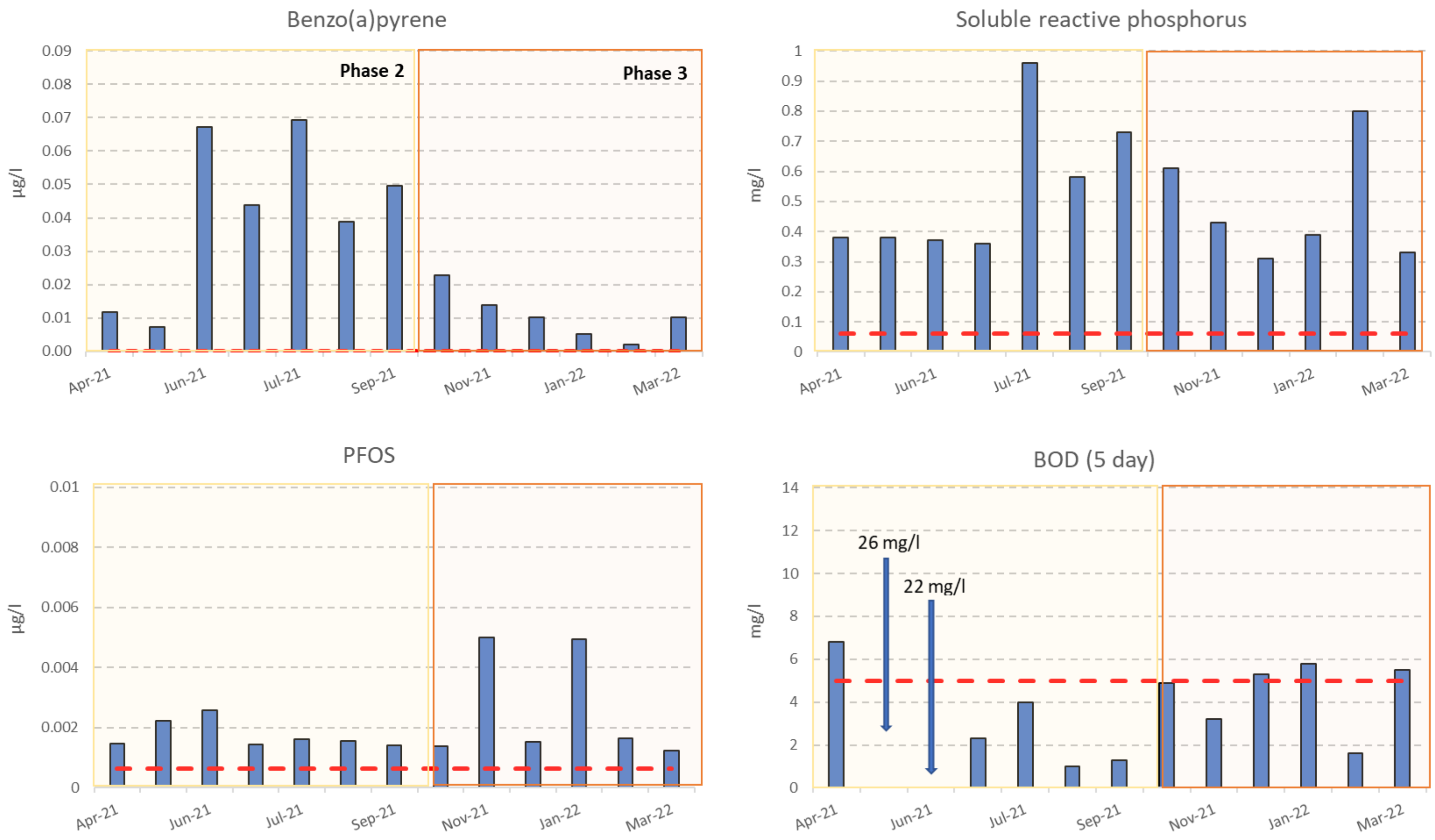


Figure 3-10 – Spatial trends in for key determinands at Site 8 GUC at Little Heath Lane Bridge, Hemel Hempstead (April 2021 - March 2022)[40].

[40] Red dashed line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.053 mg/l, BOD = 5 mg/l). Yellow shading indicated Phase 2 data and orange Phase 3 data. Values <LoD have been plotted at the LoD. Note: a different y-axis is used for soluble reactive phosphorus and PFOS due to the range of values observed at this site. Concentrations that exceeded the y-axis range are indicated by an arrow with their concentration also given.

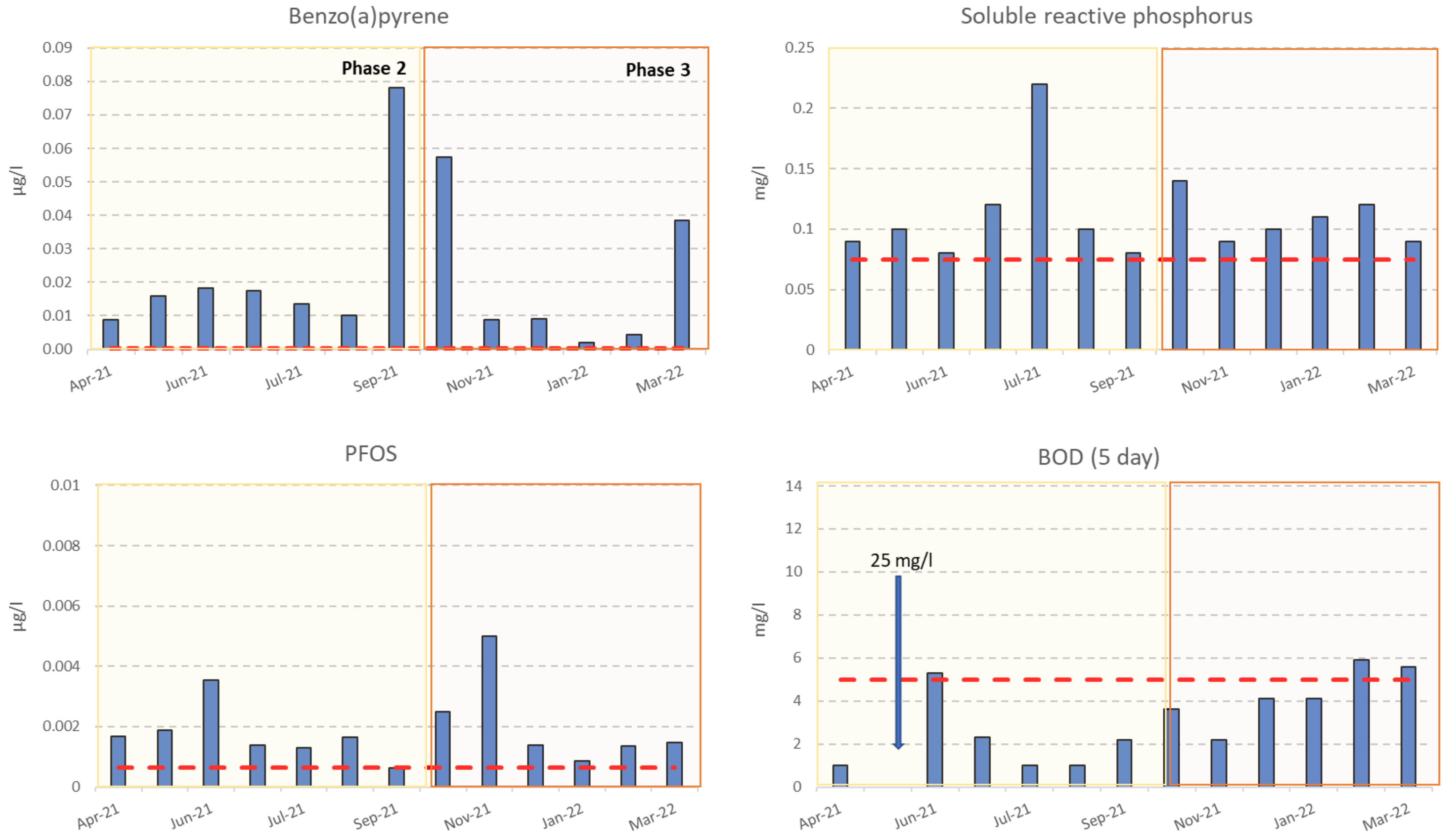


Figure 3-11 – Spatial trends in for key determinands at Site 9 GUC at The Grove, Hunton Bridge (April 2021 - March 2022)[41].

[41] Red line indicated EQS value (benzo(a)pyrene = 0.00017 µg/l, PFOS = 0.00065 µg /l, soluble reactive phosphorus = 0.053 mg/l, BOD = 5 mg/l). Yellow shading indicated Phase 2 data and orange Phase 3 data. Values <LoD have been plotted at the LoD. Concentrations that exceeded the y-axis range are indicated by an arrow with their concentration also given. Note: a different y-axis is used for soluble reactive phosphorus and PFOS due to the range of values observed at this site.

3.3. Continuous Monitoring Data

In the following sections, sonde data are discussed from each continuous monitoring locations in turn comparing relative changes in parameter values with catchment conditions, in order to make inferences regarding nutrient source areas and potential transport pathways There are a range of possible sources for patterns in water quality determinands found at each monitoring location. These could include rainfall causing runoff into the canal or a mixing of stratified water and sediment re-mobilisation, STW final effluent discharges, and illicit boat bump discharges. Typical instream responses to storm events, often responsible for the delivery of pollutant material, include a reduction in conductivity, as instream material is diluted by the receiving rainwater and increases in the flux of suspended solids, inferred using turbidity as a proxy. The inclusion of ammonium sensors within the monitoring suites allows the differentiation of material that is potentially detrimental to aquatic ecosystems. A spike in ammonium concentration for example, may also indicate the mobilisation of not only ammonium, but associated organics that may result in environmental degradation e.g., reducing BOD following instream mineralisation of any organic material present.

3.3.1. Minworth WwTW

Temporal variability in the sensor data collected from Minworth WwTW final effluent can be seen in Figure 3-12 with corresponding descriptive statistics in Table 3-8. Dissolved Oxygen concentrations during the monitoring period were low, ranging between 40.8% and 70.0% (mean = 54.6%) and are indicative of treated final effluent with elevated organic matter concentrations. Diurnal variability in conductivity was also observed. Conductivity represents the ability of water to conduct an electrical charge and is a general indicator of how much ionic material is in the water. This is often elevated in the discharge of treated effluent, and this can be affected by many factors including influent loading and the addition of chemicals during the treatment process.

3.3.2. Site 6 - GUC at Grove Lock, Leighton Buzzard

The sonde at Site 6 (Grove Lock, Leighton Buzzard) was installed on 25/11/21 and as such a shorter record exists for this site, covering predominantly winter months. This is particularly apparent when considering the low mean temperature value observed (5.91°C). Data available, seen in Figure 3-13 show clear catchment repones to both small (a) and large (b) precipitation events, with sharp increases in turbidity as sediment is mobilised from catchment sources. Sudden reductions in conductivity values are also observed in response to dilution and marginal reductions in pH following the flushing of soil horizons. Both temperature and pH values were in line with seasonal expectations. Mean dissolved oxygen was low at ~80%. Colder temperatures during the winter months impact photosynthesis – respiration diurnal dynamics and as a result, diurnal variability in oxygen saturation is expected to be reduced or absent (with periods of maximum diurnal variation usually observed in the spring/ summer months) and as such, this mean percentage is not reflective of this site as a whole. Similarly, differences in the temporal range of data range make direct comparisons of mean determinand values with other abstraction locations problematic. A sonde change on 06/03/2022, evident in Figure 3-13, resulted in a sudden increase in a number of recorded determinands including dissolved oxygen, pH, chlorophyll, and ammonium. This is a common issue when reporting long-term sensor data. Sondes commonly experience "drift", which, (as discussed in section 2.3.1) is why dedicated maintenance site visits are scheduled every four-six weeks to proactively clean and calibrate the sensors and check equipment (see section 2.3.1 for details). When additional cleaning or maintenance is required, sondes are replaced. It should also be noted that while ammonium sensors are good at representing qualitative data i.e., peaks in the data, but not at quantifying absolute values, typically over-estimating concentrations when compared with laboratory derived data. As such ammonium data are considered in conjunction with other parameters such as conductivity or turbidity for interpretation.

3.3.3. Site 7 - GUC at Beggars Lane, Tring

Multiparameter sensor data for Site 7 can be seen in Figure 3-14. Conductivity varied considerably during the period of record (Range = 498 - 792 µS/cm, mean = 614 µS/cm) with storm dilution events observed throughout. Two examples of this (see 'a' and 'b' in Figure 3-14) are evident from the decrease in conductivity due to rainfall dilution coinciding with peak turbidity and ammonium concentrations due to the mobilisation of sediment and nutrients from surrounding catchment sources. Turbidity remains high throughout the period of record with sporadic increases coinciding with periods of heavy rainfall. Diurnal fluctuations are observed in dissolved oxygen saturation and pH as a function of instream photosynthetic processes, reflected in the chlorophyll data.

In addition to observed diurnal variability, chlorophyll concentrations experienced a number of considerable increases, suggesting periods of extensive algal growth. Between 26/08/21 and 01/10/21, chlorophyll concentrations increased preceded by an increase in conductivity, suggesting elevated background nutrient concentrations. This algal growth was exacerbated by a temporary increase in river temperature, leading to significantly elevated chlorophyll concentrations peaking at 431 µg/l (09/09/21 17:01). Photosynthetic processes also resulted in oxygen supersaturation (>200% saturation). During any given year, in addition to the autumn algal bloom (observed in this data set), a preceding spring bloom would also be expected as greater light becomes available and thermal stratification starts to occur inhibiting vertical mixing, resulting in a high light high nutrient environment. As the sensors were installed in May 2021, this initial bloom was missed, however, algal cell counts returned from laboratory analysis of spot samples confirm an increase in algal cells peaking around mid-May, prior to sensor installation. No clear 2022 spring bloom was observed in the 2022 data set for Site 7, or any of the other sonde monitoring locations. Chlorophyll concentrations in the latter portion of the record (January – March 2022) reduce considerably with only one spike observed on 27/02/22 lasting through to the end of the reporting period. A concurrent increase in oxygen saturation is also observed.

