Groundwater Impacted System Management Plan

Oxford, River Thames

July 2021

Thames Water

It's everyone's water

Version control

Version	Date	Amendment	Author	Checked	Reviewed
1-d1	16/06/2021	Draft for EA	AJ	SE	DJ
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Annual Update 2022	October 2022	Addition of Annual Update 2022	MB/JH	DJ	DJ
Annual Update 2023	October 2023	Addition of Annual Update 2023	MB	DJ	DJ

Table of contents

Introduction

This document sets out Thames Water's approach to the management of groundwater infiltration in sewerage systems where the influence of groundwater infiltration is viewed as excessive and likely to be the source of uncontrolled escape of untreated or partially treated sewage.

All sewerage systems combined and separate will experience some groundwater infiltration[1] and a nominal allowance in design will be made for this. However, in some catchments the impact of groundwater infiltration can be considerable leading to impacts on service during periods of high groundwater, typically during the winter.

Groundwater can enter the sewerage system through the pipes and manholes, this may occur at a defect (crack, hole, displaced joint) or on a normal joint on the sewer or in the manhole. A key point to note is that where infiltration occurs it is not necessarily an indicator that the sewer is in poor structural state simply that jointing techniques used are not completely watertight.

Ingress of groundwater is not limited to the public system that Thames Water owns and maintains but potentially the private drains, manholes and sewers that connect to our system.

Preventing and reducing the impact of groundwater infiltration is predominately achieved through the lining of sewers and sealing of manholes. This entails the application of a synthetic liner within the pipe that creates a contiguous membrane for the length of the pipe or possibly section if the source of ingress can be narrowed down. For manholes it will typically entail sealing in a similar manner.

To line all sewers and manholes within most catchments would be prohibitively expensive to do so. Our approach to date has been centred on a 'find and fix' basis which has involved monitoring and investigating the networks in periods of high groundwater to identify sources of ingress and fix as we find them. This approach is constrained for the reason that investigations are typically limited to periods of high groundwater and when high groundwater occurs there are limited windows of time in which investigations can be successfully undertaken before flows either subside or the system is fully surcharged meaning CCTV surveys are not possible[2]. Once sections of sewers have been lined, it will be a case of waiting until high groundwater levels reoccur to assess the effectiveness of the work undertaken, which may not be the subsequent winter but several years later.

It is recognised that the approach to date lacks a degree of certainty of resolution and for this reason Thames Water has in 2020 undertaken a different approach for the medium to long-term management of groundwater, which is covered within this

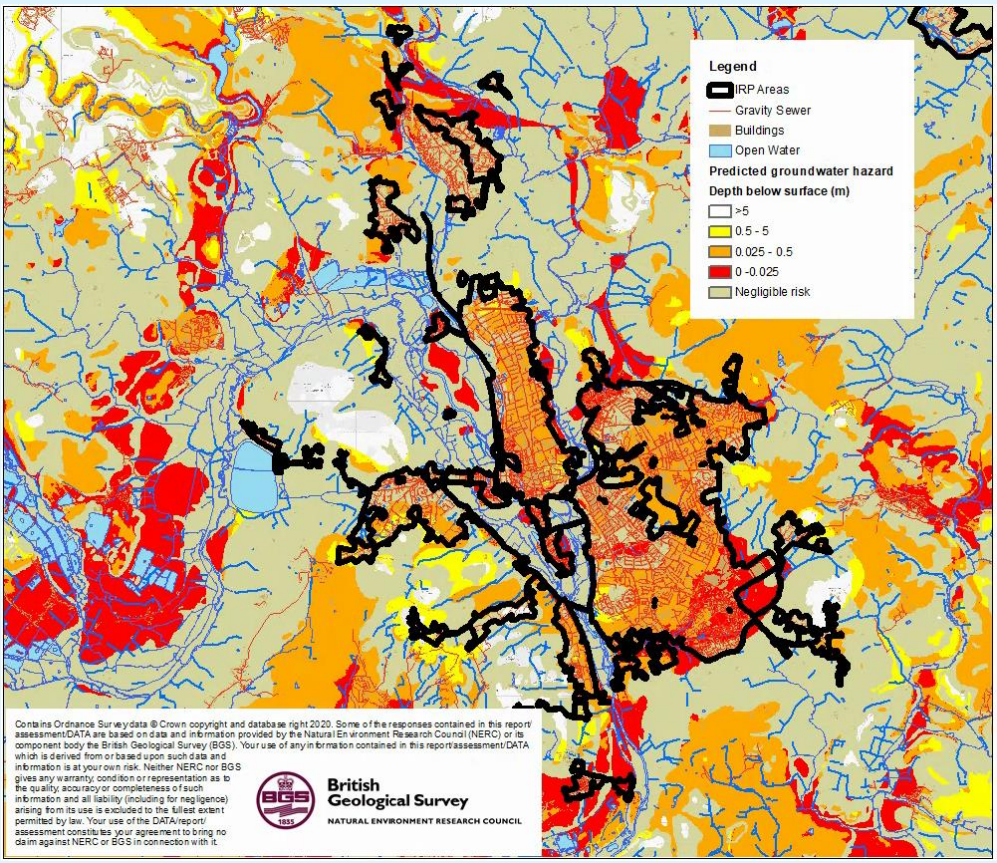
[1] Sewers for Adoption makes an allowance for 10% of normal wastewater flow to allow for unaccounted flows such as groundwater infiltration.

[2] On occasions it is possible to over-pump between manholes to isolate sections of sewer to survey, this is not always feasible when the flows involved are simply too great to over-pump or the location prohibits this approach.

document under the plan section. These plans require significant investment which Thames Water will seek to secure. In the meantime, we will continue to investigate sources of infiltration when it occurs and where feasible, undertake the work through our capital maintenance budgets. We refer to these as ‘minor works’ opportunities i.e. where we have high degree of certainty of reducing point sources of infiltration and can do so with reasonable costs and time.

