RECLAIM OUR RIVERS:

RIVER THAMES - SOUTH STOKE TO PANGBOURNE

Citizen Science Water Quality Monitoring Programme Technical Report 2024

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1. Executive Summary

What is the Reclaim Our Rivers project?

More people than ever are connecting with their local waterways and greenspaces, with a nation-wide rise in the number of people taking to their local river for recreation and exercise. The health of our inland waterways has garnered increasing media attention in recent years, leading to an awareness that open waters may not provide safe swimming spaces due to poor water quality. Meanwhile, there is a lack of information available to the public providing up-to-date, localised, and clearly communicated water quality results. The Reclaim Our Rivers project aims to improve access to safe rivers and lakes across the Thames Basin by engaging citizen scientists in water quality monitoring programmes, collecting and disseminating data to aid understanding of bacterial pollution, and increasing the number of inland bathing water designations in the region.

The need for better access and information around safer swimming in rivers is evident throughout the Upper Thames region, where there is a long history of swimming and paddling, yet little has been understood about water quality. The River Thames is a treasured cultural and natural asset to Pangbourne: there is a long history of swimming, paddling and kayaking, with the river also bringing economic value to the town through the many tourists it attracts. The demand for a cleaner, healthier River Thames is also evidenced by the successful bathing water designation at Wallingford Beach in 2023[1] and Port Meadow in Oxford in 2022[2].

Bathing water designations are a means to create more clean, safe outdoor swimming and bathing sites, but also improve water quality for all users and for nature. Such sites are tested weekly throughout the bathing season (mid-May to the end of September), allowing users to better understand the risks and make informed choices. Under current legislation, bathing water designations are the only stretches of river in the country that receive statutory bacteria monitoring by the EA. Designation also helps to increase pressure and direct investment from water companies, landowners and other stakeholders for improvements required for healthier rivers. Pangbourne Meadows is an ideal location for a bathing water designation, thanks to its popular usage during summer months, and the local facilities and amenities. In May of 2024, Defra suspended applications for bathing water designations until 2025. During this time, the Reclaim Our Rivers project thus narrowed its focus to water quality monitoring at six sample points located between Pangbourne and South Stoke.

The principal goal of the water quality sampling was to assess Pangbourne Meadows, as well as the five other sample points, mostly upstream, against the Bathing Water Regulations standards (based on EU Directive 2006[3]) for FIO ('Faecal Indicator Organisms') levels in inland waters, which the Environment Agency (EA) uses to assess and classify designated bathing water quality. Locations of upstream sample points were carefully selected to identify potential pollution sources that might impact water quality at Pangbourne Meadows.

Testing undertaken by the Water Framework Directive[4] states that the current ecological status of this stretch of the River Thames is 'Moderate'. This water quality monitoring programme is a step in filling an evidence gap and creating better understanding of the potential problems threatening river health in the Upper Thames.

This report presents the findings of the 2024 citizen science water quality monitoring programme, evaluates the potential causes of pollution, and recommends further action needed to ensure our rivers are healthy enough to swim in.

The monitoring programme was part-funded by local organization Mend the Gap and conducted in partnership with Goring Gap Environmental Organisation.

[1] https://www.thames21.org.uk/2024/05/wallingford-beach-gets-green-light-to-become-the-second-designated-bathing-site-along-the-thames/

[2] https://www.thames21.org.uk/2022/04/oxford-based-port-meadow-gets-green-light-to-become-uksecond-river-bathing-site/

[3] 2006/7/EC. (2006). Directive 2006/7/EC of the European Parliament and of the council of 15 February 2006 concerning the management of bathing water quality and repealing directive 76/160/EEC. Official Journal of the European Union, L 064(1882)

[4] https://environment.data.gov.uk/catchment-planning/WaterBody/GB106039030331

1. Key Findings

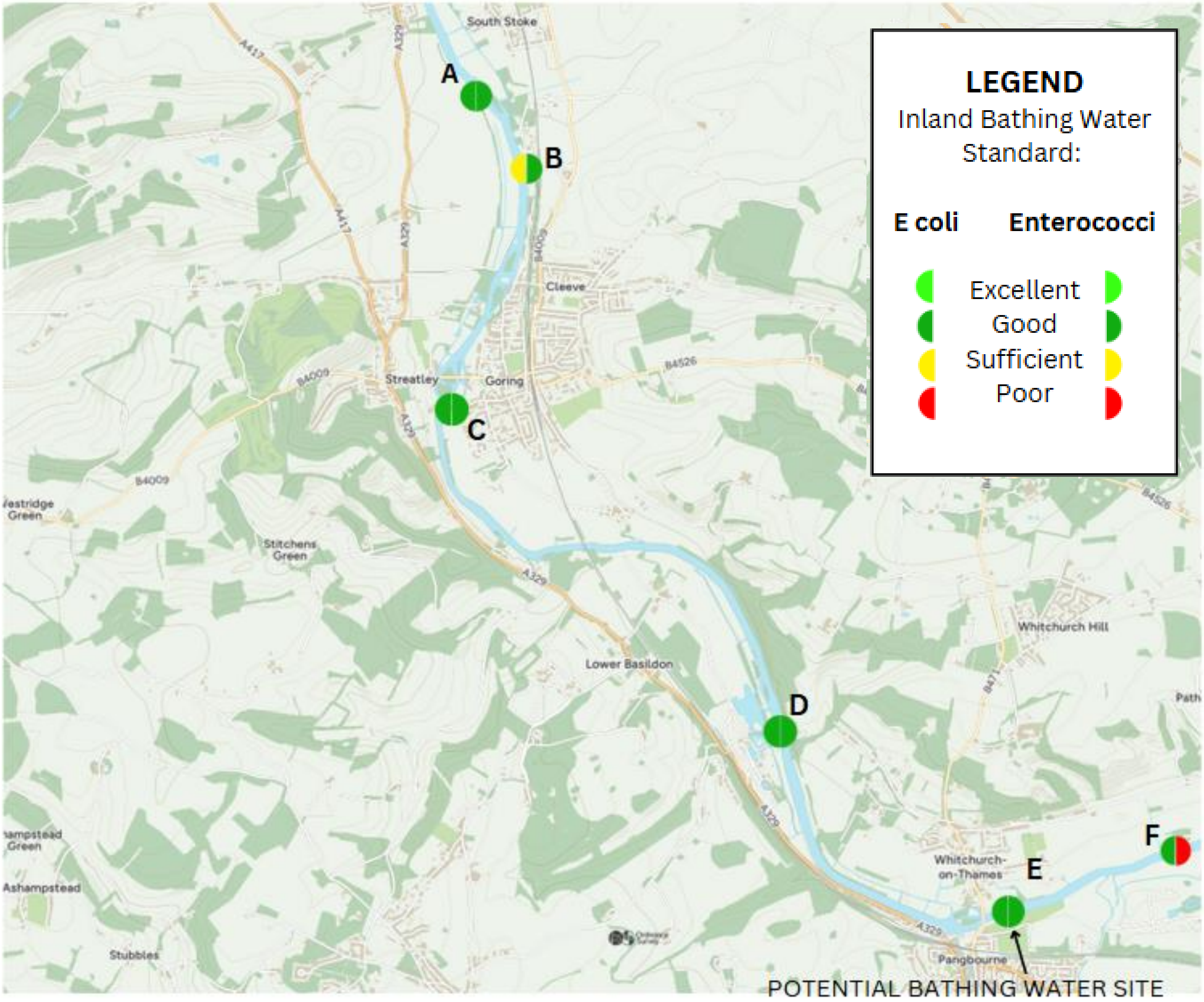

Figure 1 - Map of sample points with overall bathing water status & potential bathing water site

1. If disregarding the final sampling date as an 'abnormal situation', E. coli (EC) levels were either 'Sufficient', 'Good' or 'Excellent' at all sample points (fig 1).
2. The only sample point which exceeded recommended safe levels of Intestinal Enterococci (IE) was sample point F – Sulham Brook, 0.6km downstream of Pangbourne Sewage Treatment Works (STW), indicating that Pangbourne STW is likely to be negatively impacting water quality.
3. Dramatic increases in FIO levels on 24/09/24 correlate with heavy rainfall in the 72 hours preceding sampling, and if included would bring overall levels of EC at all sampling points down to 'Poor' and overall levels of IE at all sampling points down to either 'Poor' or 'Sufficient'. These increases in FIO levels, with EC:IE ratios of at least 2:1 display the hallmarks of point source impacts.
4. Cholsey, Goring and Streatley STWs appear to be functioning effectively during dry weather, but periods of heavy rainfall will likely cause Cholsey STW to reach capacity and discharge, negatively impacting water quality.

5. Most of this stretch of the River Thames appears to be less affected by bacterial pollution than sites up and downstream such as Wolvercote[5], Wallingford[6], and Wargrave[7], except in periods of extreme rainfall.

2.1 Recommendations

- Continued monitoring of this stretch of the Thames, including during winter months and using real-time testing methods, would help to assess whether the trends seen in the results of this programme are representative of water quality throughout the year.
- Ahead of the reopening of bathing water applications, expected in 2025, a repeat of this citizen science monitoring programme would help to further validate the findings of this report. Investigations at Wolvercote Mill Stream, a bathing water designated site upstream of Pangbourne, show variations in water quality patterns across different bathing seasons, highlighting the need for continued monitoring to build more robust data sets and validate trends in water quality results.
- Pangbourne STW, where heavier loads of IE were identified throughout the bathing season, causing sample point F to gain the only 'Poor' overall status, should be investigated further, to ensure planned asset improvements are effective in reducing any potential continued impacts on water quality.
- To reduce the negative impact on water quality seen after heavy rainfall, work could be undertaken to investigate and reduce groundwater infiltration, especially at Cholsey STW which discharged for 1815 minutes (30.25 hours) during and after heavy rainfall on 23/09/24.
- Thames21 will work collaboratively with local authorities and other local organisations to maintain awareness and facilitate future citizen science monitoring projects in this region.

2. Project Methodology

3.1 Sampling Parameters

Following the Environment Agency (EA)'s statutory bathing water sampling methodology, this programme monitored levels of 'Faecal Indicator Organisms' (FIOs), here meaning the bacteria Escherichia coli (E. coli) and Intestinal Enterococci (IE) during the bathing season. These bacteria indicate faeces and urine of warm-blooded mammals and are a significant threat to human health. Although commonly found in the gut and intestinal tracts of humans, when contaminated water is ingested or allowed to enter the bloodstream through open uncovered wounds, it can lead to gastrointestinal illnesses, infections, headaches, fever and in severe cases kidney and organ failure.

This monitoring programme employed a sampling protocol developed by TH Environmental Ltd for The Rivers Trust and follows practices required by the Bathing Water Directive 2006/7/ec at sites designated as bathing waters by the Department of Environment, Farming and Rural Affairs (Defra). Samples were analysed at Latis Scientific Limited – an accredited laboratory using a standard culturing methodology. These results have been analysed against EA Bathing Water Standards[8], as detailed below.

As will be evident in the following analysis, some results were affected by a lack of dilution analysis from the laboratory. FIO levels in these instances were communicated as 'greater than' (>) the limit of uncertainty, and in some instances may have affected overall bathing water classifications, so have been removed from overall classifications. This is explained in further detail for each sampling point in section 5, in the breakdown of sample point results with

[5] https://www.thames21.org.uk/2023/12/wolvercote-mill-stream-designated-as-poor-for-third-year-running-but-improvements-on-the-way/
[6] https://www.thames21.org.uk/wp-content/uploads/2023/11/Wallingford-Beach-Water-Quality-Report-2023.pdf
[7] https://www.thames21.org.uk/wp-content/uploads/2023/11/Mill-Meadows-Henley-on-Thames-Water-Quality-Report-2023.pdf
[8] Bathing Water Regulations (2013), https://www.legislation.gov.uk/uksi/2013/1675

comparisons of the data included and excluded, and further expanded upon in section 6.

3.2 Sampling Locations

Table 1 - Sampling Location Details

Point A	Opposite Withymead Nature Reserve	SU 59788 82906
Point B	The Leatherne Bottel	SU 60149 82323
Point C	Ferry Lane	SU 59584 80551
Point D	Beale Wildlife Park	SU 62072 78182
Point E	Pangbourne Meadows	SU 63704 76829
Point F	Sulham Brook, Pangbourne	SU 64967 77286

6 sample points (fig. 1, table 1) were chosen to best identify the possible sources of pollution, such as sample point B – Don Giovanni at the Leatherne Bottel, 0.5km downstream of the Goring Sewage Treatment Works (STW), and sample point F – Sulham Brook which is 0.6km downstream of Pangbourne STW. Sample point A, located upstream of Goring STW, was chosen to provide a control. All sample points were chosen with the citizen scientists' access and safety in mind, as well as their distance from known pollution inputs (fig. 2).

