

# A River fit for swimming Oxford: Citizen Science sampling Interim Report

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## **Introduction**

Due to restrictions on travel and indoor activities during the pandemic more people than ever are connecting with their local waterways and countryside there has been a rise in the number of people taking to their local River for recreation and exercise. With a rapid growth in recreational activities such as wild swimming, kayaking, paddleboarding and angling this has led to a growing interest in natural history and environmental issues. leading to rivers transforming from being viewed as 'dirty' or dangerous to a treasured place in many peoples' minds.

This has been seen very clearly in Oxford in the last six months of 2020. It is not an exaggeration to say the rivers are the lifeblood of the city: from the students rowing and punting on them, to the popular riverside nature reserves where locals have swum for decades, to the tourist boat tours, to the resident canal boat community. People in Oxford care deeply about having clean, healthy rivers for people and wildlife, and have been very concerned by the Environment Agency (EA) reports that not a single river passes the chemical pollution standards set out in the Water Framework Directive (WFD), and by media reports about the issue of sewer storm overflows discharging untreated sewage into UK rivers.

In the light of this, the #endsewagepollution mid-Thames campaign was established in the summer of 2020 and following the initiation of a formal partnership with Thames Water , Thames21 and The Rivers Trust a sustainable and professionally managed citizen science and community engagement program was established alongside the application for designated bathing water status being progressed by Oxford City Council.

In this report we will cover the results to date of the bacterial water quality monitoring that began in January 2021 with Thames Water sampling the four popular River Thames recreational sites in Oxford, for the presence of Faecal Indicator Organisms (FIOs) and continued with the trained volunteers taking over the sampling of the four recreational sites and a further fourteen sites around the wider catchment in April 2021.

The parameters tested for in the water quality assessment was the presence of the FIOs which are bacteria that are only present in the faeces and urine of warm-blooded animals that potentially pose a risk to public health. The two FIO bacteria tested for are *Escherichia coli* and *Intestinal Enterococci* 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.

The principal goal of the project is to assess the four recreational sites against the Bathing Water Regulations (2013) clearly defined FIO levels that are used to assess the Bathing Water (BW) designation/status of the watercourse.

## Project Methodology

### 1. Sampling Frequency

From January to April 2021 the four main recreational sites were sampled on a weekly basis by the Thames Water contactors OHES Environmental Ltd. The sampling was then passed to the trained Citizen Science volunteers to continue the weekly sampling at the four main recreational sites and a further 14 wider catchment sample points. All samplers and trained volunteers followed the Aseptic sampling protocol developed by TH-Environmental Ltd for The Rivers Trust.

When the volunteer sampling commenced in April 2021 the 18 combined sample points were split into 4 zones (Table 1). One zone is sampled per week and all four zones in one month, so all 18 sample points are sampled and tested once a month.

Sample Zone	Sample Point	Location	Grid Reference
1	Point A	River windrush	SP 38301 05888
	Point B	River Windrush	SP 39674 05459
	Point C	River Thames	SP 40365 01400
	Point D	Limb Brook	SP 41938 07621
2	Point E	Limb Brook	SP 43650 08134
	Point F	River Thames	SP 44310 08608
	Point G	Filchampstead Brook	SP 44345 07376
	Point H	Evenlode	SP 42465 12702
	Point I	Evenlode	SP 44784 10175
3	Point J	River Thames Recreational site	SP 48637 09427
	Point K	River Cherwell	SP 50455 13799
	Point L	Bletchington Brook	SP 53069 14205
	Point M	River Thames Recreational site	SP 49805 07386
4	Point N	River Cherwell	SP 51924 08778
	Point O	River Cherwell	SP 52204 06040
	Point P	River Thames Recreational site	SP 52176 04692
	Point Q	River Thames Recreational site	SP 52424 02761
	Point R	River Thames	SP 53098 01312

**Table 1: Sample point and Zone detail**

### 2. Sample Analysis

All samples are analysed for the presence of the bacteria *Total Coliforms* (TC), *Escherichia coli* (EC) and *Intestinal Enterococci* (IE) at Thames Waters accredited Laboratory using the methods laid out in the Microbiology of Drinking Waters (2018).

The method used to analyse the samples for EC and TC is the multiple tube method Colilert reporting a confirmed result with 18-24hrs.