Ammonium concentrations were variable at Site 7 (mean = 0.286 mg/l, range = 0.02 – 0.97 mg/l), peaking occasionally in response to periods of rainfall. However, during periods of elevated chlorophyll, decreases in ammonium concentrations result from algal uptake. As discussed in Section 3.3.2 ammonium sensors are good at representing qualitative data i.e., the peaks in the data, but not at quantifying absolute values, typically over-estimating concentrations when compared with laboratory derived data.

3.3.4. Site 8 – GUC at Little Heath Lane Bridge, Hemel Hempstead

Temperature and pH values demonstrated diurnal variability expected during the period of record. Temperatures remained high through June, July, and August and declined steadily through the winter months, with a minimum of 5.2℃ recorded in late November. Mean conductivity at Site 8 was 724 µS/cm with considerable diurnal variability and is likely a function of the input of nutrient rich water discharged from Berkhamsted STW. This variability masks dilution by storm events that were observed across other monitoring locations with only the most significant storm event dilutions visible. This was likely due to heavy rain falling on already saturated ground, increasing the runoff and the magnitude of instream dilution.

Three periods of increased chlorophyll concentrations were observed between 28/08/21 and 01/10/2021, 05/10/21 and 22/10/21, and 15/11/21 and 29/12/21. Although large variability in concentrations were observed, chlorophyll peaked at 74.1 µg/l, 63.1 µg/l, and 66.3 µg/l during these events, respectively. All occurrences are indicative of algal growth, with increases in dissolved oxygen saturation and diurnal signal amplitude observed as a result of increased photosynthetic activity.

Large increases in diurnal variability were observed in ammonium concentrations. Between 18/05/21 and 26/05/21, ammonium concentrations peaked between 03:00 and 07:00 and regularly exceeded 3 mg N/l, in one instance peaking at >5 mg/l (5.86 mg N/l 25/05/21 02:31). A second period of increased variability was observed between 18/06/21 and 21/06/21 (maximum ammonium concentration observed 9.15 mg/l). While this pattern is likely correct, as previously stated, absolute concentrations are typically over-estimated in sensor data and should be interpreted with caution.

This period of increased variability in ammonium concentrations corresponded with a reduction in dissolved oxygen saturation and no corresponding reduction in conductivity that would be expected if a storm event were driving delivery. These data suggest material being delivered to the water body via flow independent sources. Elevated ammonium concentrations are likely a function of either (a) the delivery of high ammonium concentration waters, or (b) the mineralisation of high concentrations of organic matter. The latter is more likely due to the corresponding decrease in dissolved oxygen saturation as a result of increased microbial metabolism. There was a period of missing data (07/06/21 – 22/06/21) that has been removed owing to the high level of noise in the dataset.

3.3.5. Site 9 - GUC at The Grove, Hunton Bridge

Storm dilution of instream conductivity was pronounced at Site 9, with increases in precipitation accompanied by a reduction in conductivity and increases in turbidity and, in some instances, ammonium concentration (Figure 3-16). This suggests material being delivered from diffuse catchment sources. From mid-December there appears to be a sporadic reversal in this relationship on a number of occasions with sharp increases in conductivity coinciding with considerable increases in ammonium. These data suggest a shift in localised land management activities, with rainfall flushing resulting in an instream enrichment of conductivity rather than dilution. Coincident spikes in turbidity for all of these events suggest this remained a diffuse source.

Dissolved oxygen saturation remained more stable in the latter half of the record (January-March) with diurnal variability observed as a result of instream photosynthetic processes. Diurnal variability in pH was also observed with sporadic reductions coinciding with storm events, which would flush soil horizons and deliver mildly acidic material to the channel. As with Site 8, notable increases in chlorophyll concentrations were observed on two occasions towards the middle of the recording period. The first increase occurred between 28/08/21 and 01/10/2021 with chlorophyll concentrations peaking at 71.2 µg/l. The second peak was smaller in magnitude, occurring between 05/10/21 and 22/10/21 with chlorophyll concentrations peaking at 29 µg/l. As stated in preceding sections, these occurrences are indicative of algal growth, with increases in dissolved oxygen saturation and diurnal signal amplitude a result of increased photosynthetic activity. A portion of pH data were removed from the record from 20/01/22 onwards due to an issue that resulted in the reporting of artificially high values. The cause of this is currently under investigation, the results of which will be presented in the next quarterly report.

Table 3-8 - Mean sensor data, presented to 3 significant figures.

Determinand	Unit	1. Minworth WwTW Final Effluent	6. GUC at Grove Lock, Leighton Buzzard*	7. GUC at Beggars Lane, Tring	8. GUC at Little Heath Lane Bridge, Hemel Hempstead	9. GUC at The Grove, Hunton Bridge
Temperature	°C	16.1	5.91	11.7	12.6	12.2
Conductivity	µS/cm	802	724	614	724	627
Dissolved Oxygen	%	54.6	80.4	96.2	65.2	93.5
pH	pH units	-	7.82	7.60	7.47	7.88
Ammonium	mg N/l	-	0.419	0.286	0.709	0.309
Turbidity	NTU	-	23.3	9.53	4.19	5.54
Chlorophyll	µg/l	-	7.23	47.9	13.9	7.93

** GUC Site 6 (Grove Lock, Leighton Buzzard) has a shorter period of record as the sonde was deployed 25/11/2021.*

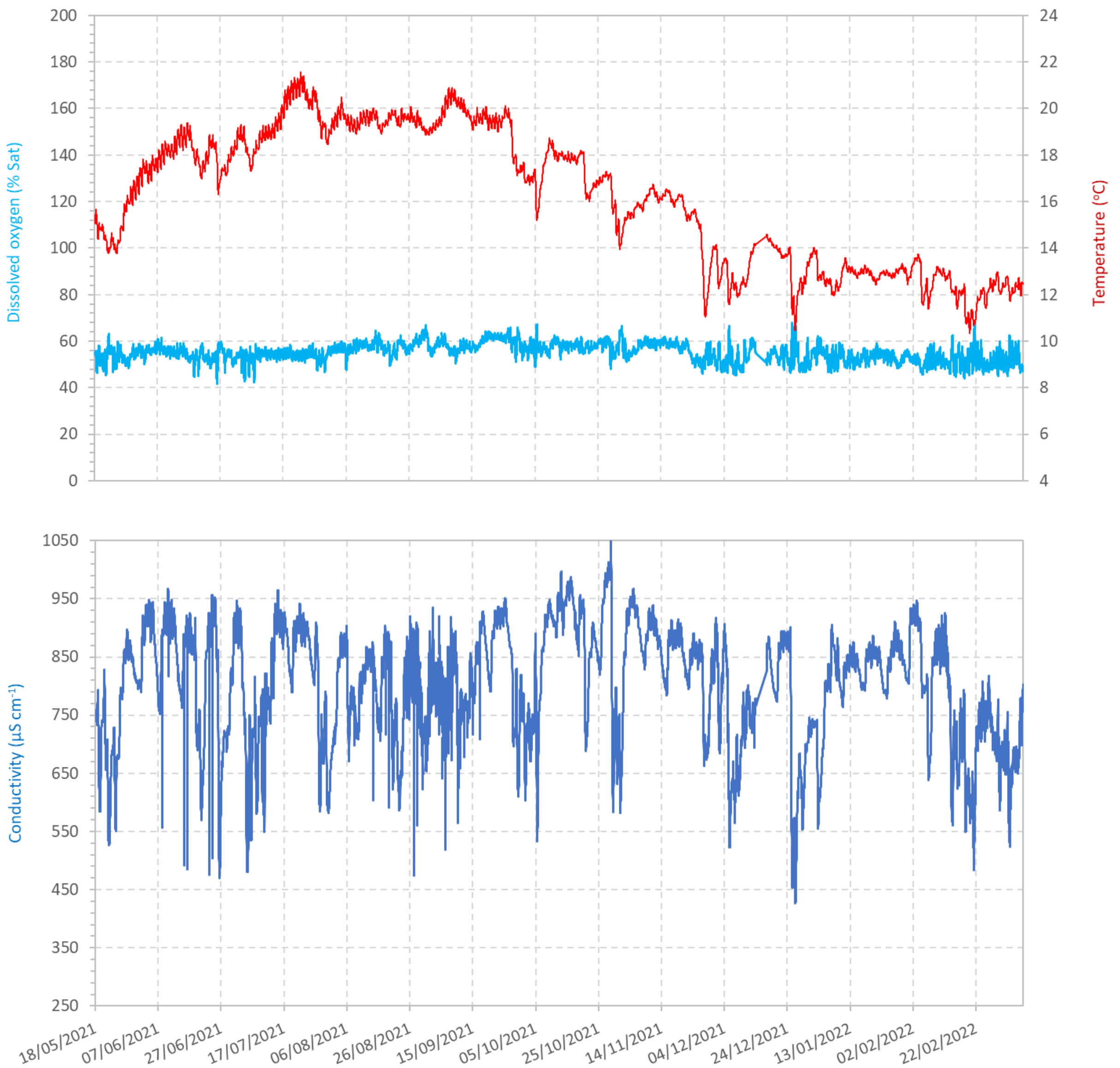


Figure 3-12 - Sensor data at Site 1, Minworth WwTW Final Effluent (May 2021 - March 2022).

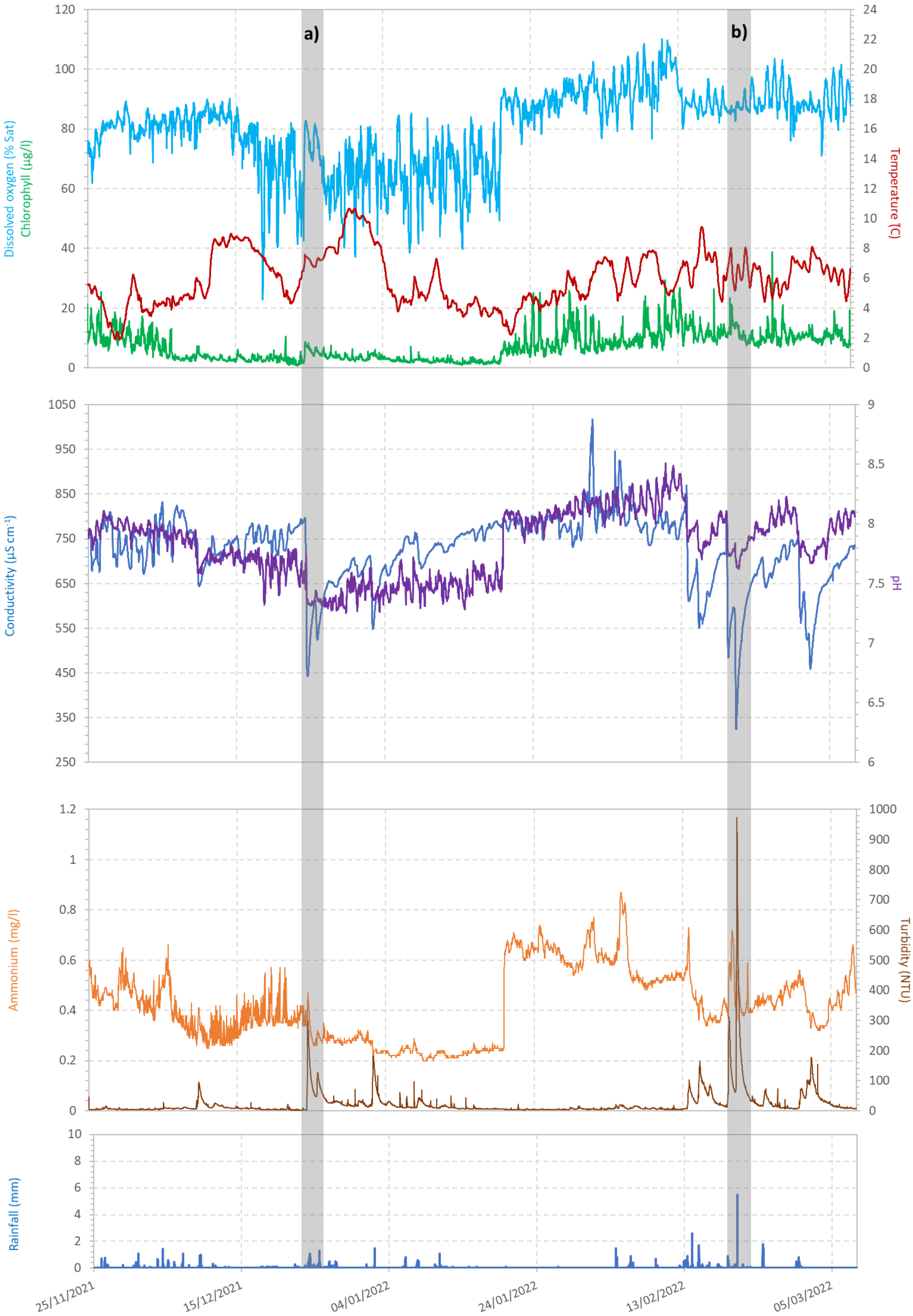


Figure 3-13 - Instream sensor data at Site 6, GUC at Grove Lock, Leighton Buzzard (November-December 2021)[42].

[42] Letters a and b indicate example storm event response. Rainfall data source: Environment Agency (Station number: 261602TP). Rainfall data source: Environment Agency (Station number: 261602TP).