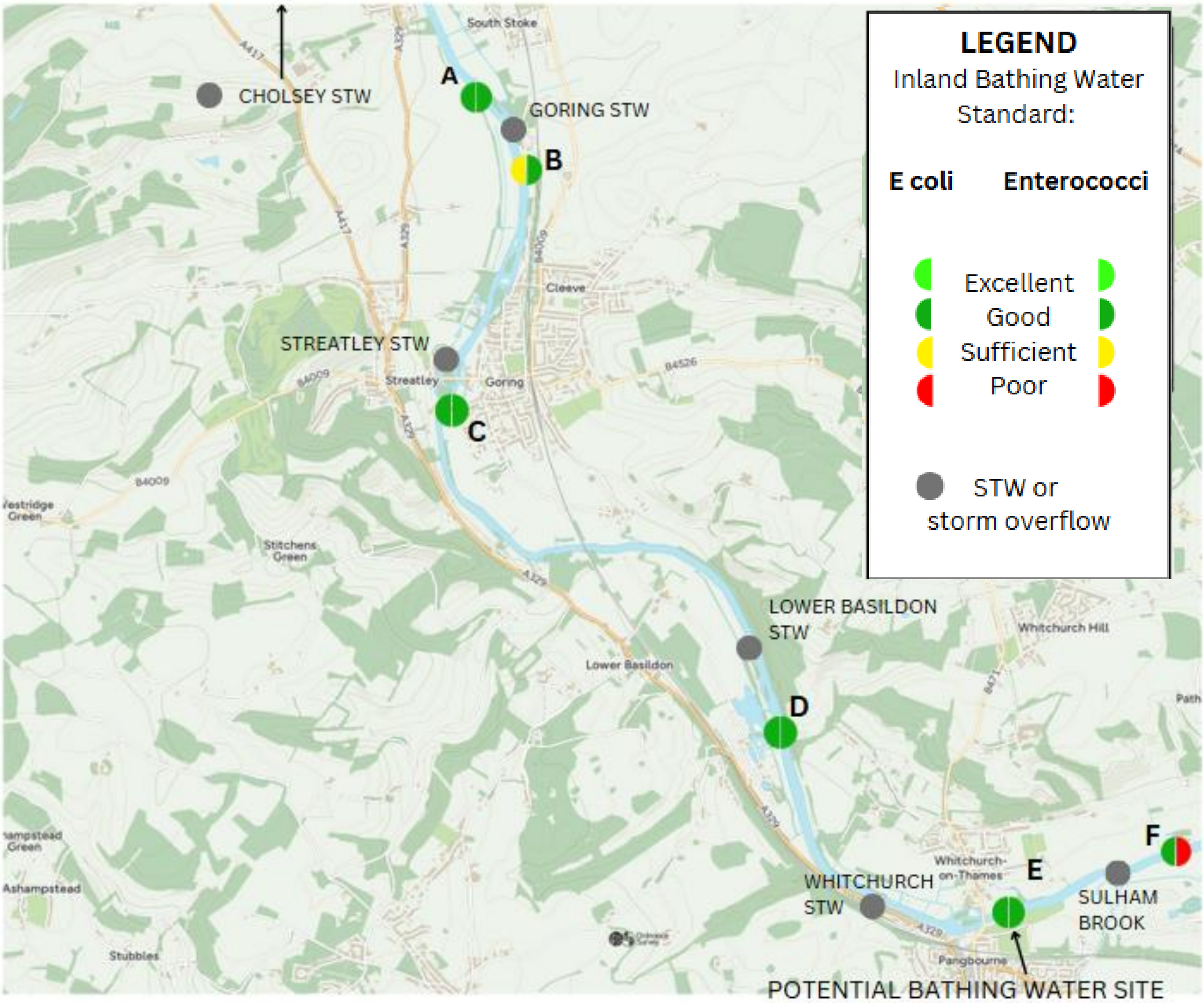

Figure 2 - Map of sample points & STWs/storm overflows

3.3 Sampling Frequency and Methodology

Weekly sampling was carried out at the six sample points by trained citizen scientists during the bathing water season (15th May - 30th September 2024). Citizen scientists were trained in May 2024 to use an aseptic sampling protocol developed by TH Environmental Ltd for The Rivers Trust (see Appendix 1). Samples were analysed at Latis Scientific Limited – an accredited laboratory – using a standard culturing methodology.

Levels of rainfall, as well as the ratio of E. coli (EC) and IE are important factors in understanding the origins of the FIOs for each sample point. Due to the different survival rates of IE[9] and EC[10], in this study an EC:IE ratio of 2:1 to 4:1 is assumed to be indicative of point source inputs (e.g. untreated sewage, either from storm overflows or partially treated final effluent) whereas a EC:IE ratio closer to 1:1 is associated with diffuse inputs (e.g. livestock excreta, misconnections) (Harris 2022). These ratios can help point towards an indication of the source of the faecal indicator organisms, and consequently help to identify the most effective options for solutions to pollution problems.

3.4 Statistical Analysis

All results obtained are required to be statistically analysed and converted to a "percentile value" based on a percentile evaluation of the log10 normal probability density function of microbiological data used for the assessment as detailed in the Bathing Water Regulations (2013).

To be able to derive a percentile value the following method (Harris 2022) was followed:

a) take the log10 value of all bacterial concentrations in the data sequence to be evaluated or, if a zero value is obtained, take the log10 value of the minimum detection limit of the analytical method used.
b) calculate the arithmetic mean ("μ") of the log10 values taken under paragraph (a);
c) calculate the standard deviation ("σ") of the log10 values taken under paragraph (a);
d) derive the upper 90-percentile point of the data probability density function from the following equation: upper 90-percentile = antilog ($\mu + 1.282\ \sigma$); and
e) derive the upper 95-percentile point of the data probability density function from the following equation: upper 95-percentile = antilog ($\mu + 1.65\ \sigma$).

The conversion to a "percentile value" is done on all collated EC and IE results obtained from the sample point over a defined period, the obtained result is then compared against the outlined water quality creating an overall bathing water status (table 2). Weekly results were also analysed, employing a different calculation to the overall bathing water status and has only two categorisations: 'Good' or 'Poor' (table 3). Weekly status is constituted by too little data to create an official status, but can help point towards trends in water quality across the bathing season.

Table 2 - Bathing water quality designations (Source: Harris, T 2022)

	E.coli		
	BW status	Levels	Percentile
(green)	Excellent	500	95
(light green)	Good	1000	95
(yellow)	Sufficient	900	90
(red)	Poor	>900	90

	Enterococci		
	BW status	Levels	Percentile
(green)	Excellent	200	95
(light green)	Good	400	95
(yellow)	Sufficient	330	90
(red)	Poor	>330	90

Table 3 – Calculations for weekly bathing water status

Info on weekly bathing water status calculation
For E.Coli, <1000 = 'Good', >1000 = 'Poor'
For Enterococci, <400 = 'Good', >400 = 'Poor'

[9] IE survival rate = 72-96 hours
[10] EC survival rate = 36-48 hours

3. Results & Analysis

4.1 Rainfall Impact

Rainfall can negatively impact FIO levels in rivers. Heavy rainfall can increase agricultural inputs entering the river, negatively impact STWs' capacity, and cause storm overflow and combined sewers overflows (CSO) to spill.

To assess the impact of rainfall events on sampled FIO levels in rivers, rainfall data must be analysed to determine whether precipitation occurred up to 72 hrs before the sampling was done. Prior to 72hrs before the sampling, the impact of a rainfall event is negligible on FIO levels due to their lifespan within the river. EC and IE have variable survival periods when outside of the host body, with EC surviving between 36-48 hrs and IE between 72-96 hrs in both a terrestrial and aquatic environment when variables such as solar degradation and temperatures are accounted for (Harris 2022).

The highest rainfall recorded this bathing season by the EA Cleeve rainfall monitor was on 22/09/24 at 38.21mm. The month of September 2024 was more than three times the average September rainfall for Berkshire.[11]

As part of the EA bathing water testing methodology, 'samples will be taken during conditions (such as extreme rainfall) that are later found to be abnormal and may be disregarded from classification'[12]. This is to ensure all samples are representative of 'normal' river conditions, rather than 'abnormal' conditions during which users would likely not enter the bathing water site. In light of this methodology, this report presents the full data set including the final sample date, but also presents the results with this date disregarded, as it would likely be by the EA in their bathing water designation.

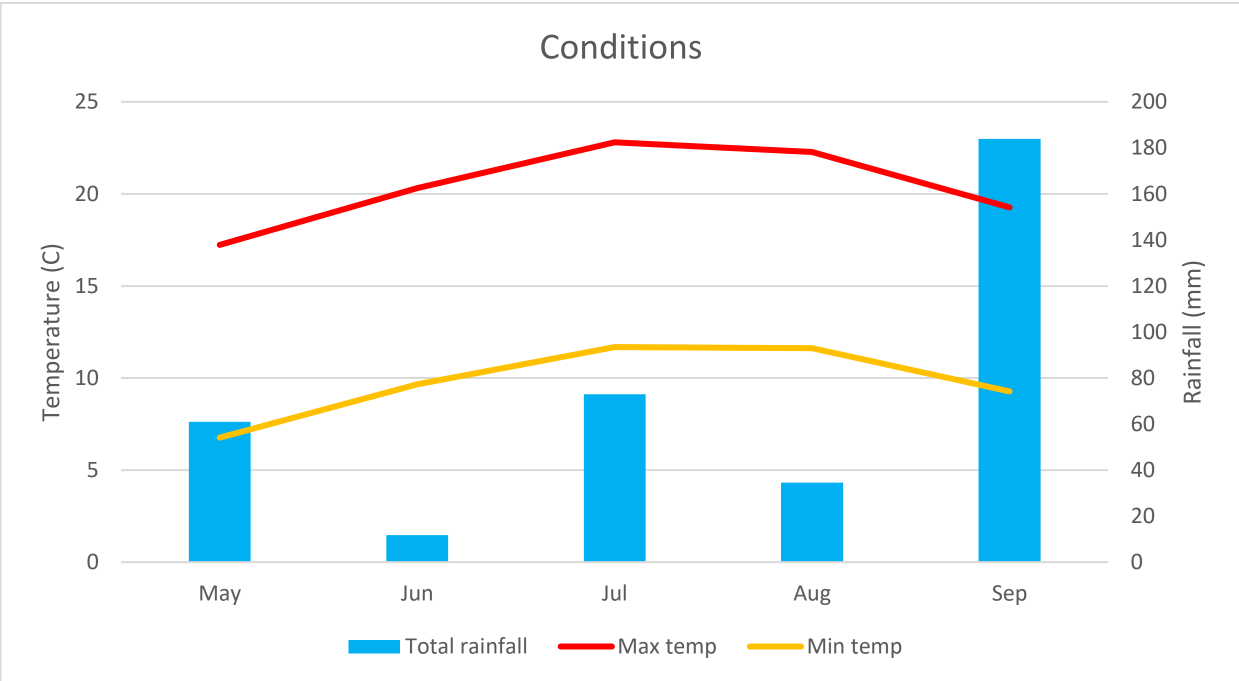

Figure 3 - Weather conditions during bathing season

[11] https://www.metoffice.gov.uk/about-us/news-and-media/media-centre/weather-and-climate-news/2024/record-breaking-rainfall-for-some-this-september

[12] https://environment.data.gov.uk/bwq/profiles/help-understanding-data.html

Table 4 - Precipitation (mm) correlated to sampling dates. Cells left blank indicate no precipitation

Precipitation (mm)		
Sampling date	**Preceding 72 hrs**	**On sampling day**
16/05/2024		
23/05/2024	14.93	
28/05/2024	1.88	1.62
04/06/2024		
12/06/2024	0.17	0.06
20/06/2024		
24/06/2024	0.23	
02/07/2024	0.06	0.08
10/07/2024	9.47	
18/07/2024	0.19	
22/07/2024	0.10	1.07
30/07/2024		
07/08/2024	3.49	
15/08/2024	4.07	
19/08/2024		
27/08/2024		
04/09/2024	0.52	
12/09/2024	3.38	2.38
16/09/2024	0.52	
24/09/2024	61.43	2.79

As table 4 depicts, rainfall events of varying precipitation levels occurred shortly before or during sampling on 14 out of 20 dates. Notable rainfall events include late May, when 14.93mm precipitation occurred in the 72hrs preceding sampling on 23/05/24, and the most extreme rainfall event on 24/09/24 when 64.22mm precipitation occurred in the 72hrs preceding sampling and on the day.