The method used to analyse the samples for IE is 0.45-micron membrane filtration onto the selective media Slanetz & Bartley a confirmed result is reported within 40-48hrs

All samples are analysed on the same day as they are sampled as per the requirements laid out in the Bathing Water Regulations (2013)

### 3. Statistical analysis

All results obtained are required to be statistically analysed and converted to a “percentile value” based on a percentile evaluation of the log<sub>10</sub> 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 was followed:

- a) take the log<sub>10</sub> value of all bacterial concentrations in the data sequence to be evaluated or, if a zero value is obtained, take the log<sub>10</sub> value of the minimum detection limit of the analytical method used.
- b) calculate the arithmetic mean (“μ”) of the log<sub>10</sub> values taken under paragraph (a);
- c) calculate the standard deviation (“σ”) of the log<sub>10</sub> 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 (μ + 1.282 σ); and
- e) derive the upper 95-percentile point of the data probability density function from the following equation: upper 95-percentile = antilog (μ + 1.65 σ).

The conversion to a “percentile value” is done on all collated EC and IE results obtained from each sampling site over a defined period, the obtained result is then compared against the outlined water quality standards (Figure 1). For this interim report only the recreational River Thames sites J, M, P and Q over the defined periods detailed below have been statistically analysed:

- The full sampling period to date 15<sup>th</sup> January to 23<sup>rd</sup> August 2021
- Monthly breakdown
- The designated bathing water season which is defined as May 15<sup>th</sup> to the end of September for this report it will be up to 23<sup>rd</sup> August.

	<b><u>E.coli</u></b>		
	<b>BW status</b>	<b>Levels</b>	<b>Percentile</b>
	Excellent	500	95
	Good	1000	95
	Sufficient	900	90
	Poor	>900	90
	<b><u>Enterococci</u></b>		
	<b>BW status</b>	<b>Levels</b>	<b>Percentile</b>
	Excellent	200	95
	Good	400	95
	Sufficient	330	90
	Poor	>330	90

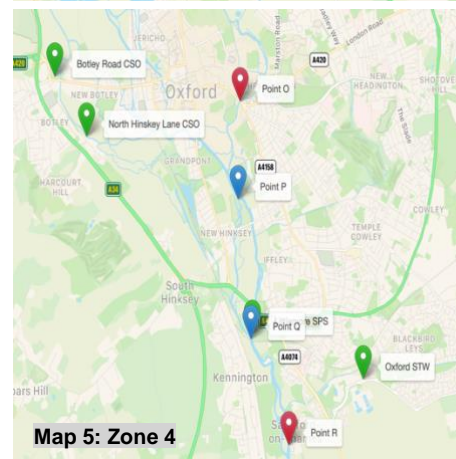
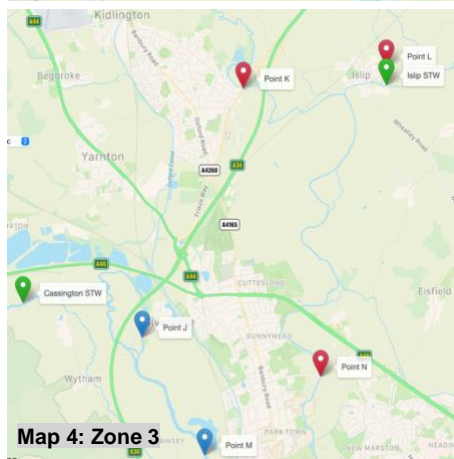
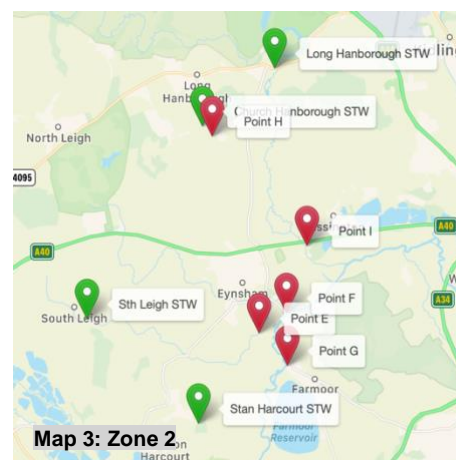
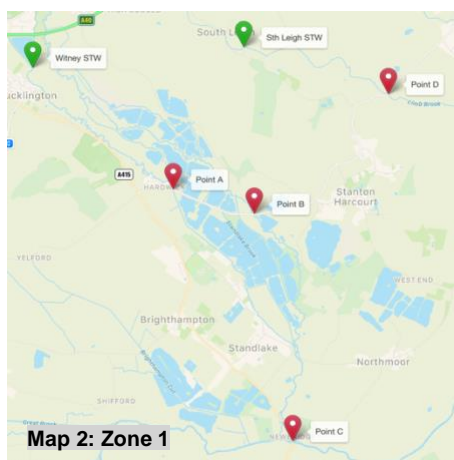
**Figure 1: Bathing Water quality designations**

#### 4. Thames Water spill data

Under excessive rainfall events Thames Water are permitted to relieve pressure on their sewer network through the release of partially diluted untreated sewage spills at Combined Sewer Overflows (CSOs) and at wastewater treatment works via Storm Tank outfalls. These releases are known to have an effect on the FIO levels within the river system so for the duration of the project Thames Water have agreed to provide all records of these spills at 11 Locations (Map 1).