The structure of this document has been created with input from the Environment Agency. Sections covered in this document include our ‘Outline Plan’ with timescales, Mitigation i.e. how we intend to manage the risk until our plan is fully implemented and when we will publish future updates on progress against this plan.

Brief description of Oxford catchment



1.0 – Oxford catchment

Oxford serves a population equivalent[3] of 235,046 with a predominantly separate sewerage network totaling some 1,485 km in length excluding private drains and sewers. The extent of the catchment is shown in Figure 1.0 above.

Problem characterisation

Groundwater can enter our sewers when levels are high and a positive head above the soffit of the sewer is created. Significant groundwater ingress can impact sewer capacity and increased risk of flooding. These have included sewer flooding, restricted use of their toilets and bathrooms, odour pollution and pollution in watercourses.

Oxford is located at confluence of the Thame, Cherwell, Ray, Windrush and Bayswater Brook and has a history of flooding including Dec 2000 and Jan 2003. This includes the area of South Hinksey where historically debris at Littlemore SPS reduced the pumping station's performance causing water to back up from the main sewer and restricted use

[3] Population equivalent or unit per capita loading, (PE), in waste-water treatment is the number expressing the ratio of the sum of the pollution load produced during 24 hours by industrial facilities and services to the individual pollution load in household sewage produced by one person in the same time.

of customer facilities.

Additionally, in recent years the foul sewerage system in the Oxford system has on occasions become overwhelmed, following prolonged and heavy rainfall and raised groundwater levels. This has resulted in operational problems at Oxford Sewage Treatment Works and Littlemore Sewage Pumping Station.

This has caused properties to suffer from sewer flooding and restricted toilet use in addition to unwanted spills to the environment. This has indirect impacts too, including road congestion and closures.

Particular areas have been highlighted for experiencing related issues. Grandpont and Botley/ West Oxford experience localised groundwater flooding as high river levels cause the groundwater to increase above surface level. This is especially an issue for basements that are not adequately protected. This is worsened by surface water outfalls being restricted by growth, for example at Abingdon Road. The sewerage system is identified on the public sewer records as being a largely separate foul system, rather than a combined system. It should therefore, in theory, only be accepting foul drainage rather than the combination of foul and surface water, however, there are a limited number of public surface water sewers in the area.

As the Groundwater Infiltration Management Plan develops, sub-catchments targeted in this report will be refined .

Historic surveys we have carried out have detected that there is some evidence of groundwater infiltration into the foul sewer network when groundwater levels are high, and surface water inundation from highways, public spaces and properties and fluvial flooding from local watercourses. Surface water misconnections (i.e. down pipes from roofs into the sewer network) are also suspected to be a contributing factor, hence further analysis is required to determine the extent to which this has contributed to sewer flooding.

We believe that heavy rainfall events creating significant volumes of surface water runoff from the surrounding area, high river levels and high groundwater levels have resulted in the network becoming overwhelmed by the volume of water thus leading to the drainage and flooding issues experienced.

Being a large urbanised area, there are several other key factors influencing increased prevalence of sewer flooding. The first relates directly to population as both population growth and urbanisation is resulting in a large combined water-tight area. This is caused by a loss of green spaces and local flood plains and thus the natural drainage they provide.

A limited number of our sewerage systems include for overflows, these structures are there to protect against sewer flooding as a result of rainfall or equipment failure where appropriate. Discharges from these structures should not be impacted by excessive infiltration as detailed by the EA Regulatory Position Statement on groundwater impacted sewerage systems. The use of storm sewage overflows is accepted by our regulators, subject to conditions

Our permit conditions for Oxford STW state:

"a discharge from the storm tank shall consist of storm sewage effluent resulting from rainfall or snowmelt into the sewerage system. The discharge from the storm tank shall not so far as reasonably practicable cause significant visual or aesthetic impact due to deposit of solids on the bed or banks of the receiving watercourse, or growth of sewage fungus on the bed of the receiving watercourse."

The network discharge permit at North Hinksey states:

"The discharge shall only occur when and only for as long as either:(i) the flow passed forward is equal to or greater than the overflow setting indicated due to rainfall and/or snow melt, or (ii)the hydraulic capacity of the sewer network downstream of the combined sewer overflow is reached due to rainfall and/or snow melt and the level of storm sewage in the sewer at the combined sewer overflow is greater than the weir level of the overflow structure which is specified as an overflow setting in table S3.3 (in the permit)".

The network discharge permits for Botley and Littlemore SPS state:

"A discharge from a Combined Sewer Overflow ("CSO") or storm tank shall consist of storm sewage effluent resulting from rainfall or snowmelt into the sewerage system. The discharge or discharges from a CSO or storm tank shall not so far as reasonably practicable cause significant visual or aesthetic impact due to deposit of solids on the bed or banks of the receiving watercourse, estuary or a beach, or growth of sewage fungus on the bed of the receiving watercourse. "

The Flood and Water Management Act 2010 places a responsibility on Lead Local Flood Authorities (LLFAs), to manage flood risk from surface and groundwater, plus a duty on all Risk Management Authorities (RMAs), to cooperate regarding flood risk. In our role as an RMA, Thames Water will work with Oxfordshire City Council Council and Oxfordshire County Council as Lead Local Flood Authority, County Council and Planning Authority, and the Environment Agency to ensure that a collaborative approach can be developed to address the problems.

Thames Water also has a statutory obligation to comply with environmental legislation. The Water Framework Directive establishes a strategic approach to managing the water environment, which the Environment Agency achieves through River Basin Management Plans and setting environmental objectives for groundwater and surface water. The environment is also protected from adverse effects of discharges of urban wastewater through the Urban Wastewater Treatment Directive, which requires us to improve and extend the sewerage system according to section 94 of the Water Industry Act (1991).

Anticipated unavoidable discharges

Within recent years there have been unplanned unconsented unavoidable discharges in the network as a result of surcharging manholes causing pollution. This has been as a direct result of the influence of groundwater infiltration.

We anticipate that this situation may continue until such time we are able to implement a long-term solution.