4.2 Spill Correlation

Thames Water event duration monitoring (EDM) data was plotted against rainfall data and FIO levels during the bathing water sampling period. When looking for correlation of spills, spill data was assessed against the following criteria:

- Was the spill no more than 72 hours before the date of sample?
- Did the correlation pattern show a significant increase in EC and IE levels, causing bathing water (BW) status to fall to 'Poor'?

The only STW to have discharged within 72 hours of a sample date in the sampling period was Cholsey (see fig. 2 for location) which, according to the results of an Environmental Information Regulations (EIR) request for historic EDM data, spilled for 1815 minutes (30.25 hours) prior to sampling on 24/09/24. No other STW discharged within 72 hours of any other sampling date.

4.3 Thames Water: Upgrades

Cholsey STW was recently upgraded, with works completed in March 2024 to increase treatment capacity from 74 to 105 litres per second (42% increase). Thames Water expects this STW to meet government targets by 2045-2050. Plans are in place to upgrade Pangbourne STW, to increase its treatment capacity. Thames Water expects these upgrades to be completed by 2026, and this STW to meet government targets by 2030-2035[13].

[13] https://www.thameswater.co.uk/about-us/performance/river-health/frequently-asked-questions/information-about-specific-sites#c

4. Breakdown of Sampling Points Results

5.1 Sample point A: Opposite Withymead Nature Reserve, South Stoke

Table 5– Sample point A: overall bathing water status at 90th & 95th percentile not including results from sampling date 24/09/24 (see note below)

E. coli			overall status
90 PERCENTILE	556.14	NA	Good
95 PERCENTILE	704.26	Good	

Enterococci			overall status
90 PERCENTILE	185.63	NA	Good
95 PERCENTILE	260.29	Good	

Table 6 - Overall bathing water status at 90th & 95th percentile (including results from sampling date 24/09/24), sample point A

E. coli			overall status
90 PERCENTILE	1938.13	Poor	Poor
95 PERCENTILE	3254.61	NA	

Enterococci			overall status
90 PERCENTILE	433.19	Poor	Poor
95 PERCENTILE	723.35	NA	

Table 7 – Weekly breakdown of results, sample point A

Date	E. coli (EC) MPN/100ml	Enterococci CFU/100ml	Weekly E. coli status	Weekly Enterococci status
16/05/2024	155	30	Good	Good
23/05/2024	201	500	Good	Poor
28/05/2024	201	52	Good	Good
04/06/2024	238	27	Good	Good
12/06/2024	214	15	Good	Good
20/06/2024	101	68	Good	Good
24/06/2024	101	34	Good	Good
02/07/2024	127	20	Good	Good
10/07/2024	461	100	Good	Good
18/07/2024	345	50	Good	Good
22/07/2024	150	26	Good	Good
30/07/2024	148	23	Good	Good
07/08/2024	172	46	Good	Good
15/08/2024	228	54	Good	Good
19/08/2024	261	180	Good	Good
27/08/2024	411	63	Good	Good
04/09/2024	461	50	Good	Good
12/09/2024	866	220	Good	Good
16/09/2024	649	180	Good	Good
24/09/2024	72700	6800	Poor	Poor

NOTE: Cells highlighted in orange indicate where the result communicated from the laboratory was greater than (>) the number shown in this table. This inaccuracy risks invalidating results, so results highlighted in orange have therefore been removed from the overall EC status in table 7. Cells highlighted in pink indicate data that would be disregarded if following EA bathing water designation methodology due to rainfall conditions constituting an 'abnormal situation'

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At sample point A, bacteria levels were consistently ‘Good’. Exceptions include a small increase in IE levels leading to a ‘Poor’ result on 23/05/24. Levels on IE on this date were only 100 CFU[14]/100ml over the threshold of ‘Good’ weekly status, and this spike in IE correlates with heavier precipitation (14.93mm) in the 72 hours preceding this sampling date and time. The other, more dramatic increase in both EC and IE occurred on 24/09/24, with EC increasing to 72700 MPN[15]/100ml and IE increasing to 6800 CFU/100ml. This upwards spike in FIO levels correlates closely with extremely heavy precipitation (64.2mm) in the 72 hours preceding the sampling date and time, as demonstrated in fig.5. This increase also correlates with spill data from Thames Water’s event duration monitoring (EDM) data which shows Cholsey STW, 4.5km upstream of sample point A, spilling for 30.25 hours prior to sampling.

Overall, at this sampling point, both EC and IE levels were ‘Good’, with an average of 289 MPN/100ml and 92 CFU/100ml respectively. This is the average if the 24/09/24 sample is disregarded; with that sample included, the average level of EC at this sampling point was ‘Poor’ at 3910 MPN/100ml, which is over 4x the minimum sufficient standard at the 90th percentile. The average level of IE with 24/09/24 included was also ‘Poor’ at 427 CFU/100ml, which is 1.3x the minimum sufficient standard at the 90th percentile.

[14] CFU = colony forming units
[15] MPN = most probable number

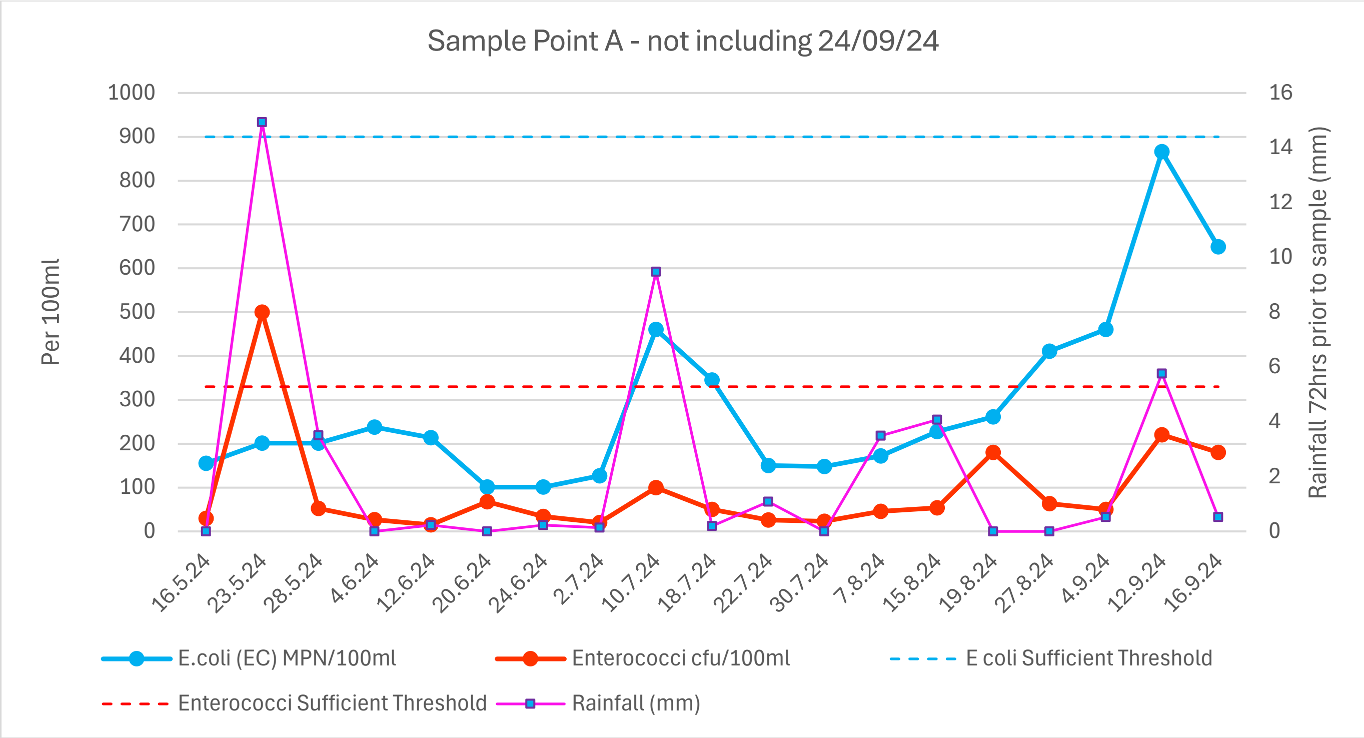

Figure 4 - FIO Levels with rainfall correlations (not including results from 24/09/24), sample point A

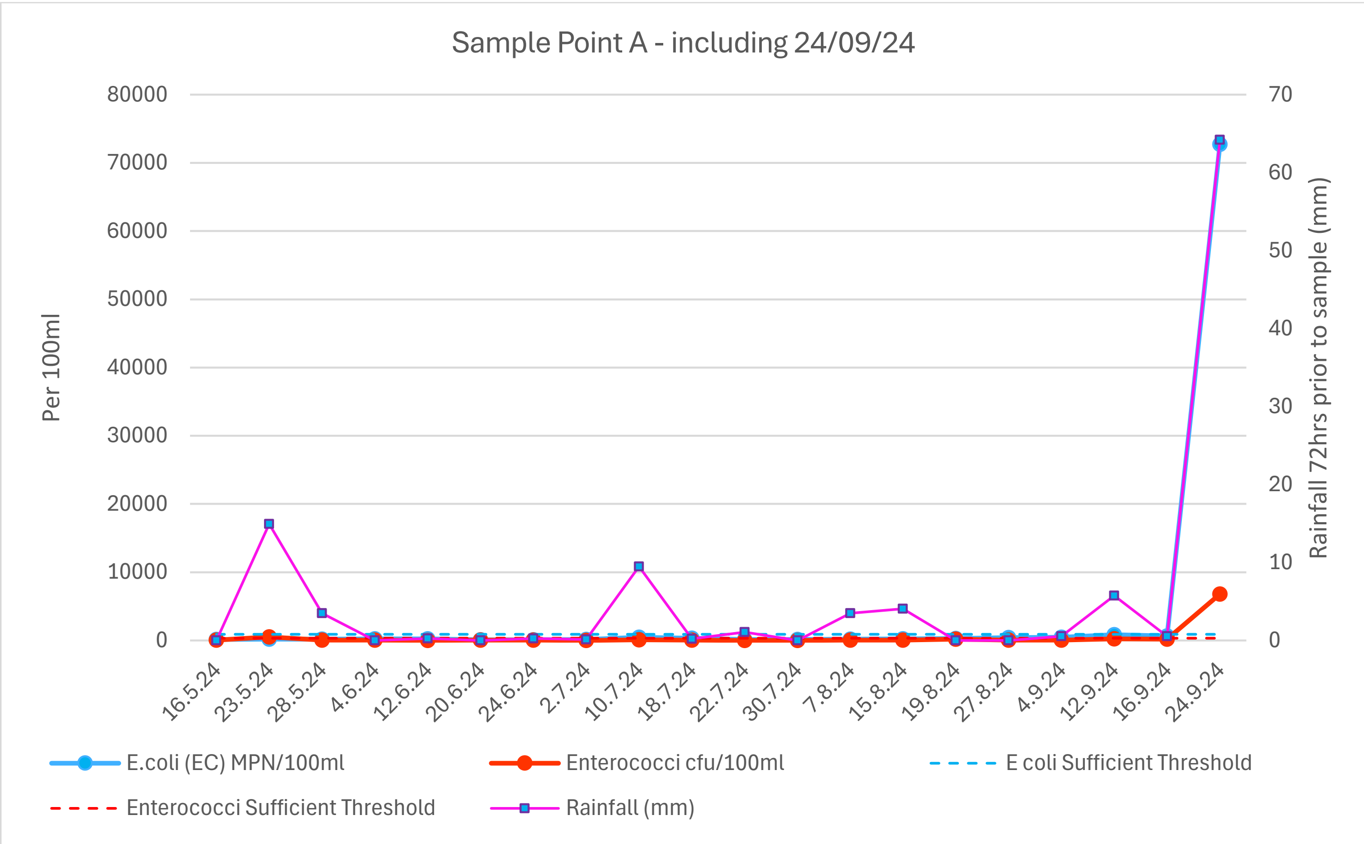

Figure 5 - FIO Levels with rainfall correlations (including results from 24/09/24), sample point A