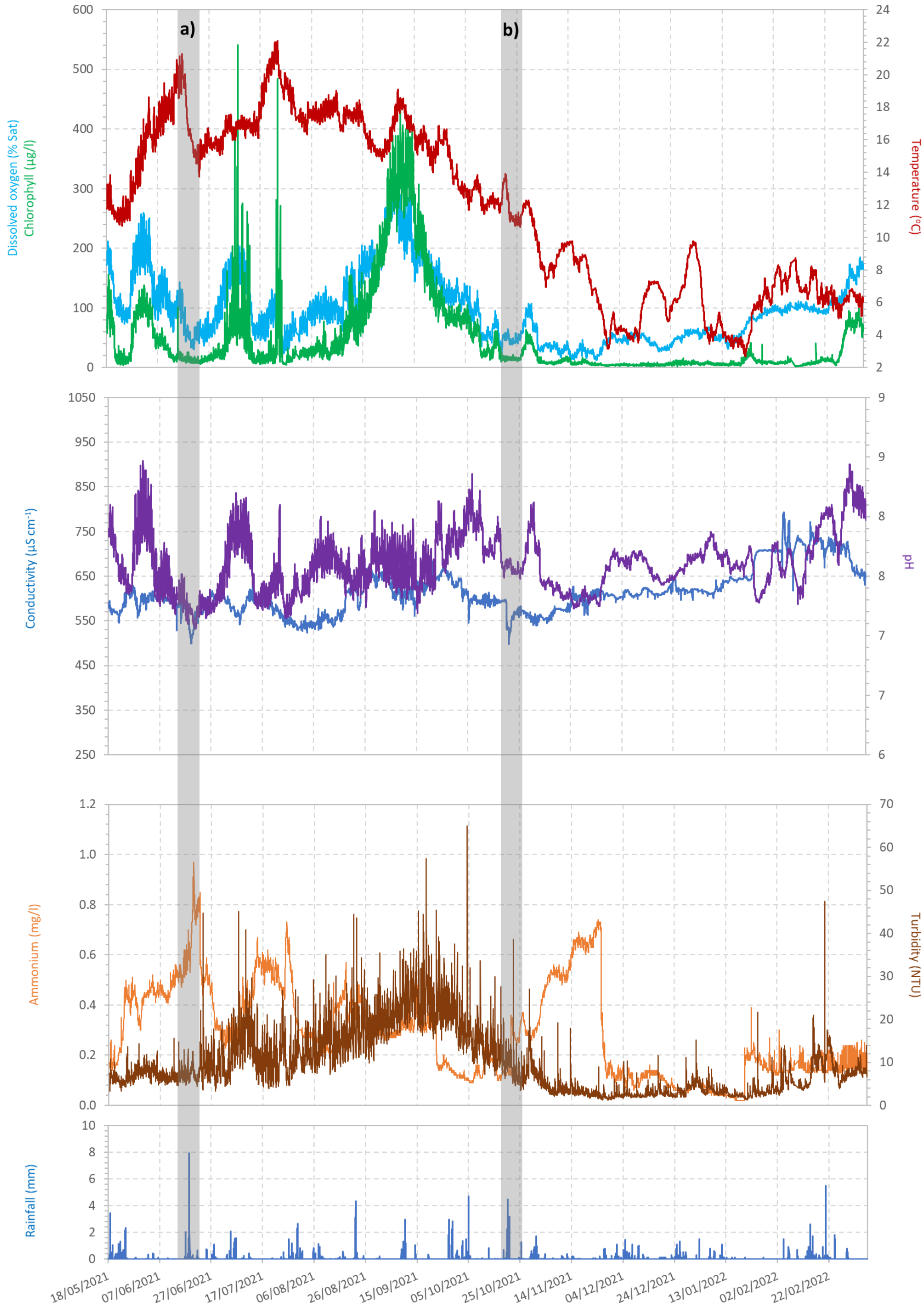


Figure 3-14 - Instream sensor data at Site 7, GUC at Beggars Lane, Tring (May 2021 - March 2022)[43].

[43] Letters a and b indicate example storm event response. Rainfall data source: Environment Agency (Station number: 261602TP).

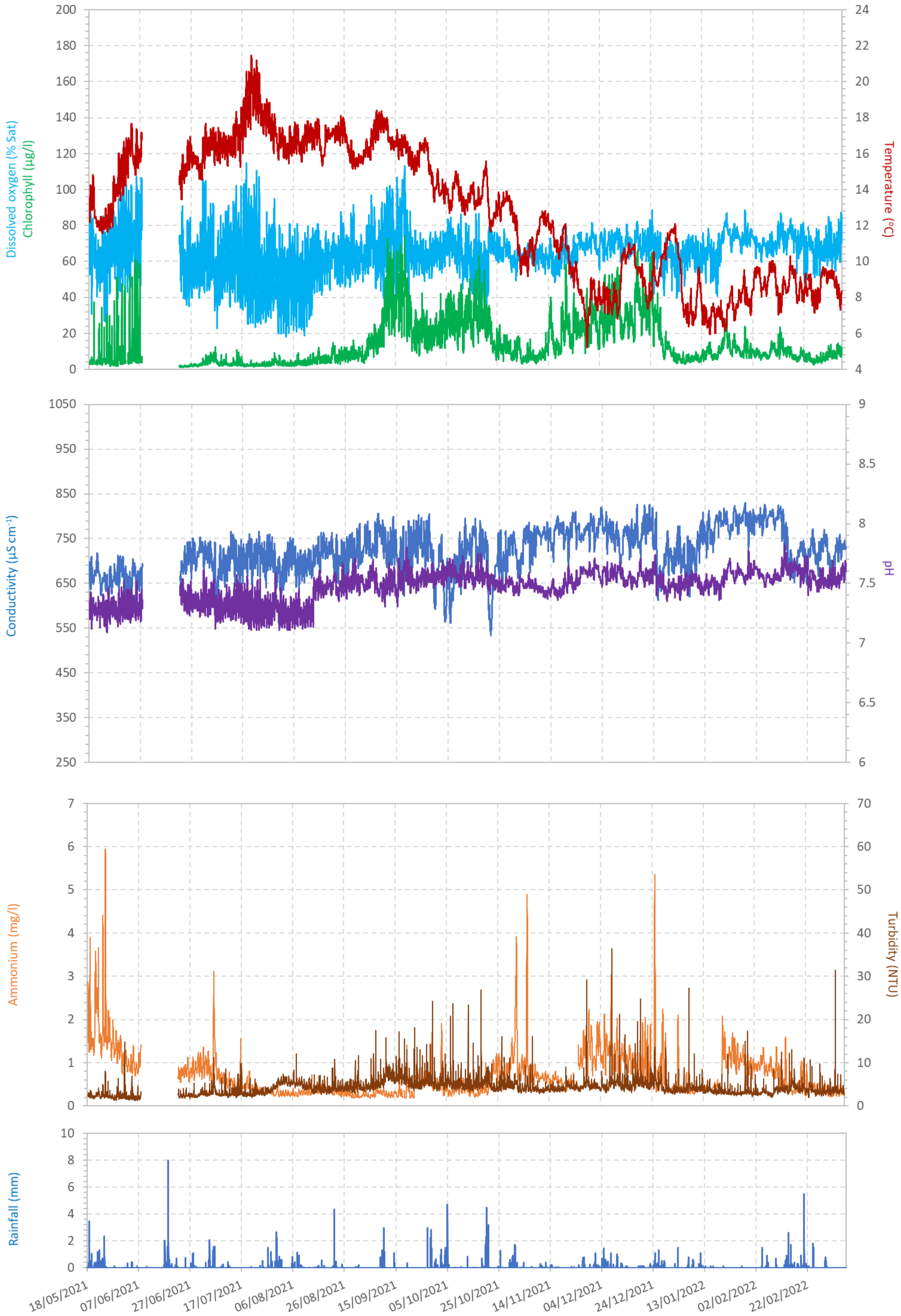


Figure 3-15 - Instream sensor data at Site 8, GUC at Little Heath Lane Bridge, Hemel Hempstead (May 2021 - March 2022)[44].

[44] Rainfall data source: Environment Agency (Station number: 261602TP).

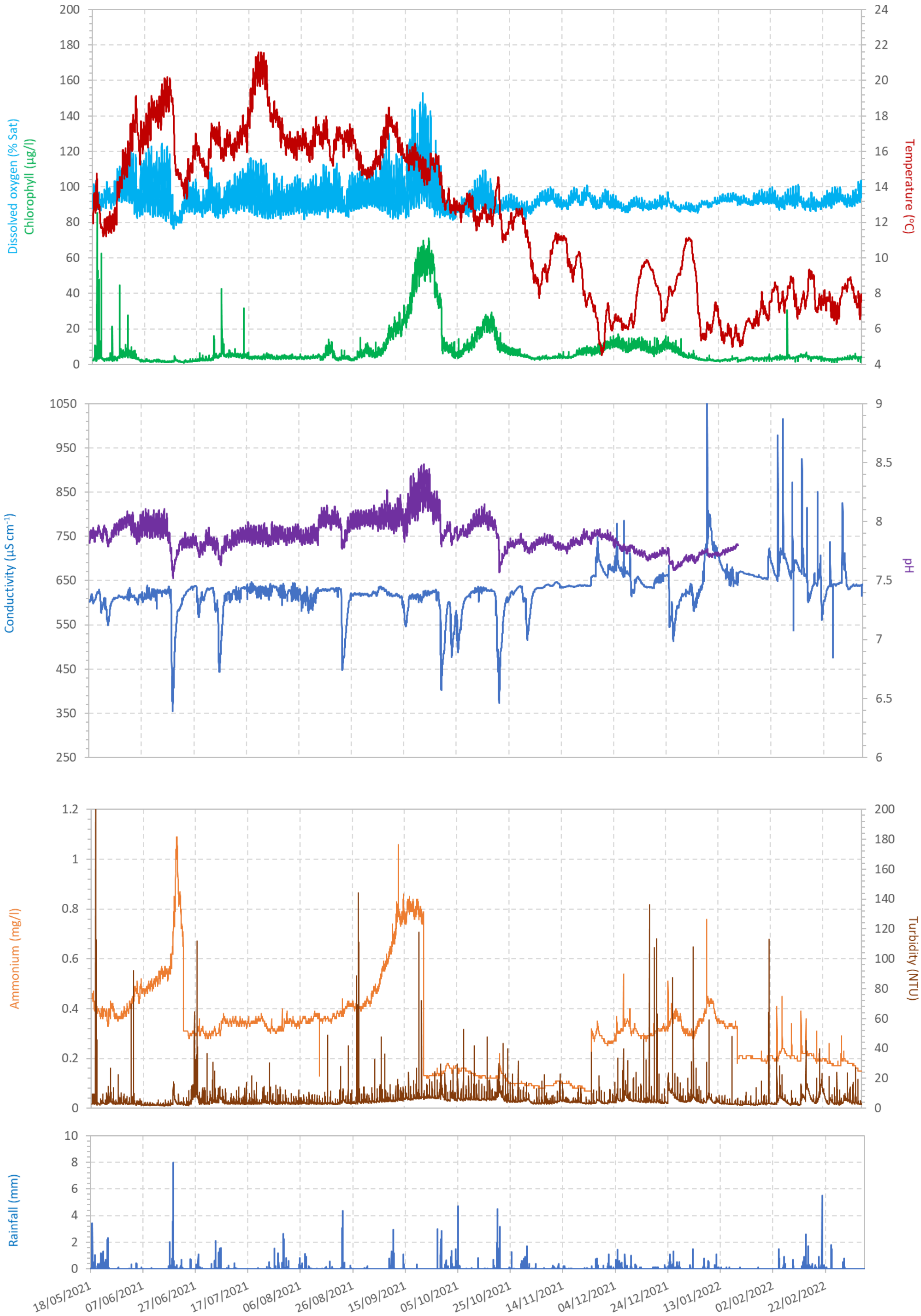


Figure 3-16 - Instream sensor at Site 9, GUC at The Grove, Hunton Bridge (May 2021 - March 2022)[45].

[45] Rainfall data source: Environment Agency (Station number: 261602TP).

4. Conclusions

At present, the following compounds demonstrated the greatest number of WFD EQS exceedances on an individual sample basis:

- Benzo(a)pyrene (9 sites, a total of 163 individual occurrences)
- PFOS (9 sites, a total of 156 individual occurrences)
- Acid neutralisation capacity (9 sites, a total of 118 individual occurrences)
- Fluoranthene (6 sites, a total of 116 individual occurrences)
- Soluble reactive phosphorus (8 sites, a total of 91 individual occurrences)
- BOD - 5-day (9 sites, a total of 46 individual occurrences)

In addition, the following determinands exceeded WFD / EQSD MAC values:

- Bromine (total residual oxidant, total individual exceedances across all sites = 45)
- Benzo(g,h,i)perylene (total individual exceedances across all sites = 33)
- Sulphide or hydrogen sulphide (total individual exceedances across all sites = 102)
- Benzo(a)pyrene (total individual exceedances across all sites = 25)
- Benzo(b)fluoranthene (total individual exceedances across all sites = 13)
- Benzo(k)fluoranthene total individual exceedances across all sites = 10)
- Nickel - dissolved (total individual exceedances across all sites = 13)
- Cypermethrin (total individual exceedances across all sites = 2)
- Tributyltin compounds (as tributyltin cation, total individual exceedances across all sites = 1)

A number of EQS exceedances were observed at Minworth WwTW discharges, that were not seen at instream potential discharge locations, these include chlorothalonil (an organic fungicide) and cypermethrin (a synthetic pyrethroid). As a result, if Minworth WwTW discharge were diverted into any of the proposed sub discharge routes without additional treatment applied, additional instream exceedances may occur, resulting in a future WFD compliance risk as the new discharge would prevent the water quality of the receiving body from achieving Good Status. In addition, bioavailable zinc was elevated in Minworth final effluent when compared with Site 3 and 4. The current mean bioavailable zinc concentration at Site 3 was 10.0 µg/l against a site specific EQS of 13.9 µg/l. The addition of the discharge of final effluent from Minworth may take concentrations at Site 3 closer to its EQS. Further assessment is required to determine the level of confidence if this is indeed the case e.g., through modelling or pairwise assessment of samples once a full year of data is collected. Treatment or other removal at works will be required in order to provide a resolution to this issue.