These locations were identified by Thames Water as affecting the river stretches defined by the sample points of the project their location in regard to the sample points are highlighted in the Zonal Maps (Maps 2, 3, 4 and 5).



The information is recorded through their Event Duration Monitors (EDM) and provide a start and end time for the spills. The sites are suspected of having an impact on 15 out of the 18 sample sites (Tables 2, 3, 4 and 5) only sample points G, K and L are not directly impacted by the EDM sites.

<b>Table 2: River Windrush</b>			
EDM monitor	Sample point immediately d/s	next d/s	final possible impacted sample point
Witney STW	A	B	C

<b>Table 3: Limb Brook</b>			
EDM monitor	Sample point immediately d/s	next d/s	final possible impacted sample point
Sth Leigh STW	D	E	F
Stanton Harcourt STW	E	F	

<b>Table 4: Evenlode and tribs</b>			
EDM monitor	Sample point immediately d/s	next d/s	final possible impacted sample point
Church Hanborough STW	H	I	
Long Hanborough STW not an EDM site	I		

<b>Table 5: Cherwell and tribs</b>			
EDM monitor	Sample point immediately d/s	next d/s	final possible impacted sample point
Islip STW	N	O	

Four of the sites have been identified as potentially impacting the recreational sample points J, M, P and Q (Table 6) this interim report will concentrate on the effect the spills have on the FIO levels at these sample points.

<b>Table 6: Thames recreational sites</b>			
EDM monitor	Sample point immediately d/s	next d/s	final possible impacted sample point
Cassington STW	J	M	
Botley Road and Nth Hinskey Lane CSO's	P	Q	
Littlemore SPS	Q	R	
Oxford STW	R		

# Results

## 1. Full Sampling Period

Tables 7, 8, 9 and 10 show the results obtained from the sampling to date for the recreational sample points J, M, P and Q.

Date	Sample Point	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml	Date	Sample Point	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml
15/01/2021	J	770	162	0	15/01/2021	M	770	186	0
18/01/2021	J	1733	411	0	18/01/2021	M	1986	435	0
26/01/2021	J	4000	1120	200	26/01/2021	M	4000	1553	200
03/02/2021	J	5000	1553	200	03/02/2021	M	3000	1046	200
11/02/2021	J	1414	328	86	11/02/2021	M	1203	435	71
19/02/2021	J	10000	3000	200	19/02/2021	M	11000	1000	200
22/02/2021	J	2420	461	78	22/02/2021	M	1733	435	85
02/03/2021	J	1203	308	0	02/03/2021	M	1753	435	0
10/03/2021	J	2000	365	52	10/03/2021	M	687	146	27
18/03/2021	J	488	125	25	18/03/2021	M	1046	155	29
26/03/2021	J	365	152	13	26/03/2021	M	548	68	8
29/03/2021	J	1986	210	30	29/03/2021	M	1553	260	44
06/04/2021	J	575	219	34	06/04/2021	M	770	179	23
20/04/2021	J	387	29	0	20/04/2021	M	291	16	0
18/05/2021	J	3000	757	110	18/05/2021	M	4000	770	210
24/05/2021	J	1000	649	520	24/05/2021	M	3000	1300	670
23/07/2021	J	41000	276	130	23/07/2021	M	5000	613	33
19/08/2021	J	12000	172	110	19/08/2021	M	2000	345	19

**Tables 7 and 8: Results to date for sample point J (left) and point M (right). Results in red indicate zero result and > than LOD surrogates**

Date	Sample Point	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml	Date	Sample Point	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml
15/01/2021	P	1300	365	0	15/01/2021	Q	980	238	0
18/01/2021	P	1300	308	0	18/01/2021	Q	2000	517	0
26/01/2021	P	8000	1553	200	26/01/2021	Q	5000	1414	200
03/02/2021	P	5000	1203	200	03/02/2021	Q	4000	1733	200
11/02/2021	P	1203	308	58	11/02/2021	Q	921	308	49
19/02/2021	P	3000	2000	200	19/02/2021	Q	3000	2420	200
22/02/2021	P	>2420	461	72	22/02/2021	Q	1120	345	71
02/03/2021	P	1414	435	0	02/03/2021	Q	2420	248	0
10/03/2021	P	866	194	59	10/03/2021	Q	1000	770	35
18/03/2021	P	921	201	22	18/03/2021	Q	1733	228	29
26/03/2021	P	757	148	24	26/03/2021	Q	1553	210	29
29/03/2021	P	1046	167	64	29/03/2021	Q	1203	186	36
06/04/2021	P	575	84	18	06/04/2021	Q	525	82	35
29/04/2021	P	1203	101	38	29/04/2021	Q	>2410	161	320
26/05/2021	P	6000	980	131	26/05/2021	Q	1000	1046	143
22/06/2021	P	3000	579	115	22/06/2021	Q	4000	326	21
26/07/2021	P	16000	248	58	26/07/2021	Q	10000	435	49
23/08/2021	P	12000	1046	710	23/08/2021	Q	11000	1120	890