General outline plan & timescale

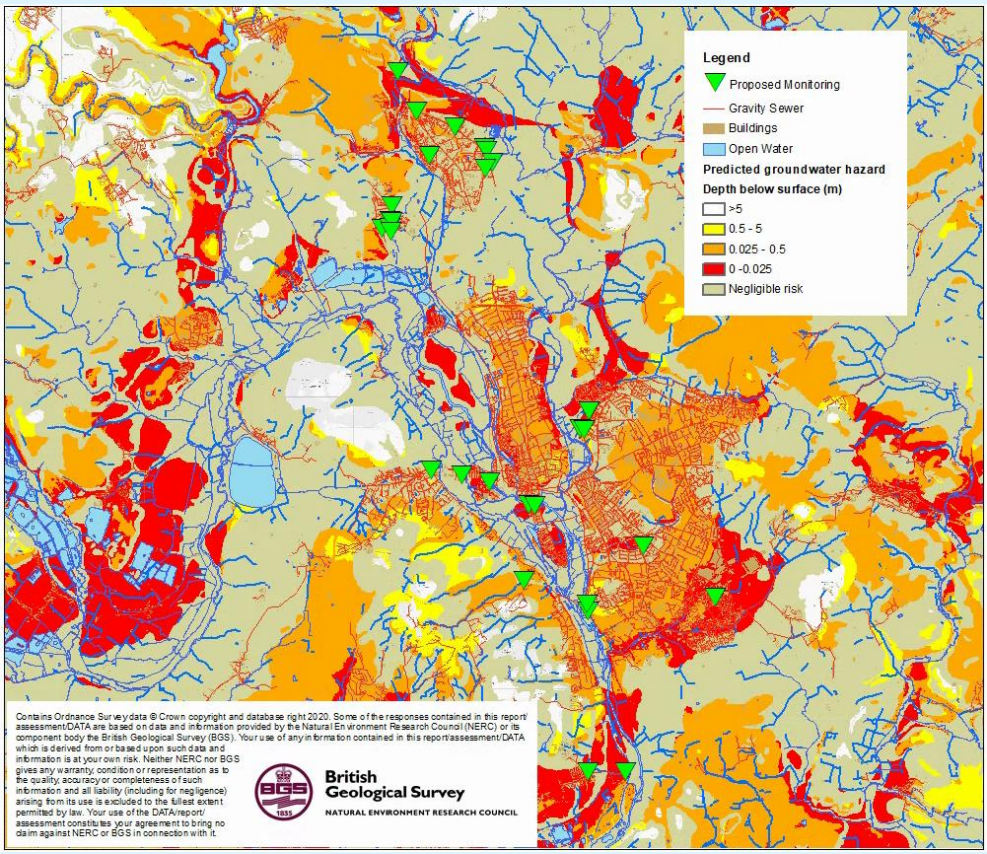


Figure 2.0 – Oxford monitoring plan area and infiltration zones

Key to bringing the impact of groundwater infiltration under control is an enhanced monitoring regime. We have identified zones and areas over which telemetered depth monitoring will be installed. Figure 2.0 presents a plan of currently proposed installation locations.

Complimenting the flow [at the treatment works] and depth measurement [in the sewer network] we will use pumping station run time data, rainfall data, river level data, and groundwater level data to create a full picture of movement and source of flows around the catchment.

Zones of Groundwater Risk

We engaged with JBA Consulting to develop plans for Oxford that identify zones of groundwater risk, see Figure 2.0. These zones are modelled areas where the groundwater has been determined to be above the sewer and hence pose a potential risk for groundwater ingress.

The sewer depth monitors referred to earlier will be sited in and around these zones to verify and calibrate the risk in each of the zones.

If following the proposal to the sealing in part or wholly[4] of the high risk zones in AMP8[5], should it be required, the system is found to be still experiencing excessive infiltration we would then look to potentially seal 'private' laterals and/or drains along with starting to seal the medium to low risk zones. The decision on this will be based on information obtained from the monitors and depending on the scale of further work required this may need to form part of PR29[6] investment planning.

The monitors are also to be used to monitor change within the system hence even should we determine that infiltration has been brought under control, we will continue to monitor for potential trends in infiltration suggesting the need for further work. We also anticipate monitoring the response of the catchment to surface water and where appropriate will use the monitor data to address this source of storm flow.

With this plan we remain committed to minimising the impact of groundwater on the sewerage system in Oxford.

Our general medium to long term plan is therefore to apply a hierarchy to sealing the sewer as follows:

Activity	When	Description
Model Zones	2020/21	JBA have been engaged to undertake modelling activities to identify the areas (zones) to be targeted for sealing in the 56 systems identified as being impacted by infiltration in the Thames Water region.
Install monitors	2021-2023	Monitors plans are being developed to help calibrate and validate the zones. Each year completeness / coverage monitors will be reviewed and added to / or modified as necessary.
Calibrate zones	Refined each year	Following each winter, we intend to review the data from the monitors and if necessary, redefine the zones.
Look & Lift	Each winter	The look & lift surveys have two purposes, firstly to compliment the monitoring and secondly to identify 'quick fixes' that we would address through our normal capital maintenance.
CCTV	2020-2023	Required to confirm sewer condition and provide information to assist with costing any sewer lining.

[4] Decision of extent of sealing will be based on outcomes of works undertaken in AMP7, results of monitoring and successful submission of our plans for investment for AMP8.

[5] Asset Management Plan 8 – covering work between 2025-2030

[6] Price Review 2029

Activity	When	Description
Minor works	2020-2023	As mentioned, if we detect minor works being required, we will look to resolve these as and when we find them.
PR24	2023/24	Ideally through monitoring and on-going investigations work towards managing the infiltration risk, in AMP7, will be successful. However, in the absence of evidence justifying the need not to undertake sealing of the high-risk zone this is to be included as part of PR24 investment plan. This work will be subject to Cost Benefit Analysis and Best Technical Knowledge Not Entailing Excessive Cost (BTKNEEC assessments).
High risk zone sealing	2025-30	Sealing of high-risk zone undertaken subject to need being demonstrated.

Oxford Infiltration Management Plan

As detailed above the impact of infiltration is experienced in the network and at the STW.