Minworth WwTW treatment engineers should be engaged as part of that process to understand the feasibility of designing treatment for any of these ‘high risk’ compounds. Equally, further work is needed to understand if there are any WFD compliant substances which have a permittability risk (e.g., due to within class deterioration).

As discussed in Section 3.2, PCVs apply only to treated drinking water, and not raw source waters. With that in mind, the following determinands are currently routinely exceeding PCV targets, where applicable:

- Coliform total (total exceedances across all sites = 58)
- *C. perfringens* veg & spores, confirmed (total exceedances across all sites = 58)
- *E.coli* (total exceedances across all sites = 58)
- Turbidity (total exceedances all sites = 53)
- Nitrite (total exceedances all sites = 43)
- Iron – total (total exceedances all sites = 31)

C. perfringens exceeded at all sites as it is widely distributed across the environment and as such, is regularly evaluated to monitor the microbiological safety of drinking water supplies. Sources of bacterial contamination can range from the input of animal manures from farmyard runoff to discharge from untreated or treated sewage effluent. *Cryptosporidium* was not detected at any site, however, given that *Cryptosporidium* events can be extremely short-lived *Cryptosporidium* monitoring should be continued going forward. Elevated turbidity values may be caused by storm event mobilisation of catchment sediment stores or localised disturbance events.

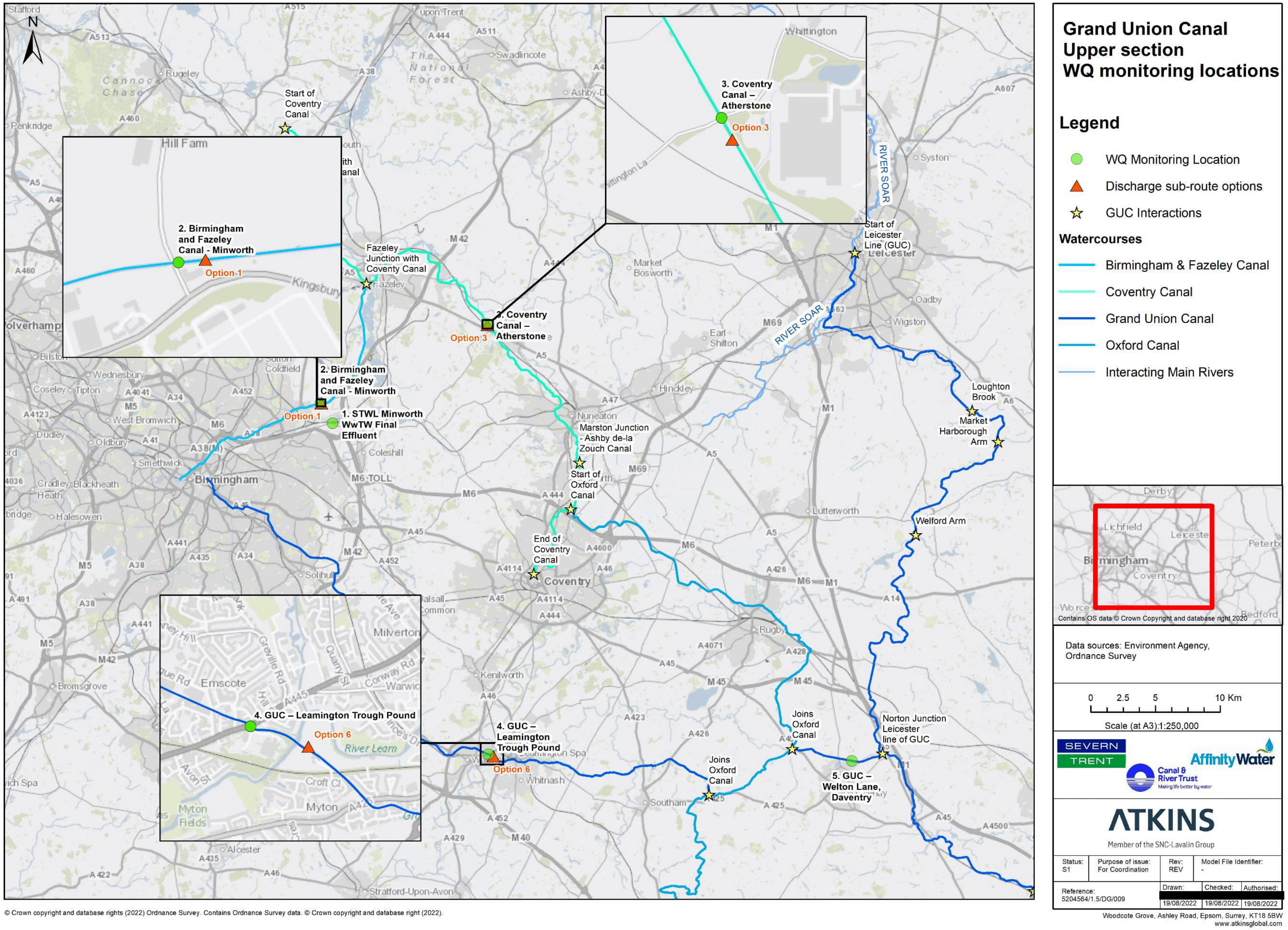
A sample collected at Site 6 (Grove Lock, Leighton Buzzard) on 20/10/2021 captured a period of heavy rainfall resulting in a number of additional exceedances not observed during lower flow conditions. These additional exceedances included PAHs, aluminium (dissolved), and iron (dissolved). However, of particular interest were the presence of tebuconazole, an agricultural triazole fungicide used to treat plant pathogenic fungi, and metribuzin, a synthetic herbicide applied both pre- and post-emergence of vegetable crops suggesting an agricultural origin. The heavily modified, and agricultural Ledburn brook, located approximately <20m south (upstream) of the monitoring location may be the source of these additional exceedances. Wet weather sampling observed a number of additional PCV exceedances common across abstraction locations including nitrate, ammonium. It is recommended that AfW update their Drinking Water Safety Plan (DWSP) and complete a review of planned mitigation to factor in these additional determinands. A second sample collected under rainfall conditions at the same location on 11/01/22 did not show a similar pattern, owing to abnormally dry antecedent conditions.

We will continue to report on compounds that breach both EQS and PCV targets as requested by the regulatory bodies. As the monitoring programme now has 12-months of sample data, a list of compounds that consistently fall below LoDs can be found in Appendix G. A subsequent analysis of compounds that can be considered for removal from the analysis suites (following discussions with the relevant regulatory bodies) can be found in Appendix H.

All sensor data appear to be reporting within ranges typical of freshwater environments. A large autumn algal bloom was observed between 26/08/21 and 01/10/21 at all sites which would pose a risk to water abstraction, with the highest chlorophyll concentrations observed at Site 7. Elevated chlorophyll at Site 7 could be a function of sensor position, being in an area of marginally reduced flow that facilitated algal colonisation. The expected preceding spring bloom was just missed in the sensor record at all sites (sensor record start date = 18/05/21). However, analysis of laboratory algal counts confirmed high algal abundance just prior to the installation of the sondes, with only the falling limb of this bloom captured. Monitoring currently underway from April 2022 onwards should capture initial spring blooms, the timing of which will have important implications for abstraction management and storage requirements. Algae blooms could have an impact on water storage as well as within the canal itself, and given this, mitigation for algae blooms should be considered in any treatment designs. The mitigation of the risks will be considered and presented as part of the Gate 3 reporting when more data has been collected and analysed. However, it is important to note that these compounds are seen ubiquitously in the canal, and it is not the responsibility of the GUC scheme to be mitigating or removing them. Further water quality modelling through Gate 3 will show how concentrations through the canal system may be affected by the scheme, and if this is shown to cause issues or deterioration in the canal itself, then the scheme will look to mitigate against these.

Appendices

Appendix A. Monitoring site location maps



Author names redacted

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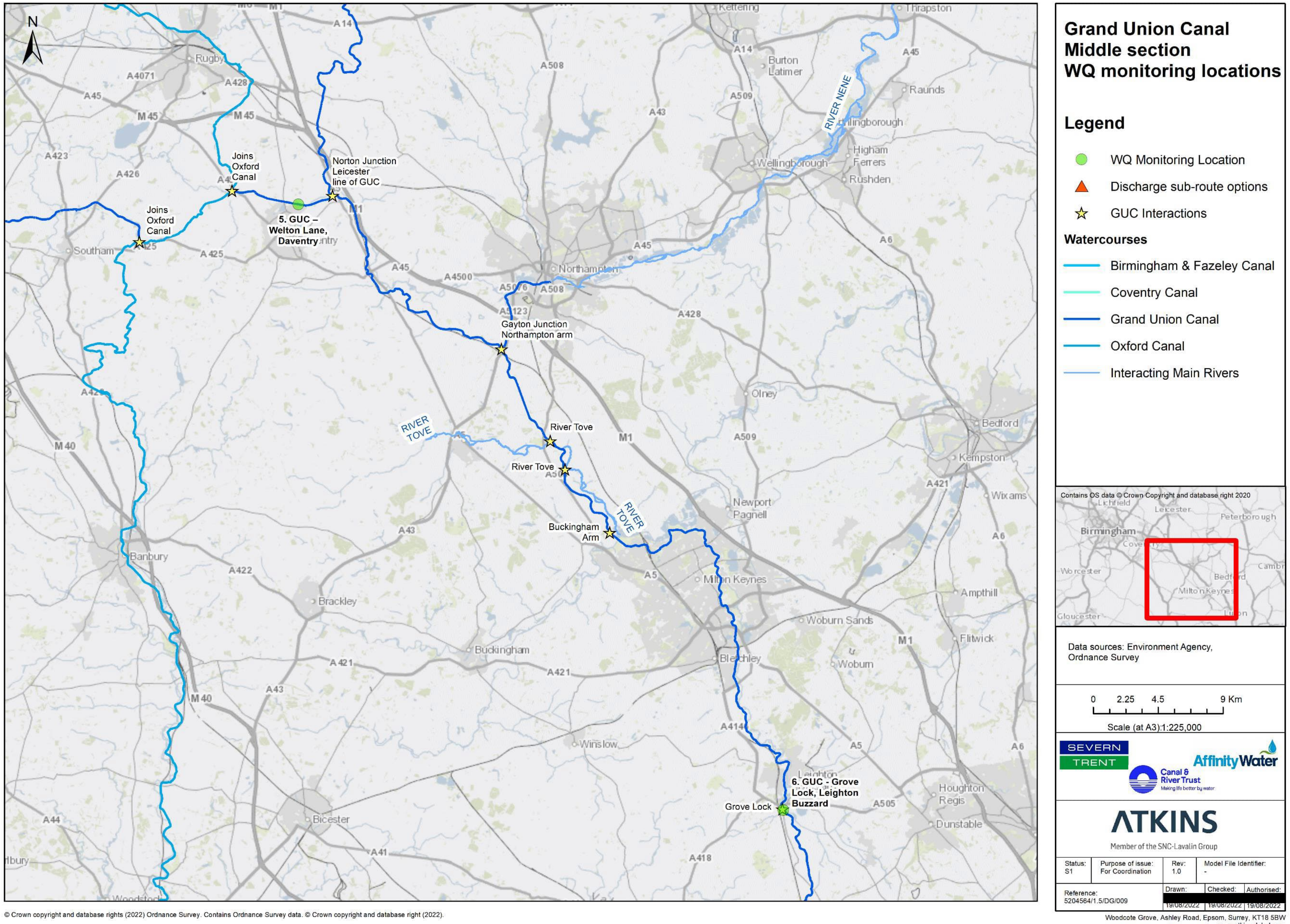
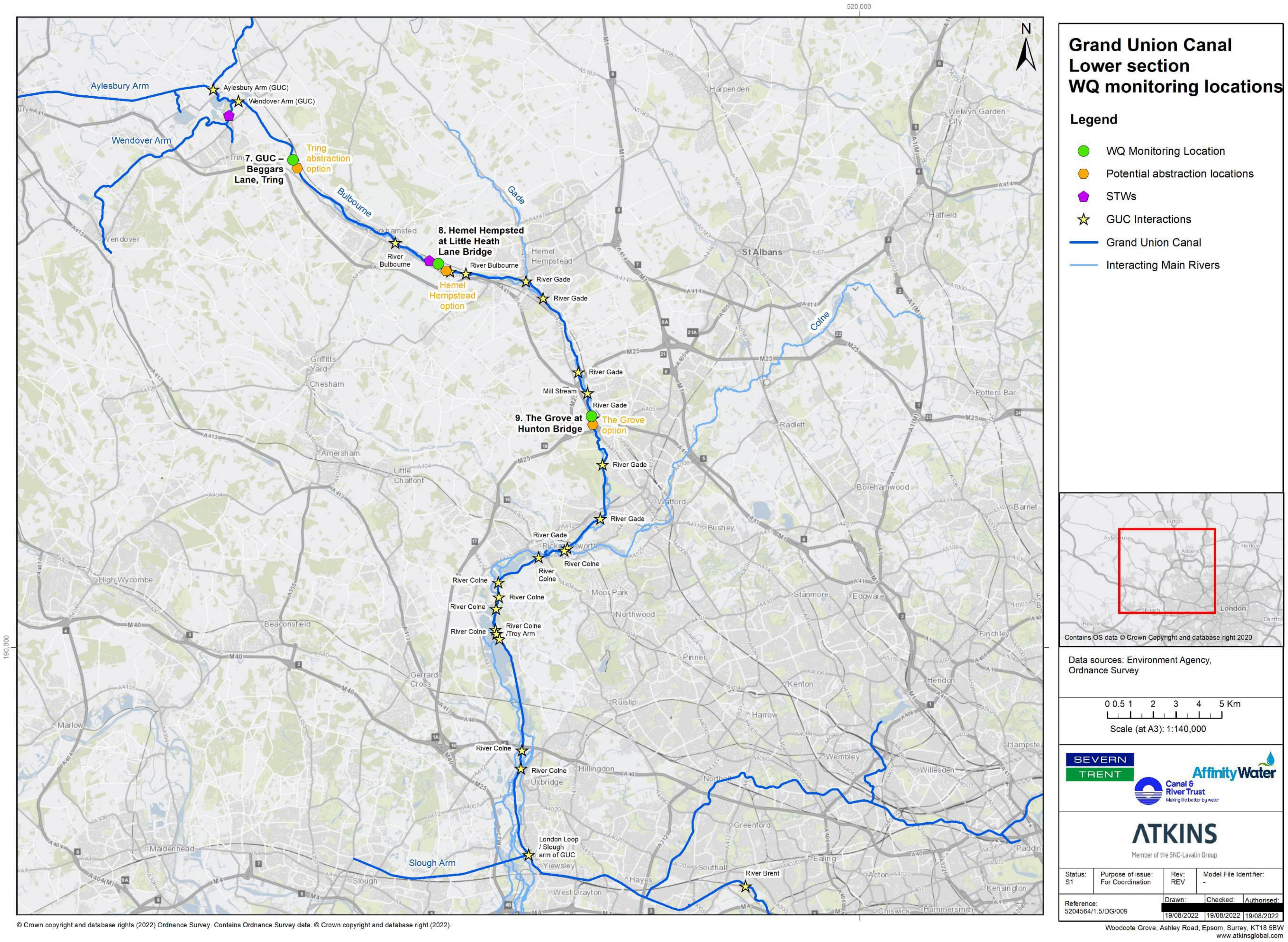
Figure A-1 - GUC Upper section water quality monitoring Sites 1-4