**Tables 9 and 10: Results to date for sample point P (left) and point Q (right). Results in red indicate zero result and > than LOD surrogates**

The calculated “Percentile value” for all four recreational sites for the full sampling period to date is shown in Table 11 for Both EC and IE. Under present river conditions all four sites would be classified as Poor.

Sample Point	E.coli		Enterococci	
	90 percentile	95 percentile	90 percentile	95 percentile
J	1308.20	1927.67	449.96	968.57
M	1429.39	2170.35	376.27	811.41
P	1274.00	1799.08	436.97	880.39
Q	1423.83	2003.47	480.34	987.69

**Table 11: Calculated “Percentile values” for the full year to date**

## 2. Monthly breakdown

Table 12 and 13 show the Calculated “Percentile value” for January and February and show significant degradation in water quality at all sites with a BW status of sufficient to poor for both EC and IE.

January								
	Date	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml	E.Coli		Enterococci	
					90 %ile	95 %ile	90 %ile	95 %ile
J	15/01/2021	770	162	0	1454.00	2075.41	295.22	909.99
	18/01/2021	1733	411	0				
	26/01/2021	4000	1120	200				
M	15/01/2021	770	186	0	1969.73	2918.17	295.22	909.99
	18/01/2021	1986	435	0				
	26/01/2021	4000	1553	200				
P	15/01/2021	1300	365	0	1747.28	2423.60	295.22	909.99
	18/01/2021	1300	308	0				
	26/01/2021	8000	1553	200				
Q	15/01/2021	980	238	0	1754.98	2438.15	295.22	909.99
	18/01/2021	2000	517	0				
	26/01/2021	5000	1414	200				

**Table 12: Januarys calculated “percentile value”**

February								
	Date	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml	E.Coli		Enterococci	
					90 %ile	95 %ile	90 %ile	95 %ile
J	03/02/2021	5000	1553	200	3452.21	5052.15	248.32	300.35
	11/02/2021	1414	328	86				
	19/02/2021	10000	3000	200				
	22/02/2021	2420	461	78				
M	03/02/2021	3000	1046	200	1256.39	1506.82	252.58	309.35
	11/02/2021	1203	435	71				
	19/02/2021	11000	1000	200				
	22/02/2021	1733	435	85				
P	03/02/2021	5000	1203	200	2299.05	3153.59	264.35	336.80
	11/02/2021	1203	308	58				
	19/02/2021	3000	2000	200				
	22/02/2021	>2420	461	72				
Q	03/02/2021	4000	1733	200	3224.04	4781.09	273.74	356.93
	11/02/2021	921	308	49				
	19/02/2021	3000	2420	200				
	22/02/2021	1120	345	71				

**Table 13: Februarys calculated “percentile value”**

Tables 14 and 15 show the calculated “percentile value” for March and April showing a significant improvement in water quality during this period with a site variation in BW status of sufficient, good and Excellent. There was a high IE result for Q in April which meant the status became poor

March								
	Date	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml	E.Coli		Enterococci	
					90 %ile	95 %ile	90 %ile	95 %ile
J	02/03/2021	1203	308	0				
	10/03/2021	2000	365	52				
	18/03/2021	488	125	25	382.90	452.51	100.90	178.49
	26/03/2021	365	152	13				
	29/03/2021	1986	210	30				
M	02/03/2021	1753	435	0				
	10/03/2021	687	146	27				
	18/03/2021	1046	155	29	431.02	556.42	87.97	154.94
	26/03/2021	548	68	8				
	29/03/2021	1553	260	44				
P	02/03/2021	1414	435	0				
	10/03/2021	866	194	59				
	18/03/2021	921	201	22	362.75	423.74	159.87	298.34
	26/03/2021	757	148	24				
	29/03/2021	1046	167	64				
Q	02/03/2021	2420	248	0				
	10/03/2021	1000	770	35				
	18/03/2021	1733	228	29	585.07	723.39	117.62	208.41
	26/03/2021	1553	210	29				
	29/03/2021	1203	186	36				