Our approach to the resolution of infiltration impacting the Oxford sewerage system is outlined below.

High level approach statement

For Oxford our approach to tackling infiltration will be undertaken as follows:

1. We will investigate the network with a view to identifying sources of ingress of infiltration that are cost effective[7] to address. To investigate the network, we have:

- Undertaken a desktop analysis to determine infiltration high to low risk zones (October 2020);

To investigate the network, we will:

- Install monitoring to back up the analysis and to aide focusing of locations for identification of infiltration (2021 to 2023). Each year we will assess the completeness of monitoring and if required add to or modify the current locations.

- Undertake sample CCTV in the high to low risk zones to assess the general asset health of the sewers and manholes (ongoing).

We will also review results of Winter 2019/20 and 2020/21 with historic data to build up evidence to support interventions in the network (Autumn 2021).

2. Where interventions can be undertaken as part of normal sewer maintenance activities these will be communicated and progressed.

3. If significant investment is identified as being required, then this will need to be considered in terms of relative need compared to other systems being investigated for infiltration reduction and need. Significant investment needs may need to be included in our next investment planning cycle at PR24.

[7] Assessment of cost effectiveness is based on assessment of the ratio of the cost of a solution to the monetised benefit gained from implementing the solution i.e. reduction in flood/pollution risk and/or reduced operating costs.

Investigations

As mentioned above we have commissioned JBA Consulting to undertake an exercise involving groundwater elevation data to determine which areas of the network are potentially below the groundwater table during high groundwater periods.

Site investigations, undertaken by Dene-Tech and our Customer Field Services (Thames Water Operations) will include 'look & lift' surveys, CCTV and where necessary dye tracing to confirm connectivity.

A table of the work undertaken is included in the appendix to this report.

Monitoring

Sewer Depth Monitors will be installed in the catchment in between 2021 and 2023. These devices are telemetered and provide real time data on the level of flow in the sewer.

The purpose of these units is to act as alerts for high groundwater impact in the sewer, calibration of the zones of infiltration risk and to demonstrate benefit gained from work undertaken to reduce infiltration. They will also provide evidence in the future of further need to manage the impact of infiltration.

Mitigation

On occasions to avoid flooding of properties or to manage the risk of damage to the environment we may undertake tankering from within the network, make use of pumps to contain flows or deploy settlement tanks to part treat sewage before release to the environment.

With regard to Oxford we do not envisage needing to undertake mitigation work beyond tankering within the network.

Updates

Work on the Groundwater infiltration management plan will continue, and we will aim to provide updates annually by the end of October each year.

Appendix

Groundwater infiltration potential analysis

The sewer network classified by the groundwater infiltration risk zones. The lengths of sewers within these zones are presented in the table below.

Risk category	Description	Length (km)	Percentage
High	Predicted groundwater extreme >1m above pipe invert	230.56	49
Medium	Predicted groundwater extreme 0-1m above pipe invert	16.85	4
Low	Predicted groundwater extreme 0-1m below pipe invert	18.61	4
Very Low	Predicted groundwater extreme >1m below pipe invert	205.46	43
Total		471.48	100

In addition, the table below presents the surface water flood risk classification for manholes within the catchment.

Manholes by Surface Water Inundation Risk Category

Risk category	Description	Number	Percentage
High	Inundation risk in 3.3% AEP fluvial or pluvial event	1,525	11
Medium	Inundation risk in 1% AEP fluvial or pluvial event	960	7
Low	Inundation risk in 0.1% AEP fluvial or pluvial event	2,522	18
Very Low	All other manholes	8,833	64
Total		13,840	100

Investigations & remedial work undertaken since 2019/20 and future plans

Lift and Look and CCTV surveys have not yet commenced in the Oxford system. A summary of findings will be provided in the next update of this report.