Woodcote Grove, Ashley Road, Epsom, Surrey, KT18 5BW
www.atkinsglobal.com

Author names redacted

Figure A-2 - GUC Middle Section water Quality Monitoring Sites 5-6



Author names redacted

Figure A-3 - GUC Lower Section water Quality Monitoring Sites 7-9

Appendix B. WFD analysis suite

Group	Parameter	Unit	Annual average EQS	90th percentile	95th percentile	MAC	LoD
General parameters	Dissolved oxygen*	mg/l	***	-	-	-	-
	Temperature**	°C	28	-	-	-	-
	pH	pH	***	-	-	-	0.1 pH unit
	BOD 5	mg/l	-	***	-	-	1
	Chemical oxygen demand	mg/l	-	-	-	-	5
	Reactive phosphorus	mg/l	***	-	-	-	0.01
	Total phosphorus	mg/l	-	-	-	-	0.01
	Salinity (at 20°C)	µS/cm	-	-	-	-	1
	Conductivity (at 20°C)	µS/cm	-	-	-	-	-
	Ammoniacal Nitrogen (as N)	mg/l	***	-	-	-	0.015
	Ammonia (as N)	mg/l	-	-	-	-	0.1
	Nitrate (as NO_3)	mg/l	-	-	-	-	0.1
	Nitrate (as N)	mg/l	-	-	-	-	calc
	Nitrite (as NO_2)	mg/l	-	-	-	-	0.1
	Nitrite (as N)	mg/l	-	-	-	-	calc
	Total nitrogen (oxidised as N)	mg/l	-	-	-	-	5
	Keldhal nitrogen	mg/l	-	-	-	-	0.2
	Organic nitrogen	mg/l	-	-	-	-	calc
	Sulphide or hydrogen sulphide	µg/l	0.25	-	-	1	10
	Alkalinity (as $CaCO_3$)	mg/l	-	-	-	-	5
	Acid Neutralisation Capacity (ANC) (unfiltered)	mg/l	40	-	-	-	5
	Hardness as ($CaCO_3$)	mg/l	-	-	-	-	0.1
	Dissolved organic carbon	mg/l	-	-	-	-	0.5
	Total organic carbon	mg/l	-	-	-	-	0.5
	Solids, Suspended (at 105°C)	mg/l	-	-	-	-	2
	Chlorophyll	µg/l	-	-	-	-	20
	Phaeophytin	µg/l	-	-	-	-	20
Metals	Antimony - total	µg/l	-	-	-	-	0.17
	Antimony - dissolved	µg/l	-	-	-	-	0.17
	Aluminium - total	µg/l	-	-	-	-	10
	Aluminium - dissolved	µg/l	-	-	-	-	10
	Aluminium - reactive	µg/l	-	-	-	-	4
	Arsenic - total	µg/l	50	-	-	-	0.16
	Arsenic - dissolved	µg/l		-	-	-	0.16
	Cadmium - total	µg/l	0.25	-	-	1.5	0.02
	Cadmium - dissolved	µg/l	0.25	-	-	1.5	0.02
	Calcium - total	mg/l	-	-	-	-	0.09
	Copper - total	µg/l	-	-	-	-	0.4
	Copper - bioavailable	µg/l	1	-	-	-	0.4

Group	Parameter	Unit	Annual average EQS	90th percentile	95th percentile	MAC	LoD
	Chromium - total	µg/l	-	-	-	-	0.25
	Chromium - dissolved	ug/l	-	-	-	-	0.25
	Iron - total	µg/l	1,000	-	-	-	5.5
	Iron - dissolved	µg/l	1,000	-	-	-	5.5
	Lead - total	µg/l	1.2	-	-	-	0.09
	Lead - dissolved+	µg/l	1.2	-	-	14	0.09
	Mercury - total	µg/l	0.07	-	-	0.07	0.001
	Mercury - dissolved	µg/l	0.07	-	-	0.07	0.001
	Nickel - total	µg/l	4	-	-	-	0.5
	Nickel - dissolved+	µg/l	4	-	-	34	0.5
	Zinc - total	µg/l	-	-	-	-	0.5
	Zinc - dissolved+	µg/l	***	-	-	-	0.5
PAH Suite	Fluoranthene	µg/l	0.0063	-	-	0.12	0.0009
	Benzo(a)pyrene	µg/l	0.00017	-	-	0.027	0.00017
Phthalates	Di(2-ethylhexyl)-phthalate (DEHP)	µg/l	1.3	-	-	-	0.15
Other WFD parameters	Brominated diphenylethers Total (sum of BDE penta congeners 28,47,99,100,153,154)	µg/l	-	-	-	0.14	0.0005
	BDE-28	µg/l	-	-	-	-	0.0001
	BDE-47	µg/l	-	-	-	-	0.0001
	BDE-99	µg/l	-	-	-	-	0.0001
	BDE-100	µg/l	-	-	-	-	0.0001
	BDE-153	µg/l	-	-	-	-	0.0001
	BDE-154	µg/l	-	-	-	-	0.0001
	Triclosan	µg/l	0.1	0.28	-	-	0.01
	Nonylphenols. (4-Nonylphenol Technical Mix)	µg/l	0.3	-	-	2	0.04
	4-n-Nonylphenol	µg/l	0.3	-	-	2	0.04
	Nonylphenol ethoxylates (sum)	µg/l	-	-	-	-	0.12
	Nonylphenol monoethoxylate NPEO1	µg/l	-	-	-	-	0.04
	Nonylphenol diethoxylate NPEO2	µg/l	-	-	-	-	0.04
	Nonylphenol triethoxylate NPEO3	µg/l	-	-	-	-	0.04
	Octylphenols ((4-(1,1′, 3,3′-tetramethylbutyl)-phenol))	µg/l	0.1	-	-	-	0.01
	Octylphenol ethoxylates (Sum OPEO 1-3)	µg/l	-	-	-	-	0.06
	Octylphenol monoethoxylate (OPEO1)	µg/l	-	-	-	-	0.02
	Octylphenol diethoxylate (OPEO2)	µg/l	-	-	-	-	0.02
	Octylphenol triethoxylate (OPEO3)	µg/l	-	-	-	-	0.02
	Tributyltin compounds (as Tributyltin cation)	µg/l	0.0002	-	-	0.0015	0.00002
	Perfluorooctane sulfonic acid PFOS	µg/l	0.00065	-	-	36	0.00065
	Perfluorooctanoic acid (PFOA)	µg/l	-	-	-	-	0.00065

Group	Parameter	Unit	Annual average EQS	90th percentile	95th percentile	MAC	LoD
	HexabromocycLoDodecane (HBCDD) Total	µg/l	-	-	-	-	0.00014
	alpha - HexabromocycLoDodecane (α-HBCDD)	µg/l	-	-	-	-	0.00004
	beta - HexabromocycLoDodecane (β-HBCDD)	µg/l	-	-	-	-	0.00004
	gamma - HexabromocycLoDodecane (γ-HBCDD)	µg/l	-	-	-	-	0.00004
VOCs	Trichloroethylene	µg/l	-	-	-	-	1
THMs	Chloroform	µg/l	2.5	-	-	-	1
	Trichloroethane (1 1 1)	µg/l	100	-	-	-	1
	Trichloroethane (1 1 2)	µg/l	400	-	-	-	1
Insecticides	Cypermethrin	µg/l	0.00008	-	-	0.0006	0.00008

**Dissolved oxygen EQS refers to a 10th percentile.*

***Temperature EQS refers to a 98th percentile.*

****It is noted that some WFD EQS are different for different river types e.g., upland, lowland, salmonid, cyprinid. Each SRO assessment will use different EQS depending on the local context, see Table 3-2 for further detail.*

+EQS refers to bioavailable concentration.

Red numbers indicate where LoD>EQS.

Appendix C. EQSD analysis suite

Parameter	Unit	Annual average EQS	90th percentile	95th percentile	MAC	RL[46]
1,1,1-trichloroethane	µg/l	100	-	-	-	1
1,1,2-trichloroethane	µg/l	400	-	-	-	1
2,4-dichlorophenol	µg/l	4.2	-	-	140	0.02
2,4-dichlorophenoxyacetic acid (2,4-D)	µg/l	0.3	-	1.3	-	0.02
2-chlorophenol	µg/l	50	-	-	-	0.02
3,4-dichloroaniline	µg/l	0.2	-	5.4	-	1
4-chloro-3-methylphenol	µg/l	40	-	-	-	0.02
Abamectin	µg/l	0.01	-	-	0.03	5
Ammonia (un-ionised)	µg/l	-	-	-	-	0.1
Arsenic - dissolved	µg/l	50	-	-	-	0.16
Azinphos-methyl - dissolved	µg/l	0.01	-	-	-	0.01
Bentazone	µg/l	500	-	-	-	0.02
Benzyl butyl phthalate	µg/l	7.5	-	51	-	0.2
Biphenyl	µg/l	25	-	-	-	0.02
Boron - total	µg/l	2,000	-	-	-	12
Bromine - total residual oxidant	mg/l	0.002	-	-	5	1
Bromoxynil	µg/l	100	-	-	1000	0.02
Carbendazim	µg/l	0.15	-	-	0.7	0.1
Chloride	µg/l	250,000	-	-	-	0.1
Chlorine - total residual oxidant	µg/l	2	-	-	5	0.1
Chloronitro toluenes	µg/l	10	-	-	-	0.02
Chlorothalonil	µg/l	0.035	-	-	1.2	0.035
Chlorotoluron	µg/l	2	-	-	20	0.05
Chlorpropham	µg/l	10	-	-	40	0.1
Chromium (III) - dissolved	µg/l	4.7	-	32	-	0.25
Chromium (VI) - dissolved	µg/l	3.4	-	-	-	7
Cobalt - dissolved	µg/l	3	-	-	100	0.16
Copper - dissolved*	µg/l	1	-	-	-	0.4
Coumaphos	µg/l	0.03	-	-	0.1	0.02
Cyanide - total	µg/l	1	-	-	-	40
Cyfluthrin	µg/l	0.001	-	0.001	-	0.1
Cypermethrin	µg/l	0.00008	-	-	0.0006	0.00008
Demetons	µg/l	0.5	-	-	-	0.02
Diazinon (sheep dip)	µg/l	0.01	-	0.02	-	0.01
Dibutyl phthalate	µg/l	8	-	-	40	0.02
Dichlorobenzene - total dichlorobenzene isomers	µg/l	20	-	-	200	0.1
Dichlorvos	µg/l	0.0006	-	-	0.0007	0.01

[46] Instrumental LoD may be lower but Reporting Limit (RL) is set by validation in real matrix based on 11 batches in duplicate and calculated as per MCERTS water definition.