Table 14: Marchs calculated “percentile value”

April								
	Date	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml	E.Coli		Enterococci	
					90 %ile	95 %ile	90 %ile	95 %ile
J	06/04/2021	575	219	34	498.17	843.06	142.57	356.91
	20/04/2021	387	29	0				
M	06/04/2021	770	179	23	477.72	895.51	82.28	186.05
	20/04/2021	291	16	0				
P	06/04/2021	575	84	18	108.86	114.21	51.49	62.54
	29/04/2021	1203	101	38				
Q	06/04/2021	525	82	35	211.81	252.46	786.76	1399.36
	29/04/2021	>2410	161	320				

Table 15: Aprils calculated “percentile value”

Tables 16 and 17 show the calculated “percentile value” for May and June showing again a significant deterioration in water quality during this period with a site variation in BW status of sufficient to poor. There was an improvement in the IE result for P and Q in May which means the status became excellent.

May								
	Date	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml	E.Coli		Enterococci	
					90 %ile	95 %ile	90 %ile	95 %ile
J	18/05/2021	3000	757	110	805.88	838.82	977.78	1464.82
	24/05/2021	1000	649	520				
M	18/05/2021	4000	770	210	1608.44	1843.28	1073.74	1452.14
	24/05/2021	3000	1300	670				
P	26/05/2021	6000	980	131	980	980	131	131
Q	26/05/2021	1000	1046	143	1046	1046	143	143

Table 16: Mays calculated “percentile value”

June								
	Date	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml	E.Coli		Enterococci	
					90 %ile	95 %ile	90 %ile	95 %ile
P	22/06/2021	3000	579	115	3874.29	5507.04	2562.85	4551.13
	18/06/2021	95167	2237	1045				
Q	22/06/2021	4000	326	21	5121.47	8525.04	4071.06	10787.24
	18/06/2021	33167	2310	888				

Table 17: Junes calculated “percentile value”



Table 18 shows the results obtained throughout the day of the 18<sup>th</sup> June blitz event, samples were taken every 2 hours starting at 07:30 am through to 17:30, the water quality throughout the day was significantly poor and showed a rise in IE levels from 11:30 to the end of the day the BW status would be Poor.

June Blitz								
	Date	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml	E.Coli		Enterococci	
					90 %ile	95 %ile	90 %ile	95 %ile
J	18/06/2021	23000	1986	1190	2588.64	3096.57	1260.44	1433.67
	18/06/2021	16000	727	720				
	18/06/2021	17000	1986	980				
	18/06/2021	22000	2420	630				
	18/06/2021	15000	980	1070				
	18/06/2021	15000	1046	480				
M	18/06/2021	15000	1203	182	7581.23	9826.65	1747.82	2378.29
	18/06/2021	2000	2420	240				
	18/06/2021	6000	3000	910				
	18/06/2021	6000	2000	780				
	18/06/2021	17000	8000	1290				
	18/06/2021	15000	6000	1140				
P	18/06/2021	46000	1000	730	3653.60	4304.07	1423.46	1568.27
	18/06/2021	62000	2000	770				
	18/06/2021	199000	2420	1060				
	18/06/2021	96000	4000	1030				
	18/06/2021	72000	2000	1260				
	18/06/2021	96000	2000	1420				
Q	18/06/2021	11000	770	530	4844.47	6403.47	1348.87	1545.40
	18/06/2021	7000	1046	580				
	18/06/2021	13000	1046	870				
	18/06/2021	43000	5000	1370				
	18/06/2021	43000	3000	840				
	18/06/2021	82000	3000	1140				

Table 18: Junes Blitz events calculated “percentile value”

Tables 19 and 20 show the calculated “percentile value” for July and August, July showed an improvement in water quality during this period with a site variation in BW status of good to excellent. Only site M showed poor water quality for EC with a BW status of sufficient. August showed variance between sites J and M with a BW status of excellent and P and Q with a BW status of poor.