Glossary of terms

AEP – Annual Exceedance Potential

AMP – Asset Management Programme

CCTV – Closed Circuit Television

EA - Environment Agency

IRP – Infiltration Reduction Plans

MH – Manhole

STW – Sewage Treatment Works

WINEP – Water Industry National Environment Programme

Addendum – Annual Update 2022

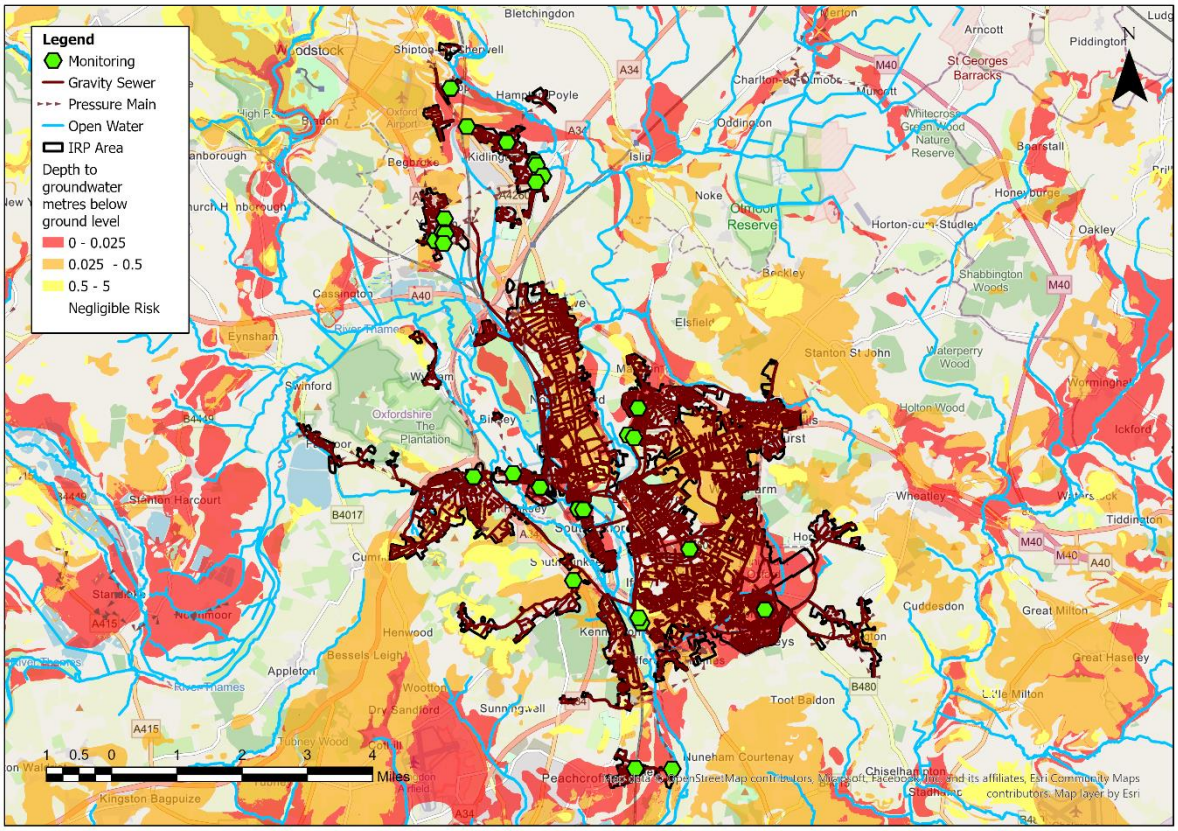
Table of contents

Overview

This addendum to the Oxford Groundwater Impacted System Management Plan 2021 (GISMP) provides an update on performance/work undertaken in the Hydrological Year October 2021 to September 2022. The key points covered include:

- Hydrological conditions
- How the sewerage system has performed over this period
- Mitigation / remedial measures progressed over the last year and being planned
- Summary and plan for 2022/23

Figure 1 – Oxford Monitoring Plan



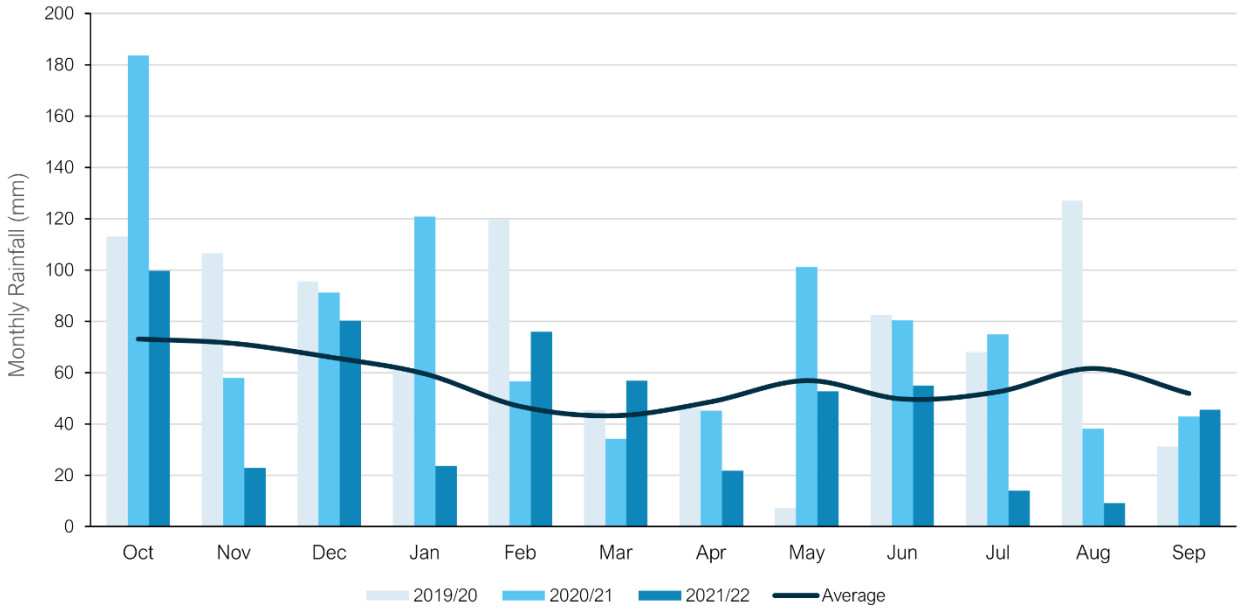
Hydrological Review – 2021-2022

This section summaries the hydrological conditions within the Oxford catchment within the period under investigation and provides comparison against previous year's performance to put the annual performance into context. The hydrological review has been undertaken based on the Hydrological Year which runs October 1st to September 30th.

Catchment Rainfall

Representative Radar rainfall has been used to generate monthly data at catchment level for comparison with average data generated by local Met Office Weather Station Records. Figure 2 presents the comparison of this data for the last three hydrological years to support longer term trends within the local system.

Figure 2 – Monthly Rainfall Performance



Average Values taken from Met Office Weather Station at Oxford based on the period 1991-2020

The total rainfall for the 2021/22 hydrological year is 17% below the annual average total. Total rainfall values are presented in Table 3 below.

Table 3 –Total Rainfall Based on Hydrological Year

Average (mm)	2019/20 (mm)	2020/21 (mm)	2021/22 (mm)
682	903	928	569

Groundwater / Local River Level

The Oxford catchment is situated in the Thame, Ock and Cotswolds East water resources areas. It primarily sits in the Oxford Clay and West Walton Formation of interbedded coarse/fine grained sediment and the Beckley Sand Member of interbedded coarse/ fine grained sediment. These are not designated principal aquifers within the UK.