Parameter	Unit	Annual average EQS	90th percentile	95th percentile	MAC	RL[46]
Diethyl phthalate	µg/l	200	-	-	1000	0.02
Diflubenzuron	µg/l	0.001	-	-	0.015	0.001
Dimethoate	µg/l	0.48	-	4	-	0.02
Dimethyl phthalate	µg/l	800	-	-	4000	0.02
Dioctyl phthalate	µg/l	20	-	-	40	0.02
Doramectin	µg/l	0.001	-	-	0.01	5
EDTA	µg/l	400	-	-	4000	100
Fenchlorphos	µg/l	0.03	-	-	0.1	0.02
Fenitrothion	µg/l	0.01	-	-	-	0.01
Flucofuron	µg/l	-	-	1	-	0.05
Fluoride – dissolved <50mg/l $CaCO_3$	µg/l	1000	-	-	-	10
Fluoride - dissolved >50mg/l $CaCO_3$	µg/l	5000	-	-	15,000	10
Formaldehyde	µg/l	5	-	-	50	50
Glyphosate	µg/l	196	-	398	-	0.1
Hydrogen sulphide	µg/l	0.25	-	-	-	10
Ioxynil	µg/l	10	-	-	100	0.02
Iron - dissolved	µg/l	1,000	-	-	-	5.5
Ivermectin	µg/l	0.0001	-	-	0.001	5
Linuron	µg/l	0.5	-	0.9	-	0.01
Malachite green	µg/l	0.5	-	-	100	1
Malathion	µg/l	0.01	-	-	-	0.02
Mancozeb	µg/l	2	-	-	20	0.1
Maneb	µg/l	3	-	-	30	0.1
Manganese - dissolved*	µg/l	123	-	-	-	0.22
MCPA pH <7	µg/l	12	-	-	80	0.02
MCPA pH >7	µg/l	80	-	-	100	0.02
Mecoprop	µg/l	18	-	187	-	0.02
Methiocarb	µg/l	0.01	-	0.77	-	0.1
Mevinphos	µg/l	-	-	-	0.02	0.02
Nitrilotriacetic acid (NTA)	µg/l	1,000	-	-	10,000	100
Omethoate	µg/l	0.01	-	-	-	0.01
PCSDs (polychloro chloromethyl sulphonamido diphenyl ethers)	µg/l	-	-	-	-	0.2
Pendimethalin	µg/l	0.3	-	0.58	-	0.02
Permethrin	µg/l	0.01	-	0.01	-	0.001
pH	pH units	6 to 9	-	-	-	0.01
Phenol	µg/l	7.7	-	46	-	1
Pirimicarb	µg/l	1	-	-	5	0.1
Pirimiphos-methyl	µg/l	0.015	-	-	0.05	0.01
Prochloraz	µg/l	4	-	-	40	0.1
Propetamphos	µg/l	0.03	-	-	0.1	0.02
Propyzamide	µg/l	100	-	-	1000	0.01
Silver - dissolved	µg/l	0.05	-	-	0.1	1

Parameter	Unit	Annual average EQS	90th percentile	95th percentile	MAC	RL[46]
Styrene	µg/l	50	-	-	500	0.1
Sulcofuron	µg/l	-	-	25	-	0.05
Sulphate	µg/l	400,000	-	-	-	0.1
Tecnazene - total	µg/l	1	-	-	10	0.02
Tetrachloroethane	µg/l	140	-	1848	-	0.1
Thiabendazole	µg/l	5	-	-	50	0.1
Tin (inorganic) - total	µg/l	25	-	-	-	0.4
Toluene	µg/l	74	-	380	-	0.1
Total anions	µg/l	250,000	-	-	-	<1000
Triallate	µg/l	0.25	-	-	5	0.02
Triazaphos	µg/l	0.005	-	-	-	0.02
Tributyl phosphate	µg/l	50	-	-	500	0.02
Triclosan	µg/l	0.1	-	0.28	-	0.01
Triphenyltin and derivatives	µg/l	-	-	-	0.02	0.002
Vanadium <200mg/l CaCO3	µg/l	20	-	-	-	0.6
Vanadium >200mg/l CaCO3	µg/l	60	-	-	-	0.6
Xylene	µg/l	30	-	-	-	1
Zinc - dissolved*	µg/l	**	-	-	-	0.5

*EQS refers to bioavailable concentration.

***It is noted that some WFD EQS are different for different river types e.g., upland, lowland, salmonid, cyprinid. Each SRO assessment will use different EQS depending on the local context, see Table 3-2 for further detail.*

Red numbers indicate where LOD>EQS.

Appendix D. Drinking water analysis suites

Parameter[47]	Unit	PCV	Source[48,49]	LoD
1, 2, 3-Benzotriazole	µg/l	-		0.1
1,4-Dioxane	µg/l	-		1
1, 2 Dibromoethane	µg/l	-		1
17β Oestradiol	µg/l	-		0.0003
1H-Benzotriazole, 4 (or 5)-methyl	µg/l	-		0.1
2 3 6-TBA	µg/l	-		0.02
2 4 5-T	µg/l	-		0.02
2 4-D	µg/l	-		0.02
2 4-DB	µg/l	-		0.02
2 EDD	µg/l	-		0.1
2 EMD	µg/l	-		0.1
2-(2-Butoxyethoxy) ethanol (DEGBE)	mg/l	-		10
22C PC Neat (plate count)	µg/l	-		300
2-Methylphenol	µg/l	-		0.02
2-Methylisoborneol (MIB)	ng/l	-		-
37C PC Neat (plate count)	No/ml	-		300
3-Methylphenol	µg/l	-		0.02
4-Methylphenol	µg/l	-		0.02
Acrylamide	µg/l	0.1	Water Supply Regulations 2016, schedule 1	0.1
Adenovirus	-	-		-
Aldrin	µg/l	0.03	Drinking Water Directive, 2021	0.02
Algae cell count	No/ml	-		-
Algal speciation (diatoms/blue-green cyanobacteria etc)	-	-		-
Alkalinity AS $CaCO_3$	mg/l	-		5
Alkalinity as HCO_3	mg/l	-		-
Alpha activity - total	Bq/l	-		0.02
Aluminium - total and dissolved	µg/l	200	Water Supply Regulations 2016, Schedule 1	10
Ametryne	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.02
Amino tris(methylene phosphonic acid) (ATMP)	µg/l	-		1
Ammoniacal nitrogen	mg/l	-		0.015
Ammonium as NH_4	mg/l	0.5	Water Supply Regulations 2016, Schedule 2	0.02
Antimony - total and dissolved	µg Sb/l	5	Water Supply Regulations 2016, Schedule 1	0.017
Arsenic - total and dissolved	µg/l	10	Water Supply Regulations 2016, Schedule 1	0.16
Atrazine	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.02
Azoxystrobin	µg/l	-		0.05
Barium - total and dissolved	µg/l	-		-

[48] https://www.legislation.gov.uk/uksi/2016/614/schedule/1
[49] https://www.legislation.gov.uk/uksi/2016/614/schedule/2

Parameter[47]	Unit	PCV	Source[48,49]	LoD
Benazolin	µg/l	-		0.02
Bentazone	µg/l	-		0.02
Benzene	µg/l	1	Water Supply Regulations 2016, Schedule 1	0.1
Benzo(a)pyrene	µg/l	0.01	Water Supply Regulations 2016, Schedule 1	0.00017
Benzo(b)fluoranthene	µg/l	-		-
Benzo(k)fluoranthene	µg/l	-		-
Benzo(g,h,i)perylene	µg/l	-		-
Beryllium - total and dissolved	µg/l	-		0.1
Beta - estradiol	µg/l	-	Added to the Drinking Water Directive watch list- no regulatory value yet	0.0003
Beta activity - total	Bq/l	-		-
Bisphenol A	µg/l	2.5	Drinking Water Directive, 2021	10
BOD	mg/l	-		1
Boron - total and dissolved	µg/l-B	1000	Water Supply Regulations 2016, Schedule 1	12
Boscalid	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.1
Bromate	µg BrO_3/l	10	Water Supply Regulations 2016, Schedule 1	2
Bromide	mg/l	-		0.1
Bromodichloromethane	µg/l	60		1
Bromoform	µg/l	100		1
Bromoxynil	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.02
Cadmium - total and dissolved	µg Cd/l	5	Water Supply Regulations 2016, Schedule 1	0.02
Calcium - total and dissolved	mg/l	-		0.09
Carbendazim	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.1
Carbetamide	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.01
Carbon tetrachloride	µg/l	-		1
Carbon, dissolved organic	mg/l	-		2
Carbon, total organic	mg/l	-		1
Carbophenothion	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.02
Chemical oxygen demand	mg/l	-		10
Chlorate	mg/l	0.25	Drinking Water Directive, 2021	0.7
Chlordane	µg/l	-		0.02
Chloride (as Cl)	mg/l	250	Water Supply Regulations 2016, Schedule 2	-
Chlorite	mg/l	0.25	Drinking Water Directive, 2021	3
Chloroform	µg/l	-		1
Chloromethylphenol (4, 3)	-	-		-
Chlorophenol (2)	µg/l	-		0.02
Chlorophenol (4)	µg/l	-		0.02
Chlorophyll	µg/l	-		20
Chlortoluron	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	-
Chromium - total and dissolved	µg/l	50	Water Supply Regulations 2016, Schedule 1	0.25
Cl. *Perfringens*-veg & spores confirmed	No/100ml	0	Drinking Water Directive, 2021	-
Clopyralid	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.02
Clostridium perfringens	No/100ml	0	Water Supply Regulations 2016, Schedule 2	-
Cobalt - total and dissolved	µg/l	-		0.16
Cocamidopropyl betaine (CAPB)	-	-		1

Parameter[47]	Unit	PCV	Source[48,49]	LoD
Coliform - total	No/100ml	0	Water Supply Regulations 2016, Schedule 1 & 2	-
Colour	mg/l Pt/Co	20	Water Supply Regulations 2016, Schedule 1	1
Conductivity (at 20°C)	$\mu S/cm^{-1}$	2,500	Water Supply Regulations 2016, Schedule 2	-
Copper - total and dissolved	µg/l	2,000	Water Supply Regulations 2016, Schedule 1	0.4
Cryptosporidium	µg/l	-		-
Cyanazine	µg/l	-		0.02
Cyanide Total	µg/l	50	Water Supply Regulations 2016, Schedule 1	40
Dalapon	µg/l	-		0.02
DDE PP'	µg/l	-		0.02
DDT OP'	-	-		-
DDT PP'	µg/l	-		0.025
Desethyl Atrazine	µg/l	-		0.02
DHC Benzene	µg/l	-		0.1
DHC Cumene	µg/l	-		0.0025
DHC Decane	µg/l	-		0.1
DHC Ethyl benzene	µg/l	-		0.1
DHC Heptane	µg/l	-		0.1
DHC Octane	µg/l	-		0.1
DHC Phenanthracene	µg/l	-		-
DHC Tetradecane	µg/l	-		0.1
DHC Toluene	µg/l	-		0.1
Diazinon	µg/l	-		0.01
Dibromochloromethane	µg/l	-		1
Dicamba	µg/l	-		0.02
Dichlobenil	µg/l	-		0.02
Dichloprop	µg/l	-		0.02
Dichloroethane (1, 2)	µg/l	3	Water Supply Regulations 2016, Schedule 1	1
Dichlorophenol (2, 4)	µg/l	-		1
Dieldrin	µg/l	0.03	Drinking Water Directive, 2021	0.02
Diethylenetriamine penta (methylene phosphonic acid) (DTPMP)	µg/l	-		1
Diflufenican	µg/l	-		0.1
Dimethylphenol (2, 4)	µg/l	-		0.02
Dimethylphenol (2, 5)	µg/l	-		0.02
Dimethylphenol (3, 5)	µg/l	-		0.02
Dissolved oxygen (on Site)	%	-		-
Diuron	µg/l	-		0.05
E.coli	No/100ml	0	Water Supply Regulations 2016, Schedule 1	-
Endosulfan A	µg/l	-		0.02
Endrin	µg/l	-		0.02
Enterococci confirmed	No/100ml	0	Water Supply Regulations 2016, Schedule 1	-
Enterovirus	-	-		-
Epichlorohydrin	µg/l	0.1	Water Supply Regulations 2016, Schedule	0.1
Ethofumesate	µg/l	-		0.05

Parameter[47]	Unit	PCV	Source[48,49]	LoD
Ethylbenzene	µg/l	-		1
Fenoprop	µg/l	-		0.02
Flufenacet	µg/l	-		0.02
Fluoranthene	µg/l	-		0.0009
Fluoride	mg/	1.5	Water Supply Regulations 2016, Schedule 1	-
Fluoroanthene	µg/l	-		0.0009
Fluroxypyr	µg/l	-		0.02
Geosmin	ng/l	-		-
Giardia	No/l	-		-
Glyphosate	µg/l	-		0.1
Haloacetic Acids (HAAs)	µg/l	60	Drinking Water Directive, 2021	-
Hardness - total (as Ca)	mg/l	-		0.1
Hardness - total (as $CaCO_3$)	mg/l	-		-
HCH Alpha	µg/l	-		0.02
HCH Beta	µg/l	-		0.02
HCH Delta	µg/l	-		0.02
HCH Gamma	µg/l	-		0.02
Heptachlor	µg/l	0.03	Drinking Water Directive, 2021	0.001
Heptachlor epoxide	µg/l	0.03	Drinking Water Directive, 2021	0.001
Hexachlorobenzene	µg/l	-		0.02
Indeno(1,2,3-cd)pyrene	µg/l	-		-
Ioxynil	µg/l	-		0.02
Iron - total and dissolved	µg/l	200	Water Supply Regulations 2016, Schedule 1	5.5
Isodrin	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.02
Isoproturon	µg/l	-		0.002
Lead - total and dissolved	µg/l	10	Water Supply Regulations 2016	0.09
Linear alkylbenzene sulphonate (LAS)	µg/l	-		0.1
Linuron	µg/l	-		0.01
Magnesium - total and dissolved	mg/l	-		-
Malathion	µg/l	-		0.02
Manganese - total and dissolved	µg/l	50	Water Supply Regulations 2016, Schedule 1	-
MCPA	µg/l	-		0.02
MCPB	µg/l	-		0.02
Mecoprop	µg/l	-		0.02
Mercury - total and dissolved	µg/l	0.07	Water Supply Regulations 2016, Schedule 1	1
Meta & Para-xylene	µg/l	-		0.1
Metaldehyde	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.02
Metamitron	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.02
Metazachlor	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.1
Methoxychlor	µg/l	-		0.02
Methyl tertiary amyl ether	µg/l	-		-
Metribuzin	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.05
Microcystin-LR (algal toxin)	µg/l	1	Drinking Water Directive, 2021	5