5.2 Sample point B: Don Giovanni at the Leatherne Bottel

Table 8 - Overall bathing water status at 90th & 95th percentile (not including results from sampling date 24/09/24), sample point B

E. coli			overall status
90 PERCENTILE	813.48	Sufficient	Sufficient
95 PERCENTILE	1058.71	NA	

Enterococci			overall status
90 PERCENTILE	158.51	NA	Good
95 PERCENTILE	219.07	Good	

Table 9 - Overall bathing water status at 90th & 95th percentile (including results from sampling date 24/09/24), sample point B

E. coli			overall status
90 PERCENTILE	1519.44	Poor	Poor
95 PERCENTILE	2283.81	NA	

Enterococci			overall status
90 PERCENTILE	448.43	Poor	Poor
95 PERCENTILE	774.95	NA	

Table 10 -Weekly breakdown of results, sample point B

Date	E. coli (EC) MPN/100ml	Enterococci cfu/100ml	Weekly E. coli status	Weekly Enterococci status
16/05/2024	201	12	Good	Good
23/05/2024	201	200	Good	Good
28/05/2024	201	54	Good	Good
04/06/2024	980	25	Good	Good
12/06/2024	108	20	Good	Good
20/06/2024	165	34	Good	Good
24/06/2024	133	41	Good	Good
02/07/2024	179	33	Good	Good
10/07/2024	770	170	Good	Good
18/07/2024	816	180	Good	Good
22/07/2024	326	11	Good	Good
30/07/2024	214	28	Good	Good
07/08/2024	291	41	Good	Good
15/08/2024	225	50	Good	Good
19/08/2024	365	80	Good	Good
27/08/2024	770	240	Good	Good
04/09/2024	162	38	Good	Good
12/09/2024	517	160	Good	Good
16/09/2024	548	45	Good	Good
24/09/2024	16070	10000	Poor	Poor

NOTE: Cells highlighted in orange indicate where the result communicated from the laboratory was greater than (>) the number shown in this table. This inaccuracy risks invalidating results, so results highlighted in orange have therefore been removed from the overall EC status in table 10. Cells highlighted in pink indicate data that would be disregarded if following EA bathing water designation methodology due to rainfall conditions constituting an ‘abnormal situation’

At sample point B, bacteria levels were consistently ‘Good’, but some increases in EC levels resulted in an overall status of ‘Sufficient’. IE levels were consistently ‘Good’ throughout the bathing season leading to an overall status of ‘Good’. Dramatic spikes in bacteria occurred on 24/09/24. This upwards spike in FIO levels correlates closely with extremely heavy precipitation (64.2mm) in the 72 hours preceding the sampling date and time, as demonstrated in fig.7. This sample point is 0.7km downstream of Goring STW and over 5km downstream of Cholsey STWs. According to Thames Water’s EDM recordings, Goring STW recorded no discharges throughout the sampling period.

If the 24/09/24 sample is included, the average level of EC at this sampling point becomes ‘Poor’ at 1162 MPN/100ml, which is over 1.3x the minimum sufficient standard at the 90th percentile. The average level of IE with 24/09/24 included was also ‘Poor’ at 573 CFU/100ml, which is 1.7x the minimum sufficient standard at the 90th percentile.

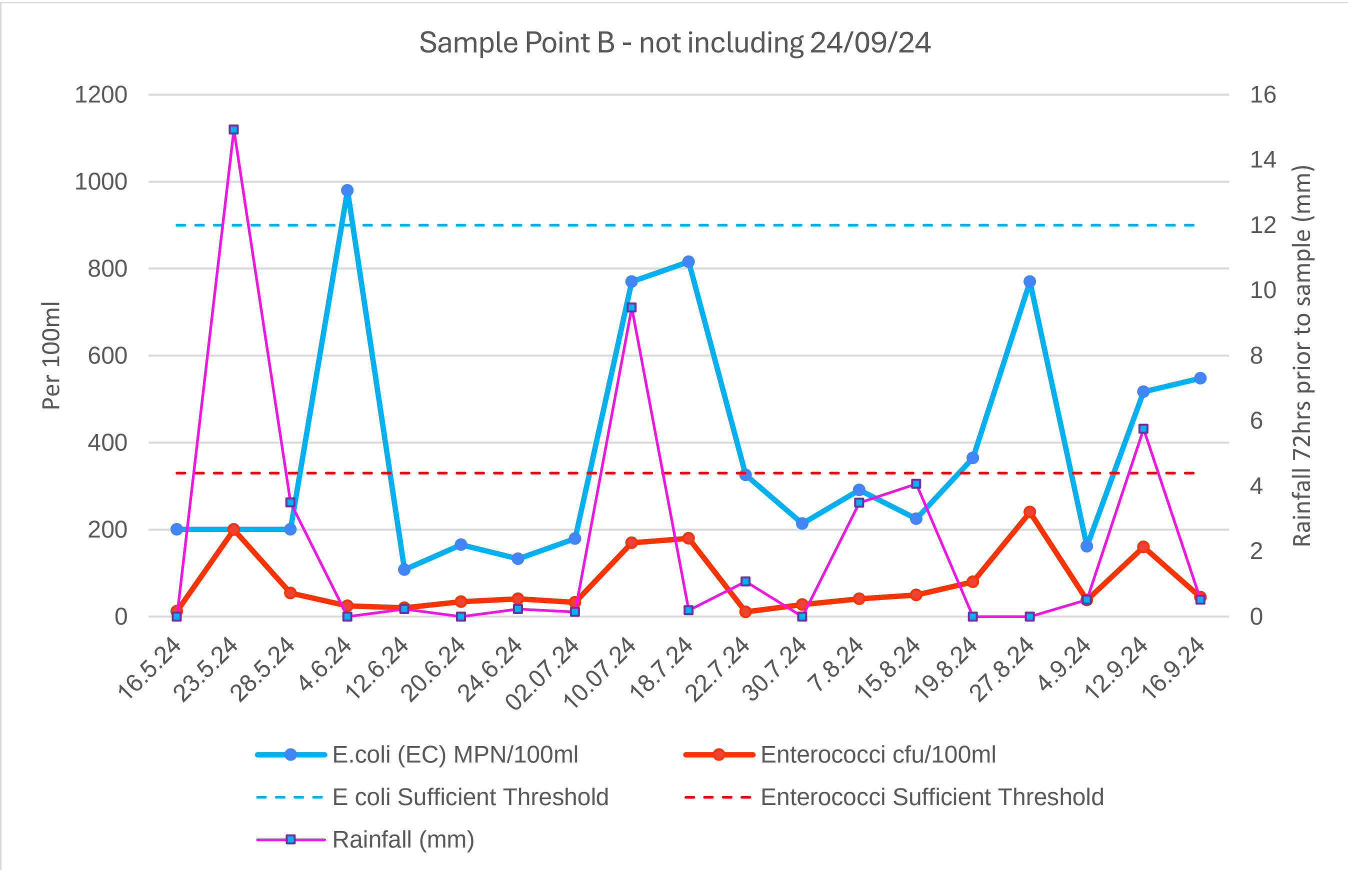

Figure 6 - FIO Levels with rainfall correlations (not including results from 24/09/24), sample point B

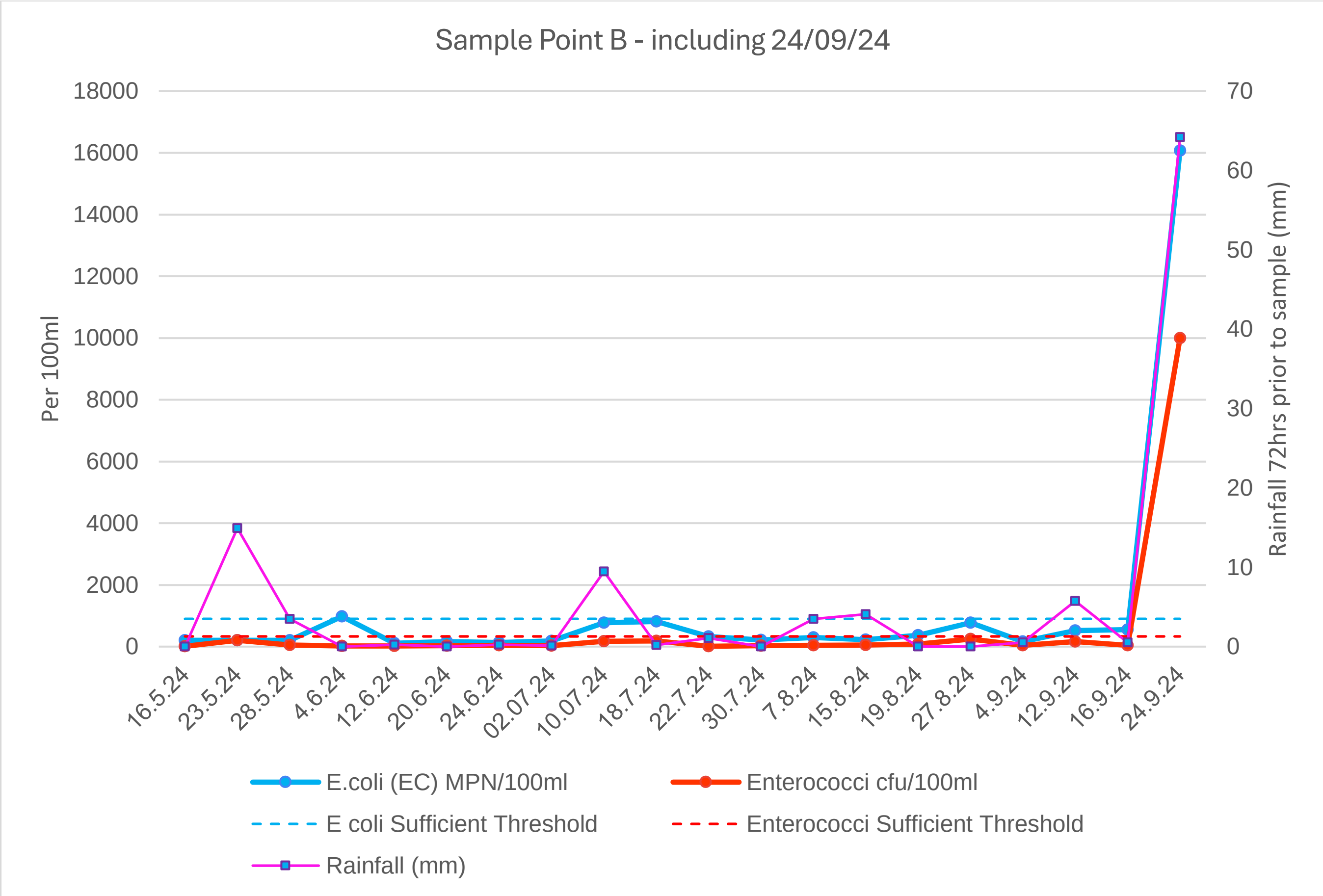

Figure 7 - FIO Levels with rainfall correlations (including results from 24/09/24), sample point B

5.3 Sample point C: Ferry Lane, Goring

Table 11 - Overall bathing water status at 90th & 95th percentile (not including results from sampling date 24/09/24), sample point C

E. coli			overall status
90 PERCENTILE	740.03	NA	Good
95 PERCENTILE	982.70	Good	

Enterococci			overall status
90 PERCENTILE	175.08	NA	Good
95 PERCENTILE	253.23	Good	

Table 12 - Overall bathing water status at 90th & 95th percentile (including results from sampling date 24/09/24), sample point C

E. coli			overall status
90 PERCENTILE	2080.76	Poor	Poor
95 PERCENTILE	3459.39	NA	

Enterococci			overall status
90 PERCENTILE	455.42	Poor	Poor
95 PERCENTILE	802.89	NA	

Table 13 – Weekly breakdown of results, sample point C

Date	E. coli (EC) MPN/100ml	Enterococci cfu/100ml	Weekly E. coli status	Weekly Enterococci status
16/05/2024	130	31	Good	Good
23/05/2024	201	70	Good	Good
28/05/2024	201	60	Good	Good
04/06/2024	435	5	Good	Good
12/06/2024	71	180	Good	Good
20/06/2024	130	9	Good	Good
24/06/2024	214	32	Good	Good
02/07/2024	142	32	Good	Good
10/07/2024	579	200	Good	Good
18/07/2024	548	71	Good	Good
22/07/2024	120	23	Good	Good
30/07/2024	276	15	Good	Good
07/08/2024	179	43	Good	Good
15/08/2024	236	61	Good	Good
19/08/2024	1203	71	Poor	Good
27/08/2024	1046	220	Poor	Good
04/09/2024	365	57	Good	Good
12/09/2024	461	130	Good	Good
16/09/2024	308	64	Good	Good
24/09/2024	51720	10000	Poor	Poor

NOTE: Cells highlighted in orange indicate where the result communicated from the laboratory was greater than (>) the number shown in this table. This inaccuracy risks invalidating results, so results highlighted in orange have therefore been removed from the overall EC status in table 13. Cells highlighted in pink indicate data that would be disregarded if following EA bathing water designation methodology due to rainfall conditions constituting an 'abnormal situation'

At sample point C, bacteria levels were consistently 'Good'. Exceptions include a small increase in EC levels leading to 'Poor' results on 19/08/24 and 27/08/24. Levels on EC on these dates were nevertheless relatively low, enough that they did not affect the overall bathing water status at this sample point. The only other increase in both EC and IE above the threshold of 'Good' occurred on 24/09/24, with EC increasing to 51720 MPN/100ml and IE increasing to >10000 CFU/100ml. This upwards spike in FIO levels correlates closely with extremely heavy precipitation (64.2mm) in the 72 hours preceding the sampling date and time, as demonstrated in fig.9. This sample point is downstream of Streatley, Goring and Cholsey STWs. According to Thames Water's EDM recordings, Goring STW recorded no discharges throughout the sampling period and Streatley STW does not have an EDM installed.