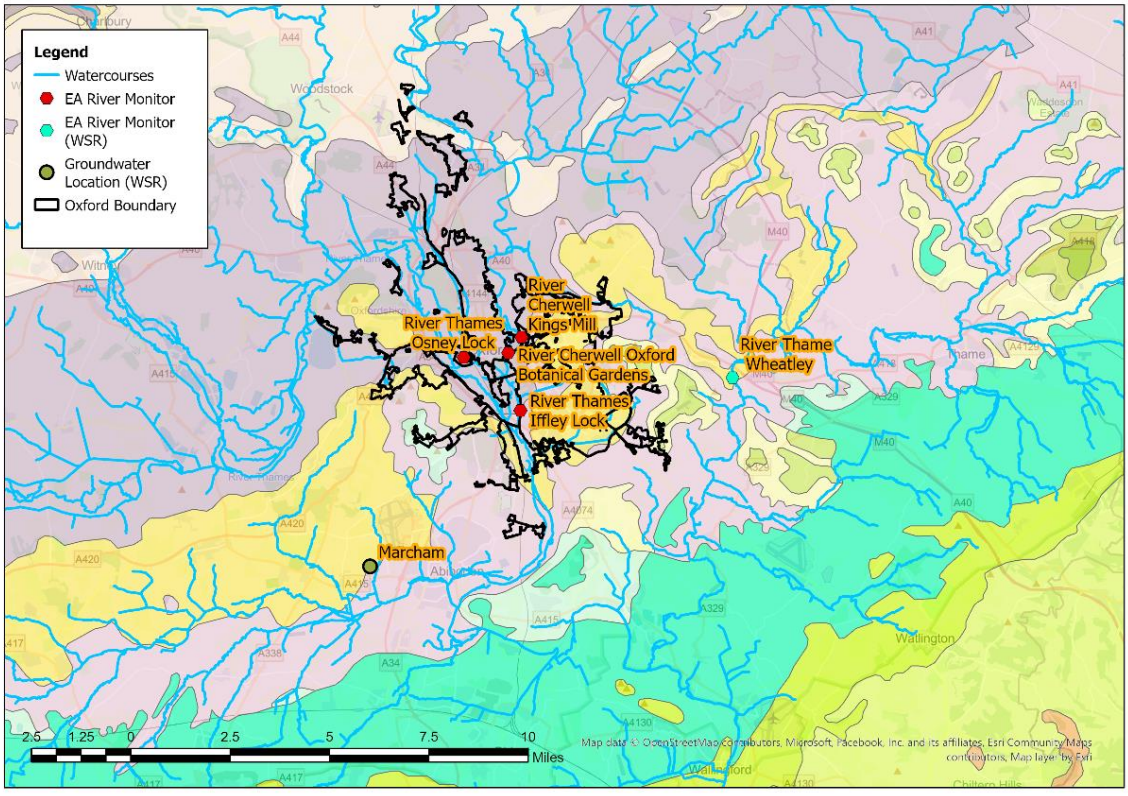
The Environment Agency has gauging stations on local watercourses measuring stage and observation boreholes measuring groundwater levels locally to the catchment which can be used to provide indicative local groundwater performance.

From previous investigations we have identified the following sites are good indicators of groundwater levels within the catchment.

- River Cherwell, Oxford Botanical Gardens
- River Cherwell, Kings Mill
- River Thames, Iffley Lock
- River Thames, Osney Lock

These sites are illustrated in the figure below, alongside the closest groundwater reference station and closest gauging station from the Water Situation Report.

Figure 4 – Local Monitoring Stations



The following figures represent the last three hydrological years of level information at the indicator sites to build a picture of the relative conditions prevalent in the current year. It is presented against both the daily total rainfall values for the catchment and a rolling 15 day total rainfall.