Parameter[47]	Unit	PCV	Source[48,49]	LoD
Molybdenum - total and dissolved	µg/l	-		1.1
Monuron	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.05
MTBE	µg/l	-		1
Nickel - total and dissolved	µg/l	20	Water Supply Regulations 2016, Schedule 1	0.5
Nitrate as N	µg/l	11.4	Water Supply Regulations 2016, Schedule 1	-
Nitrate as NO_3	mg/l	50	Water Supply Regulations 2016, Schedule 1	-
Nitrite & nitrate (calculation)	mg/l	-		-
Nitrite as N	mg/l	-		-
Nitrite as NO_2	mg/l	0.5	Water Supply Regulations 2016, Schedule 1	-
Nitrosamines	-			-
N-Nitrosodimethylamine (NDMA)	µg/l	-		0.1
Non coliforms	-	-		-
Nonylphenol	µg/l	-		0.04
Number of crypto like bodies (4-6 µm)	/10l	-		-
Odour	-	-		-
Oocyst Count	Number	-		-
Ortho-xylene	µg/l	-		1
Oxadixyl	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.05
Oxamyl	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.05
O-xylene	µg/l	-		0.1
P soluble reactive	mg/l	-		0.01
PAH (total of 4 in new reg 200)	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.05
PAH	µg/l	0.1	Drinking Water Directive, 2021	0.05
Parathion	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.02
Particulate Organic Carbon	mg/l	-		2
PCP (phenols method)	µg/l	-		-
Pendimethalin	µg/l	-		0.02
Pentachlorophenol	µg/l	-		0.02
Perfluorooctane sulfonate (PFOS)	µg/l	-		0.00065
Perfluorooctanoic acid (PFOA)	µg/l	-		0.005
Pesticides - total	µg/l	0.5	Water Supply Regulations 2016, Schedule 1.	0.1
PFAS - total	µg/l	0.5	Drinking Water Directive, 2021	-
pH value	pH units	6.5-9.5	Water Supply Regulations 2016, Schedule 2	0.1
Phenol	µg/l	-		1
Phenols - total	µg/l	-		1
Phosphorus - total inorganic (as P)	mg/l	-		0.01
Picloram	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.02
Potassium - total and dissolved	mg/l	-		0.08
Prometryn	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	-
Propazine	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.02
Propetamphos	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.02
Propyzamide	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.01

Parameter[47]	Unit	PCV	Source[48,49]	LoD
Pseudomonas (confirmed)	No/100ml	-		100
Quinmerac	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	-
Radon	Bq/l	-		10
Selenium - total and dissolved	µg/l	10	Water Supply Regulations 2016, Schedule 1	0.25
Silica reactive (SiO_2)	mg/l	-		-
Silver - total and dissolved	µg/l	-		1
Simazine	µg/l	2		0.02
Sodium - total and dissolved	mg/l	200	Water Supply Regulations 2016, Schedule 1	-
Solids, suspended (105°C)	mg/l	-		5
Somatic coliphages	-	-		-
Specific abs (254 nm)	abs	-		-
Strontium - total and dissolved	mg/l	-		0.4
Sulphate as SO_4	mg/l	250	Water Supply Regulations 2016, Schedule 2	-
Sulphide	µg/l	-		10
TDE OP'	-	-		-
TDE PP'	-	-		-
Tebuconazole	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.1
Tebuthiuron	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.1
Tecnazine	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	-
Temp (on Site)	˚C	-		-
Terbutryn	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.02
Tetra & trichloroethane (total)	µg/l	10	Water Supply Regulations 2016, Schedule 1	1
Tetrachloroethene	µg/l	40		1
THM (total)	µg/l	100	Water Supply Regulations 2016, Schedule 1	4
Tin - total and dissolved	µg/l	-		0.4
Titanium - total and dissolved	µg/l	-		0.3
Toluene	-	-		1
Total dissolved solids (TDS)	mg/l	-		-
Total dry solids (at 180°C)	mg/l	-		-
Total oxidised nitrogen	mg/l	-		-
Transmission (at 254 nm)	%	-		-
Tributyltin compounds (TBT)	µg/l	-		0.00003
Trichloroethane (1, 1, 1)	µg/l	-		
Trichloroethene	-	-		1
Trichlorophenol (2 ,4, 5)	µg/l	-		-
Trichlorophenol (2, 4, 6)	µg/l	200	Water Supply Regulations 2016, Schedule 1	-
Triclopyr	µg/l	0.1	Water Supply Regulations 2016, Schedule 1	0.02
Triclosan	µg/l	-		0.01
Trifluralin	µg/l	-		0.02
Trihalomethanes(THM) Formation Potential	µg/l	100	Water Supply Regulations 2016, Schedule 1	-
Tritium	Bq/l	100	Water Supply Regulations 2016, Schedule 2	10
Tungsten - total and dissolved	µg/l	-		10
Turbidity	NTU	1	Water Supply Regulations 2016	-
Uranium (as U)	µg/l	30	Drinking Water Directive, 2021	10

Parameter[47]	Unit	PCV	Source[48,49]	LoD
Vanadium - total and dissolved	µg/l	-		-
Vinyl chloride	µg/l	0.5	Water Supply Regulations 2016, Schedule 1	0.1
Xylene	µg/l	500	Water Supply Regulations 2016, Schedule 1	1
Zinc - total and dissolved	µg/l	-		0.5

Red numbers indicate where LOD>EQS.

Appendix E. Raw laboratory data

All raw laboratory data are provided as a separate file.

Appendix F. Raw sensor data

All raw sensor data are provided as a separate file.

Appendix G. Compounds below laboratory LoD

The following is a table listing all compounds that, where measured, consistently fall below the analytical limit of detection provided by RPS. Also given is to which analytical suite the compounds belong e.g., WFD, EQSD, or DWSP, as detailed in Table 2-2.

	Analysis suite		
Compound	**WFD**	**EQSD**	**DWSP**
1,1,1-trichloroethane	Y	Y	-
1,1,2-trichloroethane	Y	Y	-
1,2-dibromoethane	-	-	Y
1,2-dichloroethane	-	-	Y
1,4-dioxane	-	-	Y
2,3,6-trichlorobenzoic acid (2,3,6-TBA)	-	-	Y
2,4,5-trichlorophenol	-	-	Y
2,4-dichlorophenol	-	Y	Y
2,5-dimethylphenol (2,5-xylenol)	-	-	Y
2-chlorophenol	-	Y	-
2-EDD	-	-	Y
2-EMD	-	-	Y
3,4-dichloroaniline	-	Y	-
4-(2,4-dichlorophenoxy)butanoic acid (2,4-DB)	-	-	Y
4-chloro-3-methyl phenol	-	Y	Y
4-chlorophenol	-	-	Y
Abamectin	-	Y	-
Acrylamide	-	-	Y
Aldrin	-	-	Y
Alpha - HCH	-	-	Y
Ametryne	-	-	Y
Ammonia	-	Y	-
ATMP	-	-	Y
Atrazine	-	-	Y
Azinphos methyl - dissolved	-	Y	-
BDE-100	Y	-	-
BDE-153	Y	-	-
BDE-154	Y	-	-
BDE-28	Y	-	-
BDE-47	Y	-	-
Benazolin	-	-	Y
Bentazone	-	-	Y
Benzene	-	-	Y
Benzyl butyl phthalate	-	Y	-
Beta-HCH	-	-	Y
Biphenyl	-	Y	-
Boscalid	-	-	Y
Bromodichloromethane	-	-	Y

	Analysis suite		
Compound	**WFD**	**EQSD**	**DWSP**
Bromoform	-	-	Y
Bromoxynil	-	Y	Y
BTEX (benzene, toluene, ethylbenzene & O, P-xylene	-	-	Y
CAPB as lauroylamide propylbetaine	-	-	Y
Carbendazim	-	Y	Y
Carbetamide	-	-	Y
Carbon tetrachloride	-	-	Y
Carbophenothion	-	-	Y
Chlorate	-	-	Y
Chlordane	-	-	Y
Chlorothalonil	-	Y	-
Chlorotoluron	-	Y	-
Chlorpropham	-	Y	-
Chromium (VI) - dissolved	-	-	Y
Coumaphos	-	Y	-
Cyanazine	-	-	Y
Cyanide - total	-	Y	Y
Cyfluthrin	-	Y	-
Delta - HCH	-	-	Y
DHC benzene	-	-	Y
DHC cumene	-	-	Y
DHC decane	-	-	Y
DHC ethyl benzene	-	-	Y
DHC heptane	-	-	Y
DHC naphthalene	-	-	Y
DHC octane	-	-	Y
DHC tetradecane	-	-	Y
Diazinon	-	Y	Y
Dibromochloromethane	-	-	Y
Dichlobenil	-	-	Y
Dichlorobenzene - total isomers	-	Y	-
Dichlorvos	-	Y	-
Dieldrin	-	-	Y
Diethylene glycol monobutyl ether (DEGBE)	-	-	Y
Diflubenzuron	-	Y	-
Dimethoate	-	Y	-
Diuron	-	-	Y
Doramectin	-	Y	-
Endrin	-	-	Y
Epichlorohydrin	-	-	Y
Ethofumesate	-	-	Y
Fenchlorphos	-	Y	-
Fenitrothion	-	Y	-
Fenoprop (2,4,5 - TP)	-	-	Y
Flucofuron	-	Y	-

	Analysis suite		
Compound	**WFD**	**EQSD**	**DWSP**
Formaldehyde	-	Y	-
Gamma - HCH	-	-	Y
Heptachlor and heptachlor epoxide	-	-	Y
Hexachlorobenzene	-	-	Y
Ioxynil	-	Y	Y
Isodrin	-	-	Y
Ivermectin	-	Y	-
Linuron	-	Y	Y
M- & p-xylene	-	-	Y
Malachite green	-	Y	-
Malathion	-	Y	Y
MCPB	-	-	Y
Metazachlor	-	-	Y
Methiocarb	-	Y	-
Methoxychlor	-	-	Y
Mevinphos	-	Y	-
Microcystin - LR	-	-	Y
Monuron	-	-	Y
Nitrilotriacetic acid (NTA)	-	Y	-
Omethoate	-	Y	-
Oxadixyl	-	-	Y
Oxamyl	-	-	Y
O-xylene	-	-	Y
P,P' - DDE	-	-	Y
Parathion	-	-	Y
Pendimethalin	-	Y	Y
Pentachlorophenol	-	-	Y
Phenol	-	-	Y
Picloram	-	-	Y
Pirimicarb	-	Y	-
Pirimiphos-methyl	-	Y	-
Polychloro chloromethyl sulphonamido diphenyl ethe	-	Y	-
Prochloraz	-	Y	-
Prometryn	-	-	Y
Propazine	-	-	Y
Propetamphos	-	Y	Y
Radon	-	-	Y
Silver - dissolved	-	Y	Y
Silver - total	-	Y	Y
Simazine	-	-	Y
Sulcofuron	-	Y	-
Tebuthiuron	-	-	Y
Tecnazene	-	Y	-
Tert-amyl methyl ether	-	-	Y
Tetra & trichloroethane - total	-	-	Y

	Analysis suite		
Compound	**WFD**	**EQSD**	**DWSP**
Tetrachloroethane	-	Y	-
THM - total	-	-	Y
Trichloroethylene	Y	-	-
Triclopyr	-	-	Y
Trifluralin	-	-	Y
Tritium	-	-	Y
Tungsten - dissolved	-	-	Y
Tungsten - total	-	-	Y
Uranium - total	-	-	Y
Vanadium - dissolved	-	-	Y
Vanadium - total	-	Y	Y
Vinyl chloride	-	-	Y

Appendix H. Rationalisation of sampling programme

This document provides an overview of the approach taken to rationalise the GUC monitoring programme through Phase 4 by shortlisting a number of determinands that may be considered for removal from a future GUC monitoring programme. A list of determinands where at least one determinand at one site was <LoD for all 13 sampling rounds can be seen in Table 1. In order to compile a shortlist of determinands that may be considered for removal from future analysis suites, a rules-based system was used. All determinands from across the analysis suites, including WFD, EQSD, and DWSP, were included in this shortlisting. The rules applied to generate the shortlist of determinands that may be considered for removal from future monitoring are explained below.

- **Rule 1 -** Determinands were removed where concentrations were consistently <LoD at all monitored sites with the following exceptions:
  - **Rule 1a -** If a positive value was recorded at Minworth WwTW, it is advised determinands are retained enabling future investigation into potential instream deterioration.
  - **Rule 1b -** All determinands in the WFD suite were kept enabling comparison with additional monitoring sites added under Phase 4 of the monitoring programme.
  - **Rule 1c -** If a determinand has been identified as an 'emerging substances' in the recent review of GUC monitoring programme[50], it should be retained.
- **Rule 2 -** Determinands were kept where the laboratory provided LoD> environmental EQS or PCV. For these determinands suitable improvements in analytical detection is required for future analysis.

Based on these criteria, a total of 95 determinands can be considered for removal from future analysis suites following consultation with the relevant regulatory bodies (seen in Table). For determinands included in the DWSP analysis suite, this should only be the case if, following consultation with the DWI, the existing data set is considered sufficient to inform the drinking water quality risk assessment. A summary of these determinands can be seen in Table 2.

[50] Grand Union Canal Strategic Resource Option - Phase 3, Emerging Substances Review. Document Reference: 5204564/7/DG/022.

Table 1. Summary of determinands where at least one determinand from one site was <LoD for all 13 sampling rounds.