Overall, at sample point C, both EC and IE levels were 'Good' with an average of 360 MPN/100ml and 72 CFU/100ml respectively. If the 24/09/24 sample is included, the average level of EC at this sampling point becomes 'Poor' at 2928 MPN/100ml, which is over 3x the minimum sufficient standard at the 90th percentile. The average level of IE with 24/09/24 included was also 'Poor' at 569 CFU/100ml, which is over 1.7x the minimum sufficient standard at the 90th percentile.

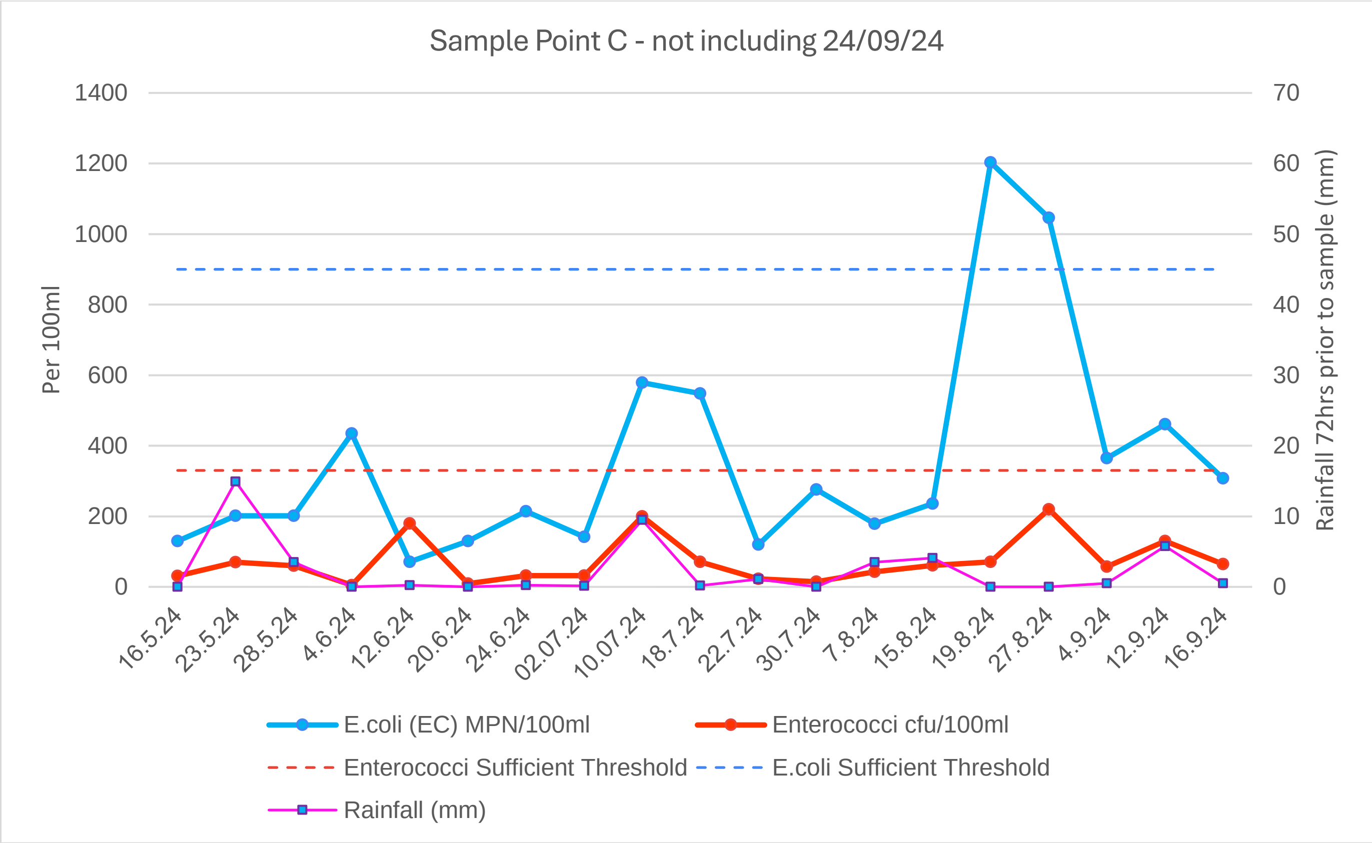

Figure 8 - FIO Levels with rainfall correlations (not including results from 24/09/24), sample point C

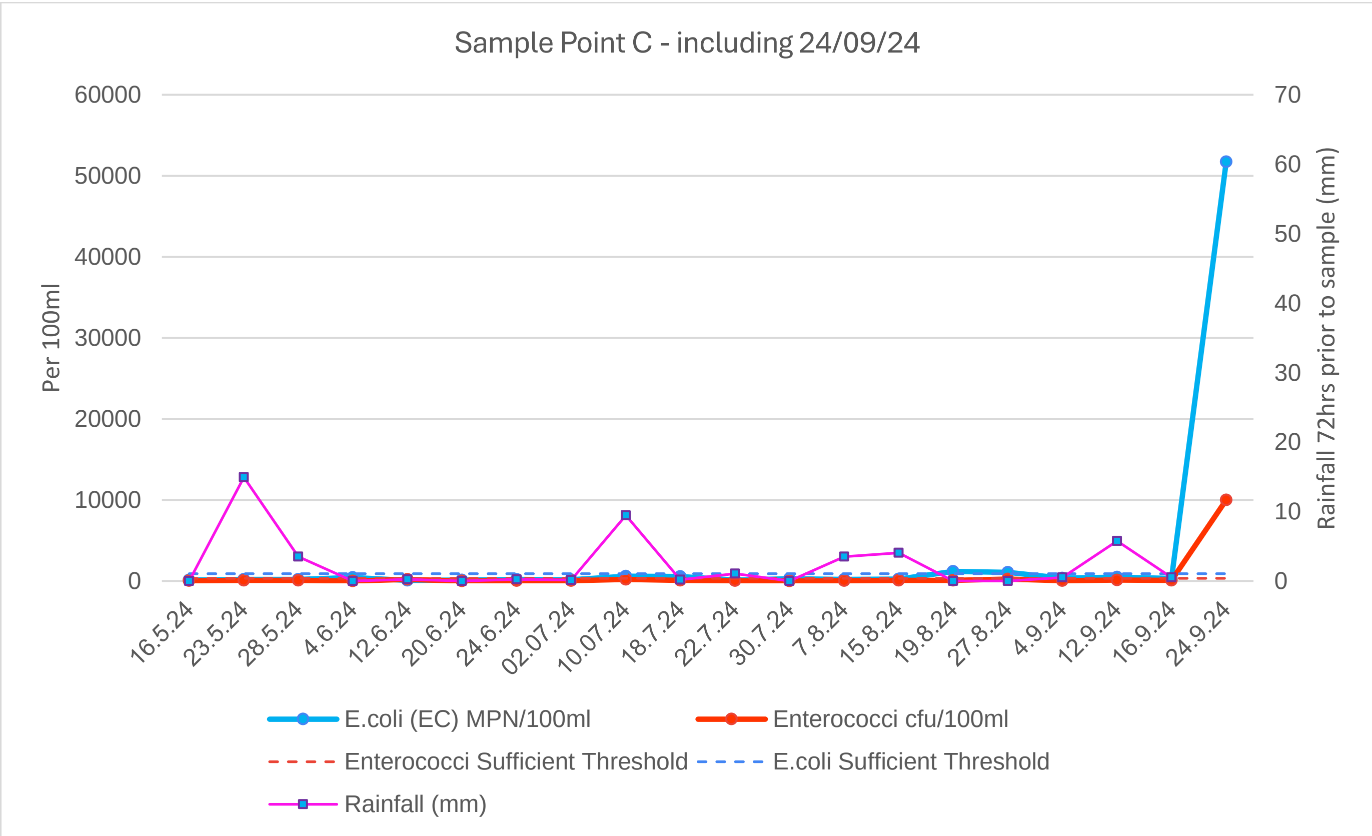

Figure 9 - FIO Levels with rainfall correlations (including results from 24/09/24), sample point C

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5.4 Sample point D: Beale Wildlife Park, Lower Basildon

Table 14 - Overall bathing water status at 90th & 95th percentile (not including results from sampling date 24/09/24), sample point D

E. coli			overall status
90 PERCENTILE	457.90	NA	Good
95 PERCENTILE	616.29	Good	

Enterococci			overall status
90 PERCENTILE	84.51	NA	Excellent
95 PERCENTILE	110.53	Excellent	

Table 15 - Overall bathing water status at 90th & 95th percentile (not including results from sampling date 24/09/24), sample point D

E. coli			overall status
90 PERCENTILE	1385.86	Poor	Poor
95 PERCENTILE	2353.29	NA	

Enterococci			overall status
90 PERCENTILE	287.06	Sufficient	Sufficient
95 PERCENTILE	491.39	NA	

Table 16 – Weekly breakdown of results, sample point D

Date	E. coli (EC) MPN/100ml	Enterococci cfu/100ml	Weekly E. coli status	Weekly Enterococci status
16/05/2024	105	13	Good	Good
23/05/2024	201	70	Good	Good
28/05/2024	201	47	Good	Good
04/06/2024	461	24	Good	Good
12/06/2024	45	7	Good	Good
20/06/2024	89	15	Good	Good
24/06/2024	75	56	Good	Good
02/07/2024	158	38	Good	Good
10/07/2024	172	56	Good	Good
18/07/2024	326	32	Good	Good
22/07/2024	79	14	Good	Good
30/07/2024	93	60	Good	Good
07/08/2024	248	28	Good	Good
15/08/2024	172	51	Good	Good
19/08/2024	99	32	Good	Good
27/08/2024	866	75	Good	Good
04/09/2024	93	17	Good	Good
12/09/2024	579	130	Good	Good
16/09/2024	210	30	Good	Good
24/09/2024	41060	10000	Poor	Poor

NOTE: Cells highlighted in orange indicate where the result communicated from the laboratory was greater than (>) the number shown in this table. This inaccuracy risks invalidating results, so results highlighted in orange have therefore been removed from the overall EC status in table 16. Cells highlighted in pink indicate data that would be disregarded if following EA bathing water designation methodology due to rainfall conditions constituting an 'abnormal situation'

At sample point D, bacteria levels were consistently 'Good'. As with previous sample points, the only increase in both EC and IE above the threshold of 'Good' occurred on 24/09/24, with EC increasing to 41060 MPN/100ml and IE increasing to >10000 CFU/100ml. This upwards spike in FIO levels correlates closely with extremely heavy precipitation (64.2mm) in the 72 hours preceding the sampling date and time, as demonstrated in fig. 11. This sample point is downstream of Streatley, Goring & Cholsey STW. Sample point D is also downstream of Lower Basildon STW, but as there is no EDM at this works, it is not possible to determine its impact on water quality at this site.