JULY								
	Date	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml	E.Coli		Enterococci	
					90 %ile	95 %ile	90 %ile	95 %ile
J	23/07/2021	41000	276	130	276	276	130	130
M	23/07/2021	5000	613	33	613	613	33	33
P	26/07/2021	16000	248	58	248	248	58	58
Q	26/07/2021	10000	435	49	435	435	49	49

Table 19: Julys calculated “percentile value”

AUGUST								
	Date	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml	E.Coli		Enterococci	
					90 %ile	95 %ile	90 %ile	95 %ile
J	19/08/2021	12000	172	110	172	172	110	110
M	19/08/2021	2000	345	19	345	345	19	19
P	23/08/2021	12000	1046	710	1046	1046	710	710
Q	23/08/2021	11000	1120	890	1120	1120	890	890

Table 20: Augusts calculated “percentile value”

### 3. Bathing Water Season

Under the Bathing Water regulations (2013) there is a clearly defined BW season that runs from 15<sup>th</sup> May until the end of September. Table 21 shows the calculated “percentile value” of the four recreational sites from samples taken within the BW season period, under the present river conditions the overall BW status would be classified as poor.

Sample Point J bathing water season								
Date	Sample Point	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml	E.coli		Enterococci	
					90 %ile	95 %ile	90 %ile	95 %ile
18/05/2021	J	3000	757	110	1548.77	2126.78	810.09	1158.03
24/05/2021	J	1000	649	520				
18/06/2021	J	18000	1524	845				
23/07/2021	J	41000	276	130				
19/08/2021	J	12000	172	110				
Sample Point M bathing water season								
Date	Sample Point	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml	E.coli		Enterococci	
					90 %ile	95 %ile	90 %ile	95 %ile
18/05/2021	M	4000	770	210	3041.55	4240.22	1289.08	2407.94
24/05/2021	M	3000	1300	670				
18/06/2021	M	10167	3771	757				
23/07/2021	M	5000	613	33				
19/08/2021	M	2000	345	19				
Sample Point P bathing water season								
Date	Sample Point	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml	E.coli		Enterococci	
					90 %ile	95 %ile	90 %ile	95 %ile
26/05/2021	P	6000	980	131	2271.73	3064.44	1144.72	1813.79
18/06/2021	P	95167	2237	1045				
22/06/2021	P	3000	579	115				
26/07/2021	P	16000	248	58				
23/08/2021	P	12000	1046	710				
Sample Point Q bathing water season								
Date	Sample Point	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml	E.coli		Enterococci	
					90 %ile	95 %ile	90 %ile	95 %ile
26/05/2021	Q	1000	1046	143	2266.70	3028.91	1424.93	2653.44
18/06/2021	Q	33167	2310	888				
22/06/2021	Q	4000	326	21				
26/07/2021	Q	10000	435	49				
23/08/2021	Q	11000	1120	890				

**Table 21: Bathing Water seasons calculated “percentile value”**

## Evaluation

### 1. Rainfall impact

Over the sampling time period there have been significant high rainfall events followed by sustained dry periods. The data clearly shows a correlation between rainfall periods and a deterioration in the water quality (Figure 2 and 3) Under the stress of excessive rainfall events Thames Water are permitted to relieve pressure on their sewer network, through the release of partially diluted untreated sewage spills at Combined Sewer Overflows (CSOs) and at wastewater treatment works via Storm Tank outfalls. The data obtained shows that there is a significant impact on the water quality at locations associated with these intermittent outfalls.

This is most clearly shown by the results obtained during the 16<sup>th</sup> June “Blitz” event (Table 18) which showed recorded levels throughout the day when converted to calculated “percentile values” were between 3x and 7x the accepted sufficient BW status levels at the 90 percentile value.

Significant rainfall events also have an impact on the overland mobilisation of agricultural based FIO sources, providing the conduit to transport them from the land surface into the river system. Along with septic tank inputs and mis-connections overall significant rainfall events cause a detriment to the Rivers water quality. By looking at the ratio and increases in the individual FIOs a conclusion can be drawn as to the most significant contributor to the FIO levels in the river system.