	Analysis suite			GUC site number*								
Determinand	**EQSD**	**WFD**	**DWSP**	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**
1,1,1-trichloroethane	Y	Y										
1,1,2-trichloroethane	Y	Y										
1,2-dibromoethane			Y	X					X	X	X	X
1,2-dichloroethane			Y	X					X	X	X	X
1,4-dioxane			Y	X					X	X	X	X
2,3,6-trichlorobenzoic acid (2,3,6-TBA)			Y	X					X	X	X	X
2,4,5-trichlorophenol			Y	X					X	X	X	X
2,4,6-trichlorophenol			Y									
2,4-dichlorophenol	Y		Y	X					X	X	X	X
2,4-dichlorophenoxyacetic acid (2,4-D)	Y		Y	X					X	X	X	X
2,4-dimethylphenol (2,4-xylenol)			Y									
2,5-dimethylphenol (2,5-xylenol)			Y	X					X	X	X	X
2-chlorophenol	Y		Y	X					X	X	X	X
2-EDD			Y	X					X	X	X	X
2-EMD			Y	X					X	X	X	X
2-methylphenol (o-cresol)			Y									
3,4-dichloroaniline	Y											
4-(2,4-dichlorophenoxy)butanoic acid (2,4-DB)			Y	X					X	X	X	X
4-chloro-3-methyl phenol	Y		Y	X					X	X	X	X
4-chlorophenol	Y		Y	X					X	X	X	X
Abamectin	Y											
Acrylamide			Y	X					X	X	X	X
Aldrin			Y	X					X	X	X	X
Alpha activity - total			Y									
Alpha-HCH			Y	X					X	X	X	X
Ametryne			Y	X					X	X	X	X

	Analysis suite			GUC site number*								
Determinand	**EQSD**	**WFD**	**DWSP**	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**
Ammonia	Y	Y	Y	X					X	X	X	X
ATMP			Y	X					X	X	X	X
Atrazine			Y	X					X	X	X	X
Azinphos methyl - dissolved	Y											
Azoxystrobin			Y	X					X	X	X	X
BDE-100		Y										
BDE-153		Y										
BDE-154		Y										
BDE-28		Y										
BDE-47		Y										
BDE-99		Y										
Benazolin			Y	X					X	X	X	X
Bentazone	Y		Y	X					X	X	X	X
Benzene			Y	X					X	X	X	X
Benzyl butyl phthalate	Y											
Beryllium - dissolved			Y	X					X	X	X	X
Beryllium - total			Y	X					X	X	X	X
Beta activity - total			Y	X					X	X	X	X
Beta-HCH			Y	X					X	X	X	X
Biphenyl	Y											
Bisphenol A			Y	X					X	X	X	X
Boscalid			Y	X					X	X	X	X
Bromate			Y	X					X	X	X	X
Bromodichloromethane			Y	X					X	X	X	X
Bromoform			Y	X					X	X	X	X
Bromoxynil	Y		Y	X					X	X	X	X

	Analysis suite			GUC site number*								
Determinand	**EQSD**	**WFD**	**DWSP**	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**
BTEX (benzene, toluene, ethylbenzene & o,p-xylene			Y	X					X	X	X	X
Cadmium - dissolved		Y	Y	X					X	X	X	X
Cadmium - total		Y	Y	X					X	X	X	X
CAPB as lauroylamide propylbetaine			Y	X					X	X	X	X
Carbendazim	Y		Y	X					X	X	X	X
Carbetamide			Y	X					X	X	X	X
Carbon tetrachloride			Y	X					X	X	X	X
Carbophenothion			Y	X					X	X	X	X
Chlorate			Y	X					X	X	X	X
Chlordane			Y	X					X	X	X	X
Chlorite			Y	X					X	X	X	X
Chloroform		Y	Y	X					X	X	X	X
Chloronitrotoluenes	Y											
Chlorothalonil	Y											
Chlorotoluron	Y											
Chlorpropham	Y											
Chromium (VI) - dissolved	Y		Y	X					X	X	X	X
Clopyralid			Y	X					X	X	X	X
Coumaphos	Y											
Cyanazine			Y	X					X	X	X	X
Cyanide - total	Y		Y	X					X	X	X	X
Cyfluthrin	Y											
Cypermethrin	Y	Y										
Dalapon			Y	X					X	X	X	X
DDT total			Y	X					X	X	X	X
Delta-HCH			Y	X					X	X	X	X

	Analysis suite			GUC site number*								
Determinand	**EQSD**	**WFD**	**DWSP**	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**
Desethyl atrazine			Y	X					X	X	X	X
DHC benzene			Y	X					X	X	X	X
DHC cumene			Y	X					X	X	X	X
DHC decane			Y	X					X	X	X	X
DHC ethyl benzene			Y	X					X	X	X	X
DHC heptane			Y	X					X	X	X	X
DHC naphthalene			Y	X					X	X	X	X
DHC octane			Y	X					X	X	X	X
DHC phenanthrene			Y	X					X	X	X	X
DHC tetradecane			Y	X					X	X	X	X
DHC toluene			Y	X					X	X	X	X
Di(2-ethylhexyl)phthalate (DEHP)		Y										
Diazinon	Y		Y	X					X	X	X	X
Dibromochloromethane			Y	X					X	X	X	X
Dicamba			Y	X					X	X	X	X
Dichlobenil			Y	X					X	X	X	X
Dichloprop			Y	X					X	X	X	X
Dichlorobenzene, total isomers	Y											
Dichlorvos	Y											
Dieldrin			Y	X					X	X	X	X
Diethyl phthalate	Y											
Diethylene glycol monobutyl ether (DEGBE)			Y	X					X	X	X	X
Diflubenzuron	Y											
Diflufenican			Y	X					X	X	X	X
Dimethoate	Y											
Dimethyl phthalate	Y											

	Analysis suite			GUC site number*								
Determinand	**EQSD**	**WFD**	**DWSP**	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**
Dioctyl phthalate	Y											
Diuron			Y	X					X	X	X	X
Doramectin	Y											
EDTA	Y											
Endosulfan			Y	X					X	X	X	X
Endrin			Y	X					X	X	X	X
Epichlorohydrin			Y	X					X	X	X	X
Ethofumesate			Y	X					X	X	X	X
Fenchlorphos	Y											
Fenitrothion	Y											
Fenoprop (2,4,5-TP)			Y	X					X	X	X	X
Flucofuron	Y											
Flufenacet			Y	X					X	X	X	X
Formaldehyde	Y											
Gamma-HCH			Y	X					X	X	X	X
Heptachlor and heptachlor epoxide			Y	X					X	X	X	X
Hexabromocyclododecane (HBCDD)		Y										
Hexachlorobenzene			Y	X					X	X	X	X
Ioxynil	Y		Y	X					X	X	X	X
Isodrin			Y	X					X	X	X	X
Isoproturon			Y	X					X	X	X	X
Ivermectin	Y											
Linear alkylbenzenesulfonate			Y	X					X	X	X	X
Linuron	Y		Y	X					X	X	X	X
m- & p-xylene	Y											
Malachite green	Y											

	Analysis suite			GUC site number*								
Determinand	**EQSD**	**WFD**	**DWSP**	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**
Malathion	Y		Y	X					X	X	X	X
Maneb	Y											
MCPA	Y		Y	X					X	X	X	X
MCPB	Y		Y	X					X	X	X	X
Mecoprop	Y		Y	X					X	X	X	X
Metaldehyde			Y	X					X	X	X	X
Metamitron			Y	X					X	X	X	X
Metazachlor			Y	X					X	X	X	X
Methiocarb	Y											
Methoxychlor			Y	X					X	X	X	X
Metribuzin			Y	X					X	X	X	X
Mevinphos	Y											
Microcystin - LR			Y	X					X	X	X	X
Molybdenum - dissolved			Y	X					X	X	X	X
Monuron			Y	X					X	X	X	X
MTBE			Y	X					X	X	X	X
Nitrilotriacetic acid (NTA)	Y											
Nonylphenols (4-nonylphenol technical mix)		Y										
Octylphenols ((4-(1,1',3,3'-tetramethylbutyl)pheno		Y										
Omethoate	Y											
Organic nitrogen		Y										
Oxadixyl			Y	X					X	X	X	X
Oxamyl			Y	X					X	X	X	X
O-xylene			Y	X					X	X	X	X
P,p'-DDE			Y	X					X	X	X	X

	Analysis suite			GUC site number*								
Determinand	**EQSD**	**WFD**	**DWSP**	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**
Parathion			Y	X					X	X	X	X
Pendimethalin	Y		Y	X					X	X	X	X
Pentachlorophenol			Y	X					X	X	X	X
Phenol	Y		Y	X					X	X	X	X
Picloram			Y	X					X	X	X	X
Pirimicarb	Y											
Pirimiphos-methyl	Y											
Polychloro chloromethyl sulphonamido diphenyl ether	Y											
Polycyclic aromatic hydrocarbons (PAH) sum			Y	X					X	X	X	X
Prochloraz	Y											
Prometryn			Y	X					X	X	X	X
Propazine			Y	X					X	X	X	X
Propetamphos	Y		Y	X					X	X	X	X
Propyzamide	Y		Y	X					X	X	X	X
Radon			Y	X					X	X	X	X
Silver - dissolved	Y		Y	X					X	X	X	X
Silver - total	Y		Y	X					X	X	X	X
Simazine			Y	X					X	X	X	X
Strontium - dissolved			Y	X					X	X	X	X
Strontium - total			Y	X					X	X	X	X
Styrene	Y											
Sulcofuron	Y											
Tebuconazole			Y	X					X	X	X	X
Tebuthiuron			Y	X					X	X	X	X
Tecnazene	Y											

	Analysis suite			GUC site number*								
Determinand	**EQSD**	**WFD**	**DWSP**	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**
Terbutryn			Y	X					X	X	X	X
Tert-amyl methyl ether			Y	X					X	X	X	X
Tetra & trichloroethane -total			Y	X					X	X	X	X
Tetrachloroethane	Y											
THM total			Y	X					X	X	X	X
Toluene	Y		Y	X					X	X	X	X
Triallate	Y											
Tributyl phosphate	Y											
Trichloroethylene		Y										
Triclopyr			Y	X					X	X	X	X
Triclosan	Y	Y	Y	X					X	X	X	X
Trifluralin			Y	X					X	X	X	X
Triphenyltin compounds	Y											
Tritium			Y	X					X	X	X	X
Tungsten - dissolved			Y	X					X	X	X	X
Tungsten - total			Y	X					X	X	X	X
Uranium total			Y	X					X	X	X	X
Vanadium - dissolved	Y		Y	X					X	X	X	X
Vanadium - total	Y		Y	X					X	X	X	X
Vinyl chloride			Y	X					X	X	X	X

** Blue shading indicates determinands have been continuously below the LoD for all 13 sampling rounds (April 2021 – March 2022). WFD determinands are analysed at all sites, EQDS determinands at Sites 1-4, and DWSP determinands at Sites 1, 6-9. X indicates sites monitored for DWSP determinands, white cells indicate the presence of at least 1 recorded value >LoD*

Table 2 Determinands that meet the criteria to be considered for removal from future GUC analysis suites.

	Analysis suite	
Determinand	**EQSD**	**DWSP**
1,2-dibromoethane		Y
1,4-dioxane		Y
2,3,6-trichlorobenzoic acid (2,3,6-TBA)		Y
2,4,5-trichlorophenol		Y
2,4-dichlorophenol	Y	Y
2,5-dimethylphenol (2,5-xylenol)		Y
2-EDD		Y
2-EMD		Y
4-(2,4-dichlorophenoxy)butanoic acid (2,4-DB)		Y
4-chloro-3-methyl phenol	Y	Y
Abamectin	Y	
Alpha-HCH		Y
Ametryne		Y
ATMP		Y
Atrazine		Y
Benazolin		Y
Benzene		Y
Benzyl butyl phthalate	Y	
Beta-HCH		Y
Boscalid		Y
Bromoform		Y
Bromoxynil	Y	Y
BTEX (benzene, toluene, ethylbenzene & o,p-xylene		Y
CAPB as lauroylamide propylbetaine		Y
Carbendazim	Y	Y
Carbetamide		Y
Carbon tetrachloride		Y
Carbophenothion		Y
Chlordane		Y
Chlorothalonil	Y	
Chlorotoluron	Y	
Chlorpropham	Y	
Coumaphos	Y	
Cyfluthrin	Y	
Delta-HCH		Y
DHC benzene		Y
DHC cumene		Y
DHC decane		Y

	Analysis suite	
Determinand	**EQSD**	**DWSP**
DHC ethyl benzene		Y
DHC heptane		Y
DHC naphthalene		Y
DHC octane		Y
DHC tetradecane		Y
Diazinon	Y	Y
Dichlobenil		Y
Dichlorobenzene, total isomers	Y	
Diethylene glycol monobutyl ether (DEGBE)		Y
Diflubenzuron	Y	
Dimethoate	Y	
Diuron		Y
Ethofumesate		Y
Fenchlorphos	Y	
Fenitrothion	Y	
Fenoprop (2,4,5-TP)		Y
Flucofuron	Y	
Gamma-HCH		Y
Hexachlorobenzene		Y
Ioxynil	Y	Y
Linuron	Y	Y
Metazachlor		Y
Methoxychlor	-	Y
Mevinphos	Y	
Monuron		Y
Nitrilotriacetic acid (NTA)	Y	
Omethoate	Y	
Oxadixyl		Y
Oxamyl		Y
o-xylene		Y
p,p'-DDE		Y
Parathion		Y
Picloram		Y
Pirimicarb	Y	
Pirimiphos-methyl	Y	
Polychloro chloromethyl sulphonamido diphenyl ether	Y	
Prochloraz	Y	
Prometryn		Y
Propazine		Y
Propetamphos	Y	Y
Radon		Y

	Analysis suite	
Determinand	**EQSD**	**DWSP**
Silver - dissolved	Y	Y
Silver - total	Y	Y
Simazine		Y
Sulcofuron	Y	
Tebuthiuron		Y
Tecnazene	Y	
Tert-amyl methyl ether		Y
Tetrachloroethane	Y	
THM total		Y
Triclopyr		Y
Trifluralin		Y
Tritium		Y
Tungsten - dissolved		Y
Tungsten - total		Y
Uranium - total		Y
Vanadium - total	Y	Y

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