Overall, at sample point D, both EC and IE levels were 'Good', averaging at 225 MPN/100ml and 42 CFU/100ml respectively. If the 24/09/24 sample is included, the average level of EC at this sampling point becomes 'Poor' at 2267 MPN/100ml, which is over 2.5x the minimum sufficient standard at the 90th percentile. The average level of IE with 24.09.24 included was also 'Poor' at 540 CFU/100ml, which is 1.6x the minimum sufficient standard at the 90th percentile.

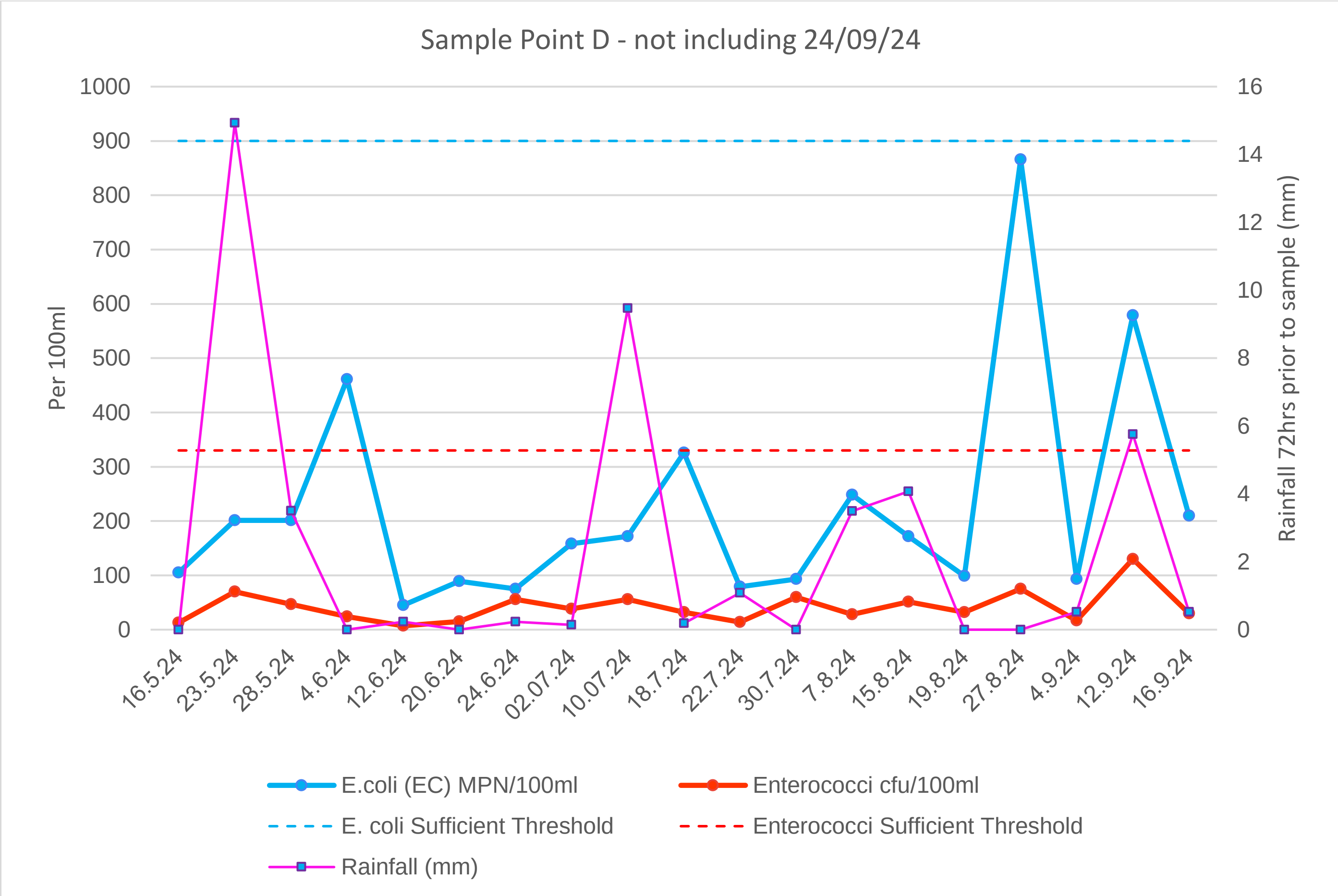

Figure 10 - FIO Levels with rainfall correlations (not including results from 24/09/24), sample point D

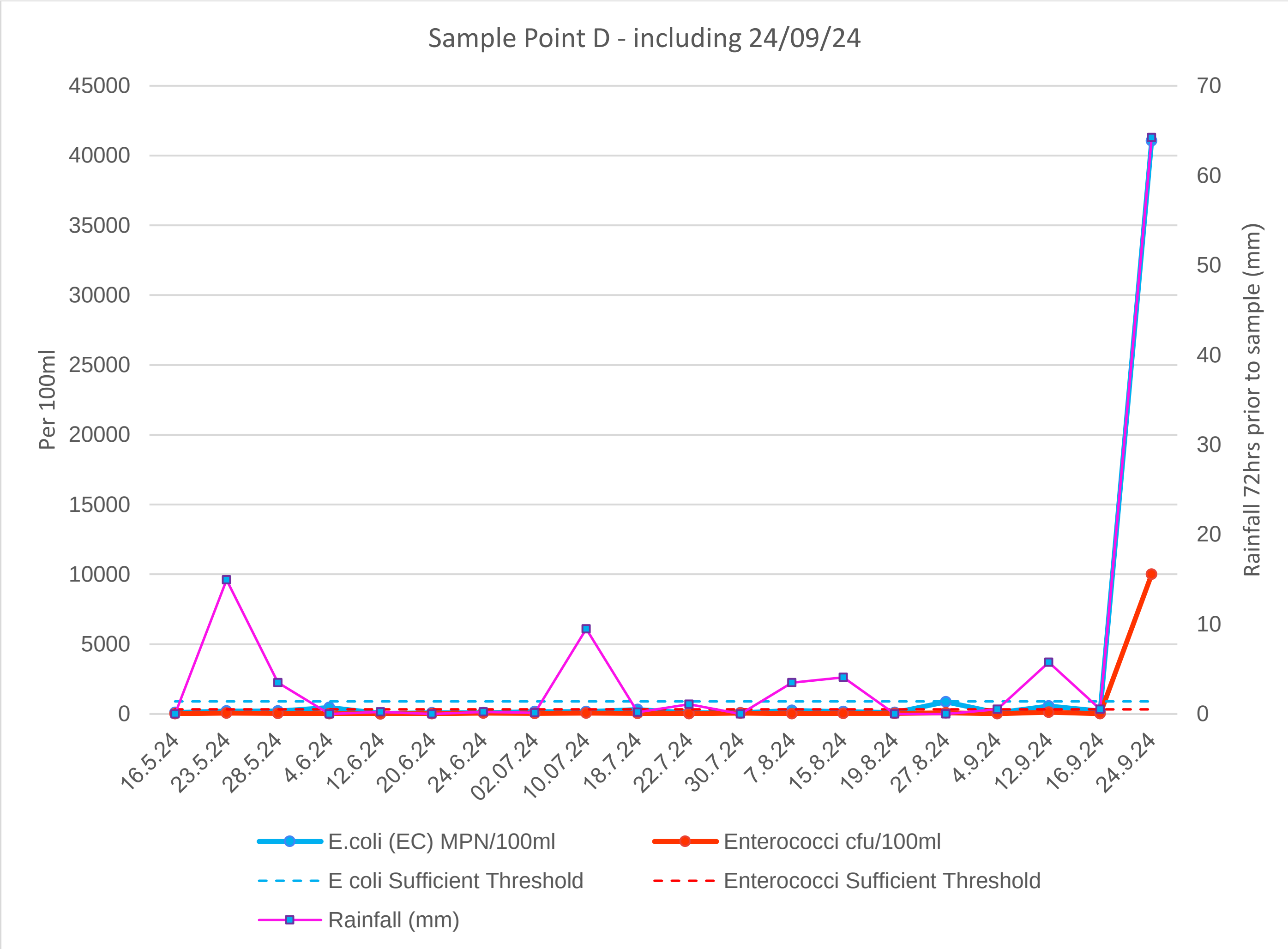

Figure 11 - FIO Levels with rainfall correlations (including results from 24/09/24), sample point D

5.5 Sample point E: Pangbourne Meadows

Table 17 - Overall bathing water status at 90th & 95th percentile not (including results from sampling date 24/09/24), sample point E

E. coli			overall status
90 PERCENTILE	662.12	NA	Good
95 PERCENTILE	874.18	Good	

Enterococci			overall status
90 PERCENTILE	224.89	NA	Good
95 PERCENTILE	365.12	Good	

Table 18 - Overall bathing water status at 90th & 95th percentile (including results from sampling date 24/09/24), sample point E

E .coli			overall status
90 PERCENTILE	1438.87	Poor	Poor
95 PERCENTILE	1950.78	NA	

Enterococci			overall status
90 PERCENTILE	434.83	Poor	Poor
95 PERCENTILE	701.01	NA	

Table 19 - Weekly breakdown of results, sample point E

Date	E. coli (EC) MPN/100ml	Enterococci cfu/100ml	Weekly E. coli status	Weekly Enterococci status
16/05/2024	120	20	Good	Good
23/05/2024	201	88	Good	Good
28/05/2024	201	45	Good	Good
04/06/2024	210	1	Good	Good
12/06/2024	102	15	Good	Good
20/06/2024	145	26	Good	Good
24/06/2024	67	33	Good	Good
02/07/2024	152	27	Good	Good
10/07/2024	228	12	Good	Good
18/07/2024	365	59	Good	Good
22/07/2024	248	18	Good	Good
30/07/2024	172	92	Good	Good
07/08/2024	140	38	Good	Good
15/08/2024	770	66	Good	Good
19/08/2024	1046	230	Poor	Good
27/08/2024	548	55	Good	Good
04/09/2024	387	500	Good	Poor
12/09/2024	727	180	Good	Good
16/09/2024	345	62	Good	Good
24/09/2024	54750	5500	Poor	Poor

NOTE: Cells highlighted in orange indicate where the result communicated from the laboratory was greater than (>) the number shown in this table. This inaccuracy risks invalidating results, so results highlighted in orange have therefore been removed from the overall EC status in table 19. Cells highlighted in pink indicate data that would be disregarded if following EA bathing water designation methodology due to rainfall conditions constituting an 'abnormal situation'

At sample point E, bacteria levels were consistently 'Good'. The only exceptions were on 19.08.24 when EC levels increased 1046 MPN/100ml, and 04/09/24 when IE levels increased to 500 CFU/100ml. These increases were not significant to affect the overall 'Good' bathing status for both bacteria at this sample point, but are of note as they do not correlate with heavier rainfall prior to sampling. This is could suggest a number of diffuse pollution sources, including increased river use or misconnections, but further evidence would be needed to confirm the cause of this spike in FIO levels.

As with previous sample points, the other, more dramatic increase in both EC and IE above the threshold of 'Good' occurred on 24/09/24, with EC increasing to 54750 MPN/100ml and IE increasing to 5500 CFU/100ml. This upwards spike in FIO levels correlates closely with extremely heavy precipitation in the 72 hours preceding the sampling date and time, as demonstrated in fig. 13.

Overall, at sample point E, both EC and IE levels were 'Good' with an average of 325 MPN/100ml and 83 CFU/100ml respectively. If the 24/09/24 sample is included, the average level of EC at this sampling point becomes 'Poor' at 3046 MPN/100ml, which is over 3x the minimum sufficient standard at the 90th percentile. The average level of IE with 24/09/24 included was also 'Poor' at 353 CFU/100ml, which is just over the minimum sufficient standard of 330 CFU/100ml at the 90th percentile. Sample point E is also downstream of Lower Basildon STW, but as there is no EDM at this works, it is not possible to determine its impact on water quality at this site.