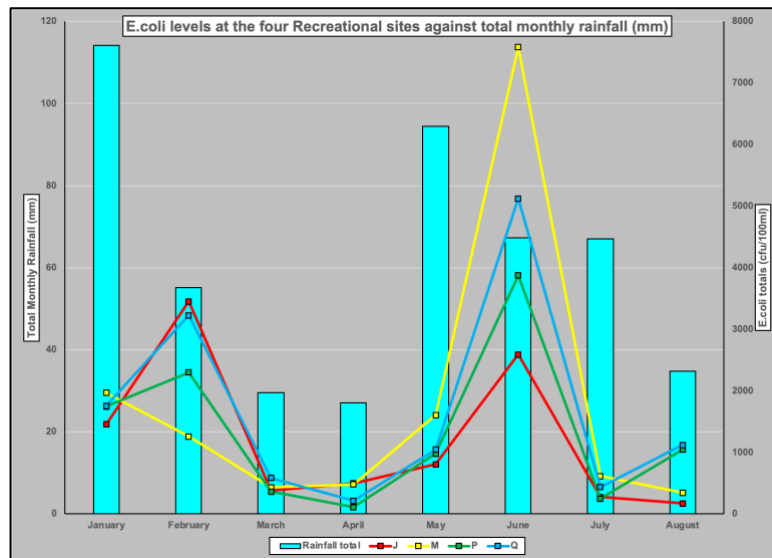


Figure 2: Shows the impact of rainfall on E.coli levels in the River

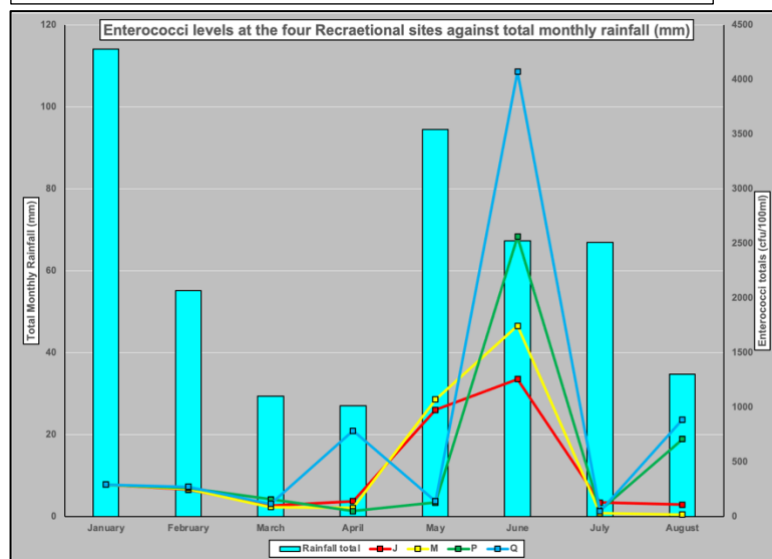


Figure 3: Shows the impact of rainfall on Enterococci levels in the River

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. Looking at the ratios between EC and IE you can conclude whether the levels of FIOs are caused by intermittent inputs (spills) or consistent inputs (WwTW outfalls). Typically, EC would be at levels 2-4x higher than IE, if the recorded counts are at a ratio that favours IE it is due to a longer residence time within the watercourse without being added to by another sewage input occurrence. Therefore, under dry conditions you can conclude that the input was a result of a spill due to a longer residence time resulting in lower EC counts as they begin to die off. When the ratio is closer to the typical then the FIO input is consistent, with the EC levels being replenished regularly.

Therefore, under rainfall conditions if the increase during or post rainfall event significantly favours EC and closely correlates to the typical ratio you can conclude that it is point source not diffuse overland/agricultural inputs.

## 2. Spill Correlation

The evaluation criteria for assessing whether the spills correlated with and impacted the sample result are as follows:

- Was the spill no more than 72 hrs before the sample date
- Did the correlating sample show an increase in EC and IE levels when compared with the previous sample
- Was the rise significant resulting in the BW status becoming poor.

The four recreational sample points were impacted by four of the EDM sites reported to us by Thames water (Table 6). Overall P and Q you were more significantly impacted by the correlated spills with J and M only showing one significant rise correlated to a reported spill (Table 21 and 22)

Sample ID	Date	Sample time	Sample Point	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml	Spill impact on Water Quality	Spill details (duration and dates of spills)
F9329766	26/01/2021	09:00-15:00	J	4000	1120	200	Detrimental	Spill at Cassington STW on 26/01 started 02:58 ended 06:10 for a total of 3.19 hrs also spills on 23/01 for a total of 9.71 hrs
F9329767	26/01/2021	09:00-15:00	M	4000	1553	200		
F9364077	11/02/2021	09:00-15:00	J	1414	328	86	No impact	Spill at Cassington STW on 08/02 intermittent for a total of 22.28 hrs, spill on 09/02 intermittent for a total of 10.49 hrs and on 11/02 intermittent for 5.50 hrs started 01:28 ended 09:10
F9364078	11/02/2021	09:00-15:00	M	1203	435	71		
F9395891	02/03/2021	09:00-15:00	J	1203	308	0	No impact	Spill at Cassington STW on 02/03 intermittent for a total of 5.39 hrs never for longer than 1.82 hrs over two distinct periods 03:29-10:45 (am) and 18:55-23:18 (pm)
F9395892	02/03/2021	09:00-15:00	M	1753	435	0		
F9395895	10/03/2021	09:00-15:00	J	2000	365	52	No impact	Spill at Cassington STW on 07/03 for a total of 12.05 hrs started at 12:13 ended 00:16 on the 08/03
F9395896	10/03/2021	09:00-15:00	M	687	146	27		

**Table 21: Showing the correlated spills at Cassington STW and sample dates**

Sample ID	Date	Sample time	Sample Point	Total Coliforms MPN/100ml	E.coli (EC) MPN/100ml	Enterococci cfu/100ml	Spill impact on Water Quality	Spill details (duration and dates of spills)
F9329772	03/02/2021	09:00-15:00	P	5000	1203	200	Detrimental	Spill at BR on 02/02 started at 08:26 ended 09:11 for a total of 0.75 hrs.
F9329773	03/02/2021	09:00-15:00	Q	4000	1733	200		Intermittent spills at NHL throughout 02/03 for a total of 22.21 hrs and 03/03 started at 09:13 ended 15:00 for 5.79 hrs.
F9364079	11/02/2021	09:00-15:00	P	1203	308	58	No impact	Intermittent spills at Little SPS on 01/02 for a total of 8.74 hrs, on 02/03 for a total of 15.20 hrs and on 03/03 intermittent spills starting at 09:02 for a total of 7.05 hrs ending at 23:59 longest spill 1.74 hrs
F9364080	11/02/2021	09:00-15:00	Q	921	308	49		No spill at BR in the time period (72hrs before the sample was taken) No spill at NHL in the time period (72hrs before the sample was taken)
F9364071	19/02/2021	09:00-15:00	P	3000	2000	200	Detrimental	2 small spills on 07/02 for a total of 0.75 hrs
F9364072	19/02/2021	09:00-15:00	Q	3000	2420	200		Spills at BR on 17/02 from 06:58 to 09:00 for a total of 2.05 hrs and 18/02 from 09:07 to 10:10 for a total of 1.05 hrs No spill at NHL in the time period (72hrs before the sample was taken)
F9563136	23/08/2021	09:00-15:00	P	12000	1046	710	Detrimental	No spill at Little in the time period (72hrs before the sample was taken)
F9563137	23/08/2021	09:00-15:00	Q	11000	1120	890		Spills at BR on 21/08 from 13:24 to 14:09 for a total of 0.75 hrs No spill at NHL in the time period (72hrs before the sample was taken) No spill at Little in the time period (72hrs before the sample was taken)

**Table 22: Showing the correlated spills at the CSO's Botley Rd (BR), Nth Hinskey Lane (NHL) and Littlemore SPS (Little) and sample dates**

The EDM data at the four associated sites with the exception of Botley Rd CSO showed no spills after the following dates:

- Cassington STW – 07<sup>th</sup> March 2021
- North Hinskey Lane CSO – 05<sup>th</sup> February 2021
- Littlemore SPS – 07<sup>th</sup> February 2021

There were the following sample dates that matched the evaluation criteria that had no associated spills or were after the dates when the associated EDM site recorded no more

spills. This is despite significant recorded rainfall during the months of May, June and July that were greater than the rainfall recorded in February and March (Table 23)

- Recreational sites J and M – 03/02, 19/02, 18/05, 24/05 and 23/07 (M only)
- Recreational sites P and Q – 26/01, 26/05, 22/06 and 10/03 (Q only)

Month	Rainfall total (mm)
January	114.1
February	55.2
March	29.5
April	27.1
May	94.5
June	67.3
July	67
August	34.8

**Table 23: Total rainfall recorded for the first 8 months of 2021 at the Oxford Met Office Rain gauge.**

Diffuse inputs would have to be considered as the causation of these significant rises but the data correlates more with a direct point source input as described in Evaluation Section 1: Rainfall impact.

The results obtained on the 16<sup>th</sup> June “Blitz event” showed significant impact due to the extreme rainfall event experienced on the day, but despite the data being indicative of significant point source inputs only Botley Road CSO recorded a spill. The spill started at 10:28 am and ended at 15:58 pm spilling for a total of 5.49 hours the data clearly shows a detrimental impact to the water quality of this spill with the higher levels post 11:30 on the day at sites P and Q.

## Overall Conclusion

As highlighted throughout the 8 months of the sampling project only March, April and July would meet Good to Excellent BW status for both EC and IE at all four recreational sites and at sites J and M only in August.

Throughout the defined BW season the data gathered in that period would result in the four sites being awarded the BW status of Poor overall for both EC and IE with results being between 2x and 3x the levels required to meet sufficient status at the 90 percentile.

The data clearly indicates that the causation of the detrimental water quality can be linked to continuous and intermittent point source inputs and the impact rainfall events have on the quality of the outfalls into the River Thames. Diffuse inputs are not to be discounted as adding to the water quality problems but it is my conclusion that the data indicates the most significant impact is caused by fully and partially treated sewage inputs.