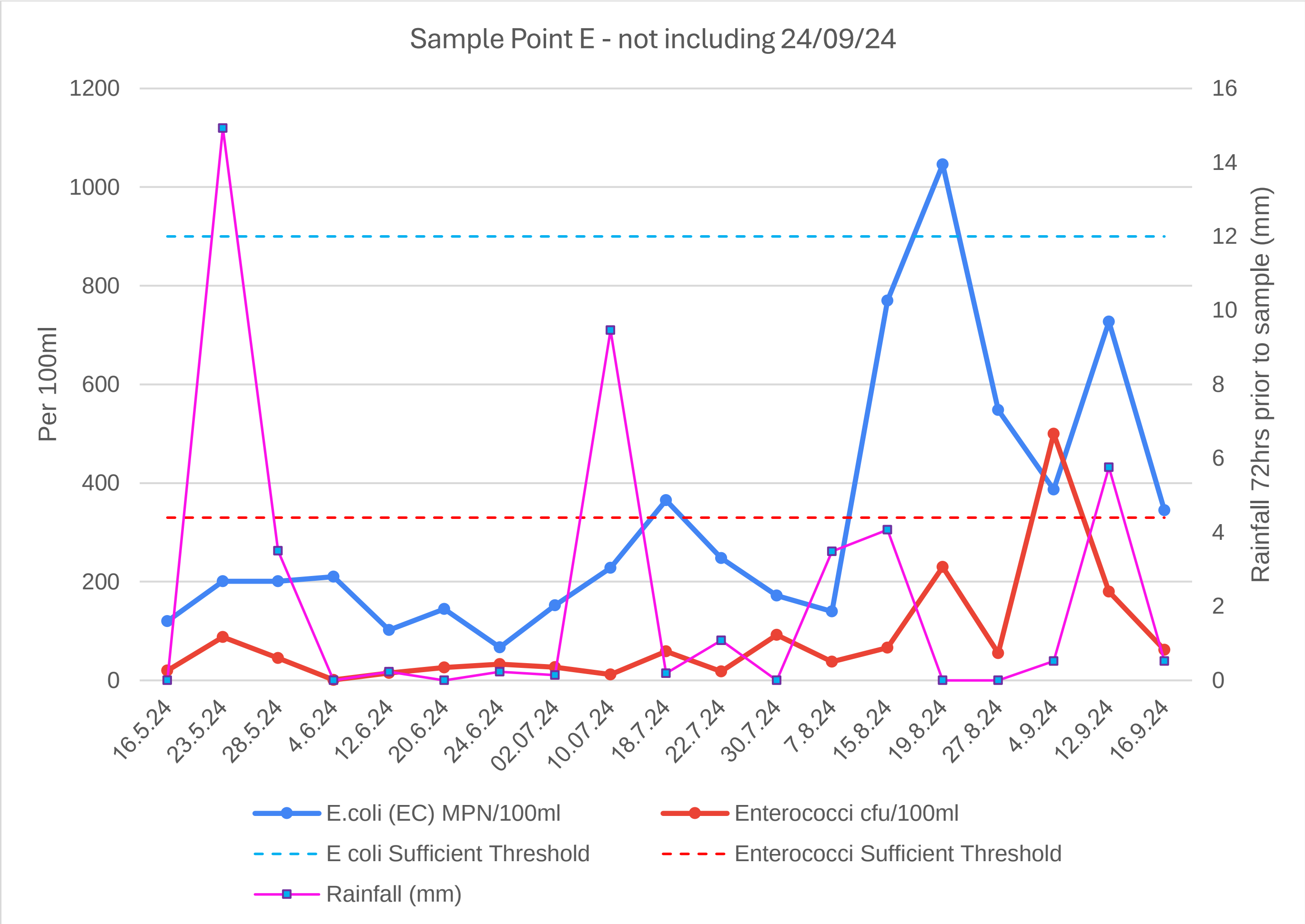

Figure 12 - FIO Levels with rainfall correlations (not including results from 24/09/24), sample point E

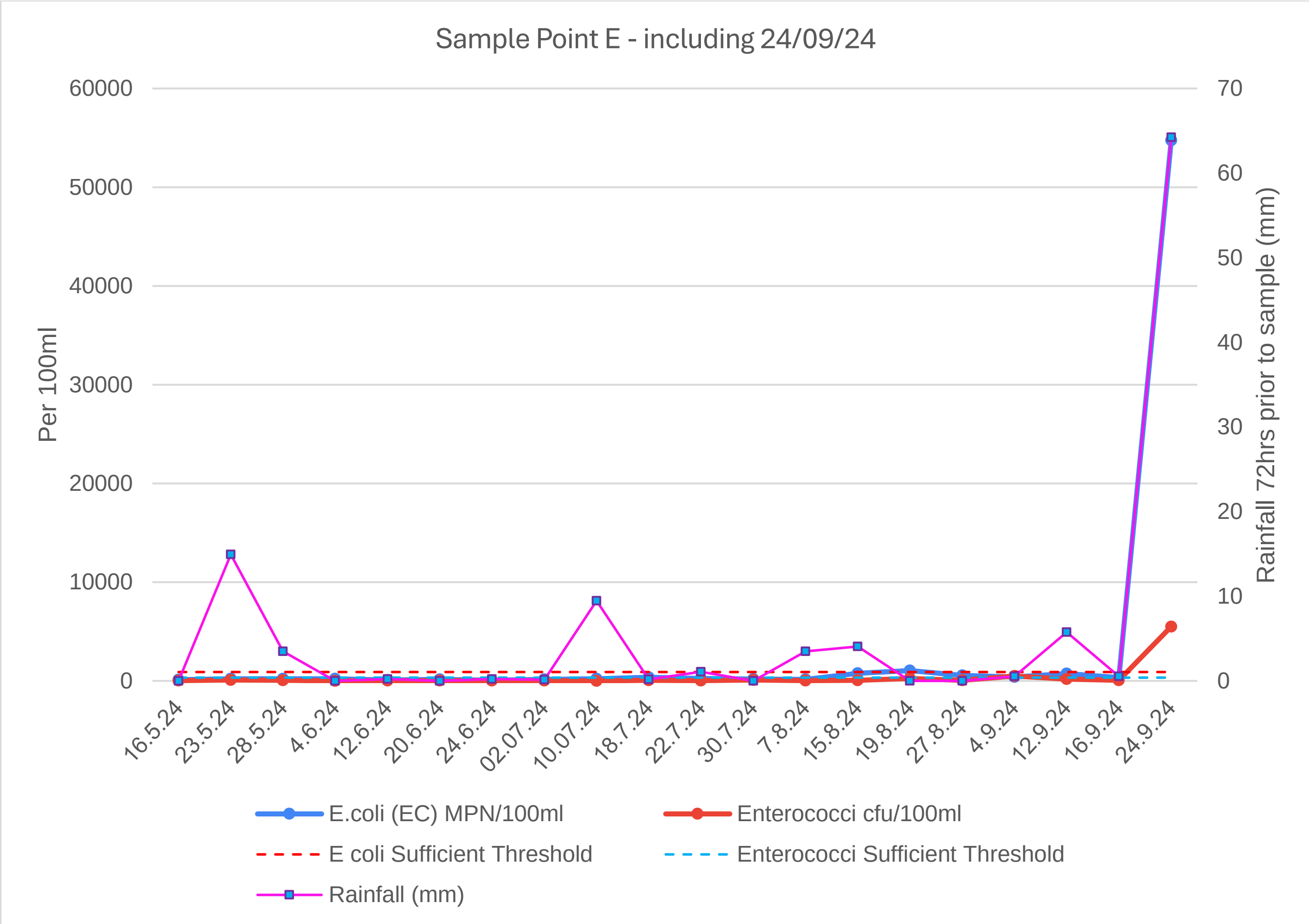

Figure 13 - FIO Levels with rainfall correlations (including results from 24/09/24), sample point E

4.6 Sample point F: Sulham Brook, Pangbourne

Table 20 - Overall bathing water status at 90th & 95th percentile (not including results from sampling date 24/09/24), sample point F

E. coli			**overall status**
90 PERCENTILE	486.41	NA	Good
95 PERCENTILE	602.95	Good	

Enterococci			**overall status**
90 PERCENTILE	536.85	Poor	Poor
95 PERCENTILE	815.19	NA	

Table 21 - Overall bathing water status at 90th & 95th percentile (including results from sampling date 24/09/24), sample point F

E. coli			**overall status**
90 PERCENTILE	1752.60	Poor	Poor
95 PERCENTILE	2905.89	NA	

Enterococci			**overall status**
90 PERCENTILE	756.11	Poor	Poor
95 PERCENTILE	1214.17	NA	

Table 22 - Weekly breakdown of results, sample point F

Date	E. coli (EC) MPN/100ml	Enterococci cfu/100ml	Weekly E. coli status	Weekly Enterococci status
16/05/2024	192	410	Good	Poor
23/05/2024	201	160	Good	Good
28/05/2024	201	400	Good	Poor
04/06/2024	411	8	Good	Good
12/06/2024	140	110	Good	Good
20/06/2024	145	530	Good	Poor
24/06/2024	107	320	Good	Good
02/07/2024	107	30	Good	Good
10/07/2024	236	880	Good	Poor
18/07/2024	435	78	Good	Good
22/07/2024	162	53	Good	Good
30/07/2024	102	74	Good	Good
07/08/2024	225	51	Good	Good
15/08/2024	365	79	Good	Good
19/08/2024	166	71	Good	Good
27/08/2024	326	270	Good	Good
04/09/2024	308	150	Good	Good
12/09/2024	517	260	Good	Good
16/09/2024	649	76	Good	Good
24/09/2024	64880	2400	Poor	Poor

NOTE: Cells highlighted in orange indicate where the result communicated from the laboratory was greater than (>) the number shown in this table. This inaccuracy risks invalidating results, so results highlighted in orange have therefore been removed from the overall EC status in table 22. Cells highlighted in pink indicate data that would be disregarded if following EA bathing water designation methodology due to rainfall conditions constituting an 'abnormal situation'

At sample point F, EC levels were consistently 'Good' (see note). Meanwhile, IE levels were less consistent, breaching 'Poor' status on four sampling dates, which brought the overall bathing water status down for IE to 'Poor'. The only exception for EC was on 24/09/24, when EC levels increased to 64880 MPN/100ml. EC levels also increased on this date, to 2400 CFU/100ml. This increase in both FIOs correlates closely with heavy precipitation in the 72 hours prior to sampling, as demonstrated in fig.15.

Of note at this sample point is the trend in the first half of the sampling period of a higher ratio of IE to EC. As noted in section 3.3, IE has a longer survival rate than EC in river environments, which may contribute to this ratio, but without further investigation it is not possible to determine the source of raised IE counts. Possible pollution inputs at this site could include treated effluent from Pangbourne STW which is located between sample points E and F. According to the results of an EIR request for historic EDM data, Pangbourne STW did not discharge untreated sewage during the sampling period. Real-time testing is thus recommended to better understand the source of FIO pollution at this site.

Overall, at sample point F, EC levels were 'Good' with an average of 263 MPN/100ml. If the 24/09/24 sample is included, the average level of EC at this sampling point becomes 'Poor' at 3494 MPN/100ml, which is almost 4x the minimum sufficient standard at the 90th percentile. IE levels at sample point F were 'Poor', with an average of 211 CFU/100ml, demonstrating the effect of early 'Poor' results in May, June, and July on the overall status. The average level of IE with 24/09/24 included was 321 CFU/100ml.

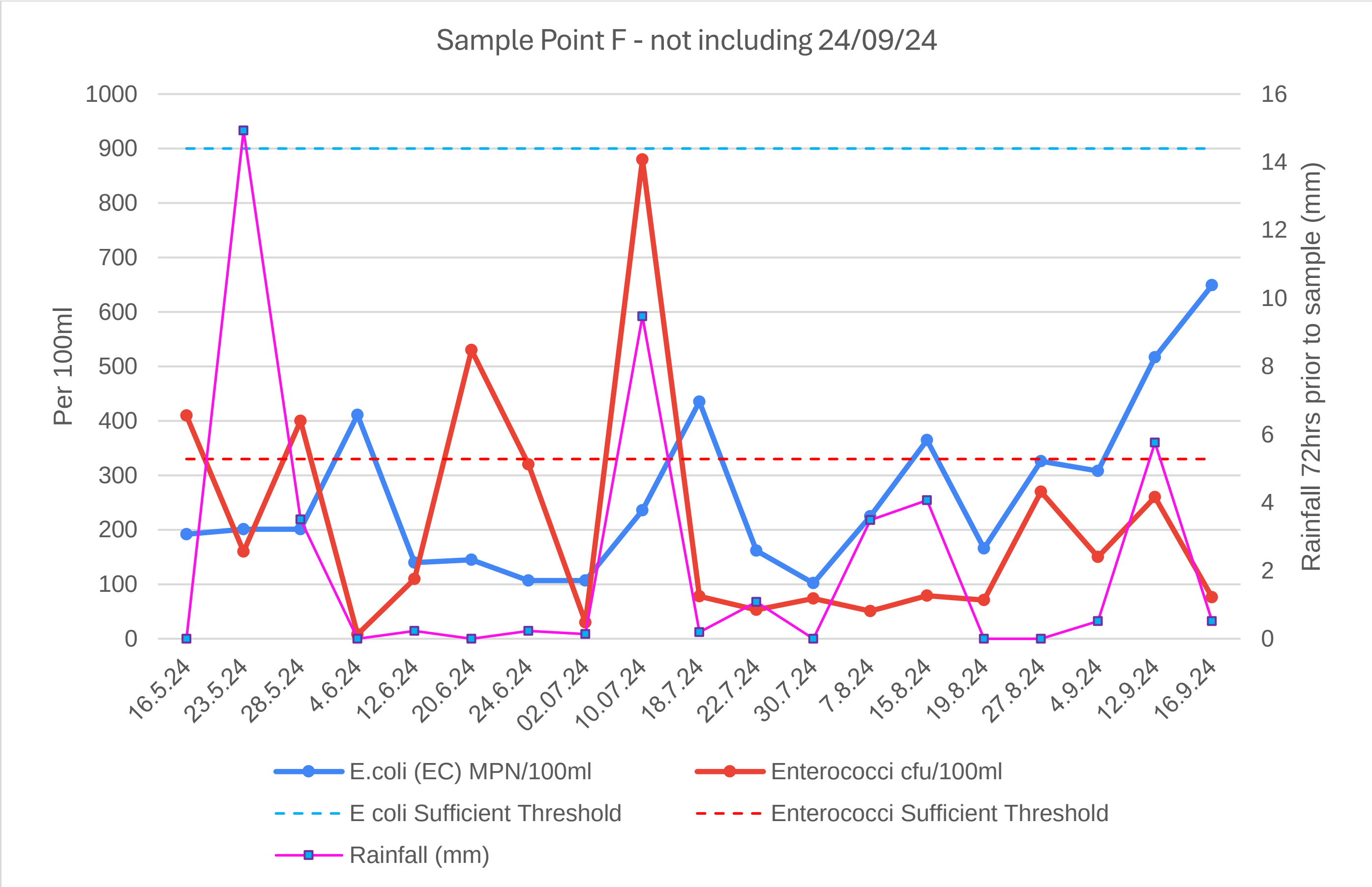

Figure 34 - FIO Levels with rainfall correlations (not including results from 24/09/24), sample point F

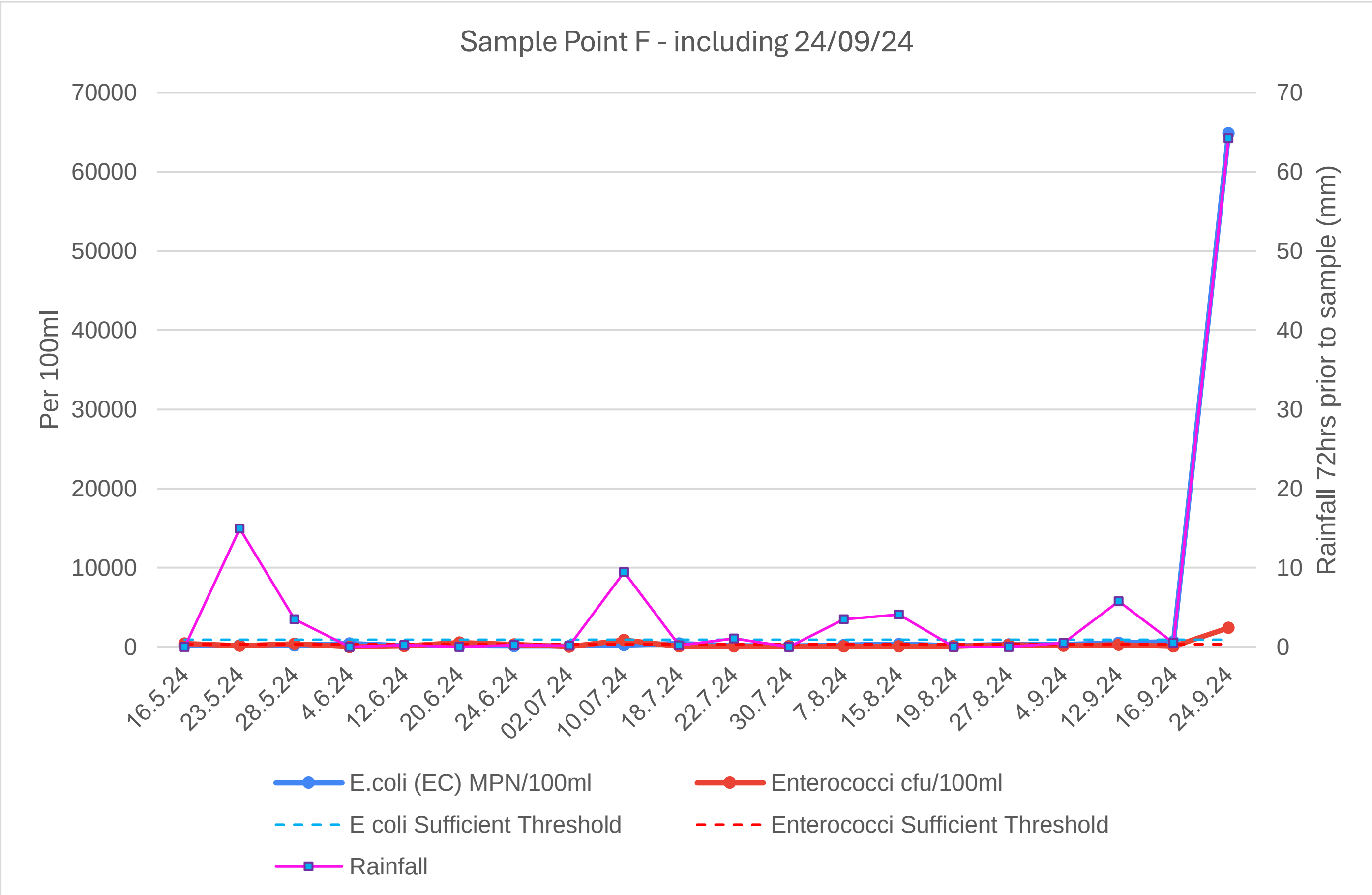

Figure 15 - FIO Levels with rainfall correlations (including results from 24/09/24), sample point F

5. Limitations

Lab Analysis

Due to errors in lab analysis as described in section 3.1, some E. coli results have been removed, to mitigate risk of invalidating the overall bathing water status. This means overall classifications for E. coli at some sample points are based on 17 or 18 weeks' worth of data. According to EA bathing water standards methodology, 10 weeks or more of data is deemed sufficient to calculate a bathing status. Therefore, the bathing water results outlined above can be considered robust classifications. Nevertheless, further monitoring during periods of heavy rainfall would improve the validity of these findings and confirm trends in FIO increases after heavy rainfall seen at these sample points.

The 2024 bathing water season in this region was characterised by dry, warm weather, until a period of heavy rainfall in September, with less extreme heat as seen in previous summers. To create a more representative picture of water quality on this stretch of the Thames, testing should be continued in different seasons, which would also help to identify the sources of bacterial pollution that created spikes in FIOs at various sample points across the season. To gain an even more thorough understanding of the source of the pollution, microbial source tracking could be used, which is a technique which can determine whether, and which proportions, of the FIO originate from humans or from other animals. More frequent and real-time monitoring and analysis of bacterial water quality data would also help improve understanding of how bacteria persists and/or degrades in river environments as it moves downstream.

6. Conclusion

As indicated in tables 5-22, and figure 1, all sample points except point F (Sulham Brook) met bathing water standards for both FIOs. Increases in FIO levels at the end of the bathing season correlate with heavy rainfall in the 72 hours preceding sampling date 24/09/24. These are an example of results that would be disregarded under EA testing methodology, due to the 'abnormal situation' in which they occurred, meaning they would not represent the normal conditions in which most people would choose to use the river.

Most of this stretch of the River Thames appears to be less affected by bacterial pollution than sites up and downstream such as Wolvercote[16], Wallingford[17], and Wargrave[18], except in periods of extreme rainfall. The slightly raised E. coli levels at sample point B also did not appear to impact water quality at sample points downstream. However, spikes in FIO levels at sample points B and F indicate the need for further investigations into potential pollution sources.

The results of this monitoring programme indicate that Cholsey, Goring and Streatley STWs upstream of Pangbourne are functioning effectively during dry weather, but periods of heavy rainfall likely caused Cholsey STW to reach capacity and discharge, with negative impacts on water quality. Increases in FIO levels observed late in the programme correlate with heavy rainfall in the 72 hours prior to sampling and appear to correlate to the EDM spill events at Cholsey STW, with the ratio of EC:IE of at least 2:1 at all sample points displaying the hallmarks of point source impacts.

Pangbourne STW, meanwhile, could be a possible source of the higher IE counts seen throughout the bathing season at sample point F, which recorded 'Poor' status at the 90th percentile. At present, sewage is legally only treated to environmental and not public health standards, under the conditions of the Bathing Water designation this would change with obligations for all WwTW sites impacting the designated stretch to treat the sewage to public health standards.

Climate change is likely to continue to trigger extreme and sporadic weather events, such as heavy rainfall and drought during the bathing season, meaning the poor conditions seen towards the end of the 2024 season may be seen more frequently throughout future seasons. This highlights the need for improved governance and regulation to futureproof our waterway infrastructure and river health so that it is fit for the demands of the 21st century.

[16] https://www.thames21.org.uk/2023/12/wolvercote-mill-stream-designated-as-poor-for-third-year-running-but-improvements-on-the-way/

[17] https://www.thames21.org.uk/wp-content/uploads/2023/11/Wallingford-Beach-Water-Quality-Report-2023.pdf

[18] https://www.thames21.org.uk/wp-content/uploads/2023/11/Mill-Meadows-Henley-on-Thames-Water-Quality-Report-2023.pdf

This monitoring programme contributes much-needed data to the understanding of river health on this stretch of the Thames, which is frequently used by swimmers, paddlers and rowers. To further validate the evidence collected during this bathing water season, a repeat of this citizen science monitoring programme would be beneficial in building a more robust data set. With it being the only statutory monitoring of bacteria levels on rivers at present, bathing water data collected and disseminated by the EA should be easier to access and be presented in a format more tangible to the everyday public, with explanations of the meaning of the data, and what it means for water safety. This, along with programmes such as the Reclaim Our Rivers project, would improve the transparency of data communication, and consequently improve safety for all those wishing to enjoy England's rivers, lakes and seas.

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8. Appendices

8.1 Appendix 1: Sampling Protocol

1. Take samples as close to the centre of the stream as it is possible to safely do. Take samples upstream where possible.

2. Before taking sample, check for river users e.g. passing boats.

3. To take a sample, put gloves on, fill up and empty the sampling bucket in the river water a minimum of 3 times to rinse bucket.

4. Then fill sampling bucket once more, this time ensuring bucket is as full as possible.

5. Pour the sample water into the pre-labelled red-lidded microbiology bottles up to the 500ml mark.

6. **Very important:** send message with details of sample: photo clearly depicting sample point and time sample was taken. Notepad will be kept in bag if preferred for keeping record, but images will still need to be sent.

7. Using a disinfectant wipe clean sample bottle and all surfaces of the sampling bucket and the first few feet of the sample rope thoroughly making sure all are covered and then allow to air dry/dry with kitchen roll.

8. After the sample is taken, put sample in bag as soon as possible to minimise sunlight.

9. Change gloves between sampling points. Used gloves, wipes and other rubbish can be placed in the rubbish zip lock bag provided, to be disposed of at the end of the day in regular rubbish bin.

10. Repeat steps 1-10 for each of the next sampling points. For sample point **E** – bathing water site, take note of visuals

11. Once all samples are taken the sampling bucket is to be cleaned by using virkon spray bottle and kitchen roll.