Figure 5A – Cherwell at Oxford Botanical Gardens

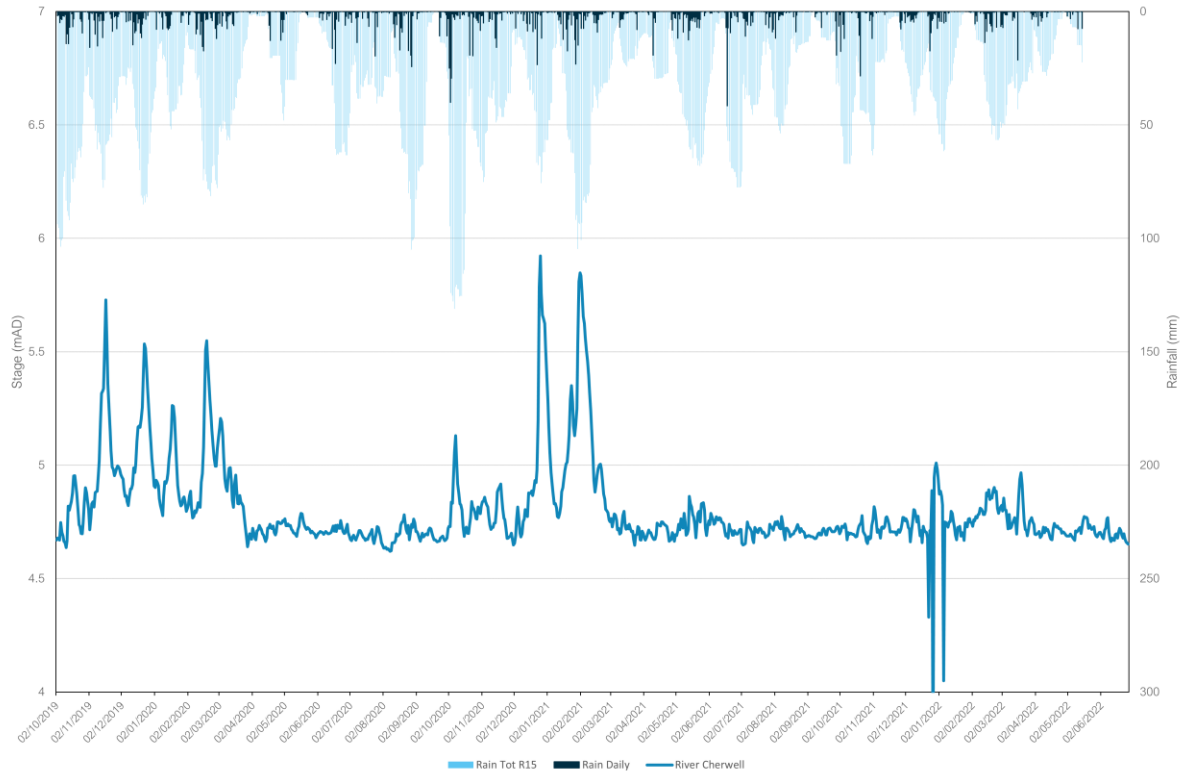


Figure 5B – Cherwell at Kings Mill

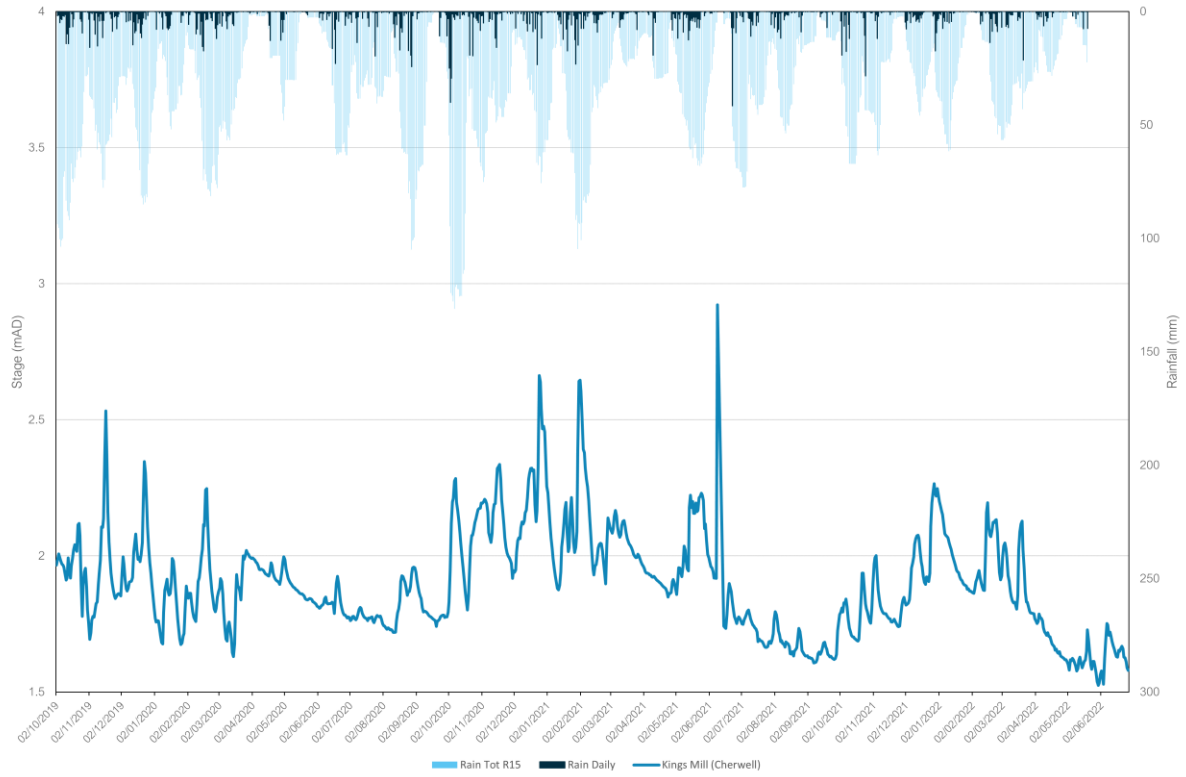


Figure 5C – Thames at Iffley Lock

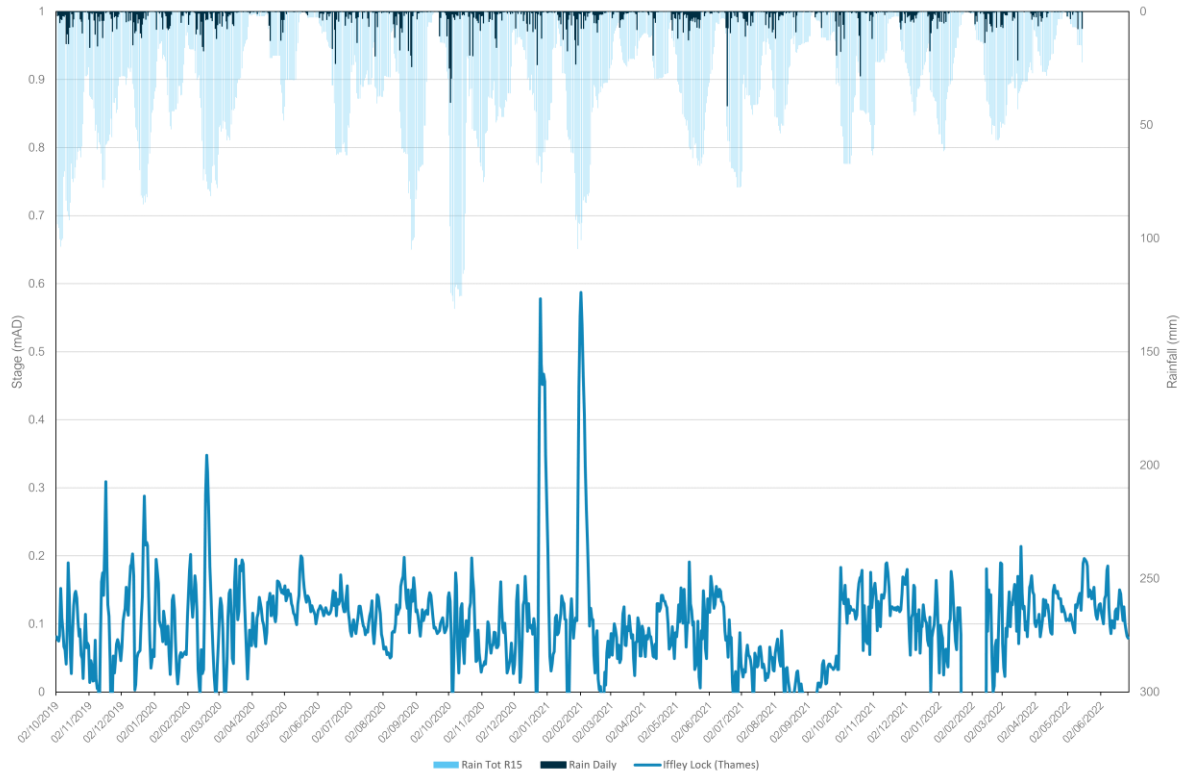
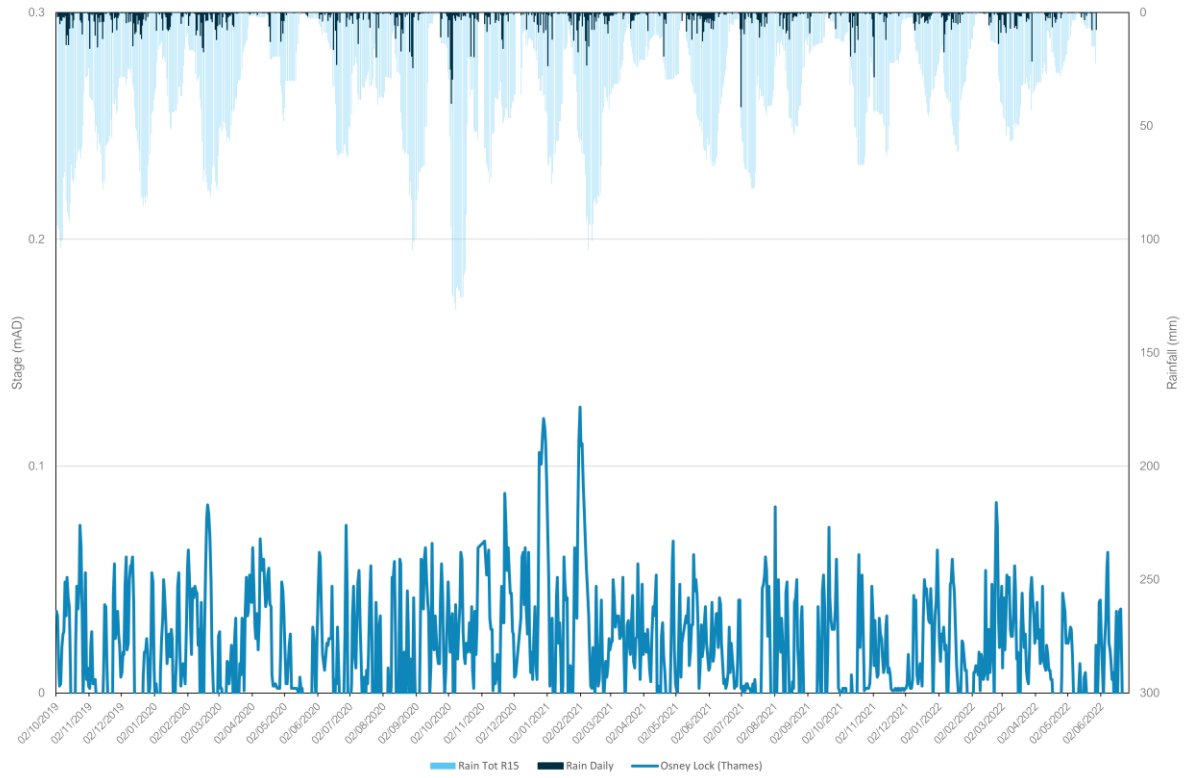
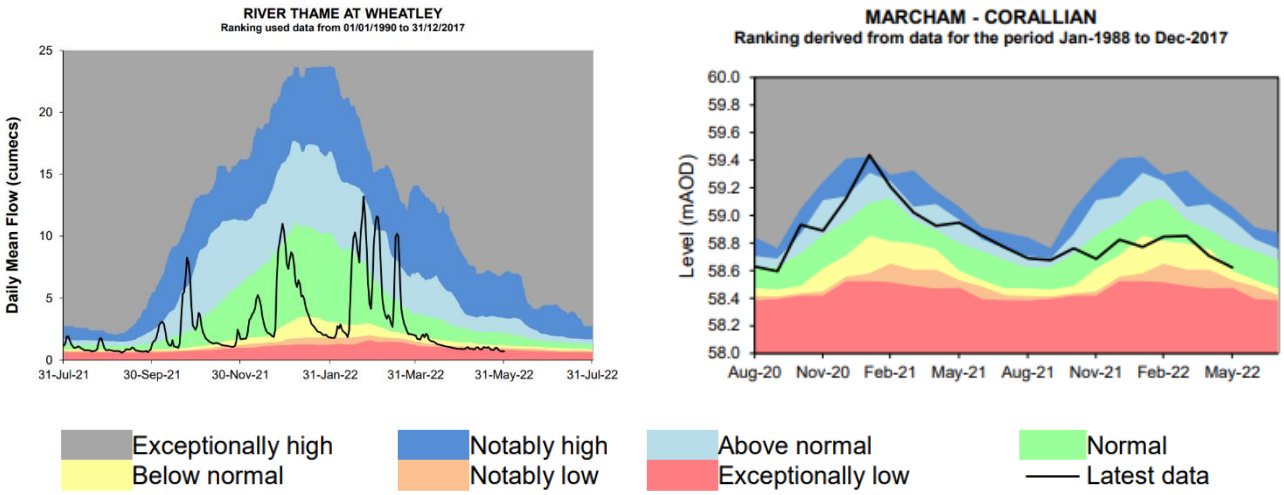


Figure 5D – Thames at Osney Lock



In addition to these specific stations, the wider groundwater context is illustrated in the Water Situation Report for the Thame. Whilst the Oxford catchment does not sit within a principal aquifer, the closest groundwater reference station is Marcham. This site shows significantly lower overall groundwater than the previous year. This can be seen in the figure below alongside the river indicator location at Wheatley on the River Thame.

Figure 6 – Water Situation Report



Extract from - [Water Situation Report (publishing.service.gov.uk)]

Network Performance

Within the Oxford catchment there are four sites detailed within the Environment Agency Consents Database which have an Event Duration Monitor (EDM) fitted.

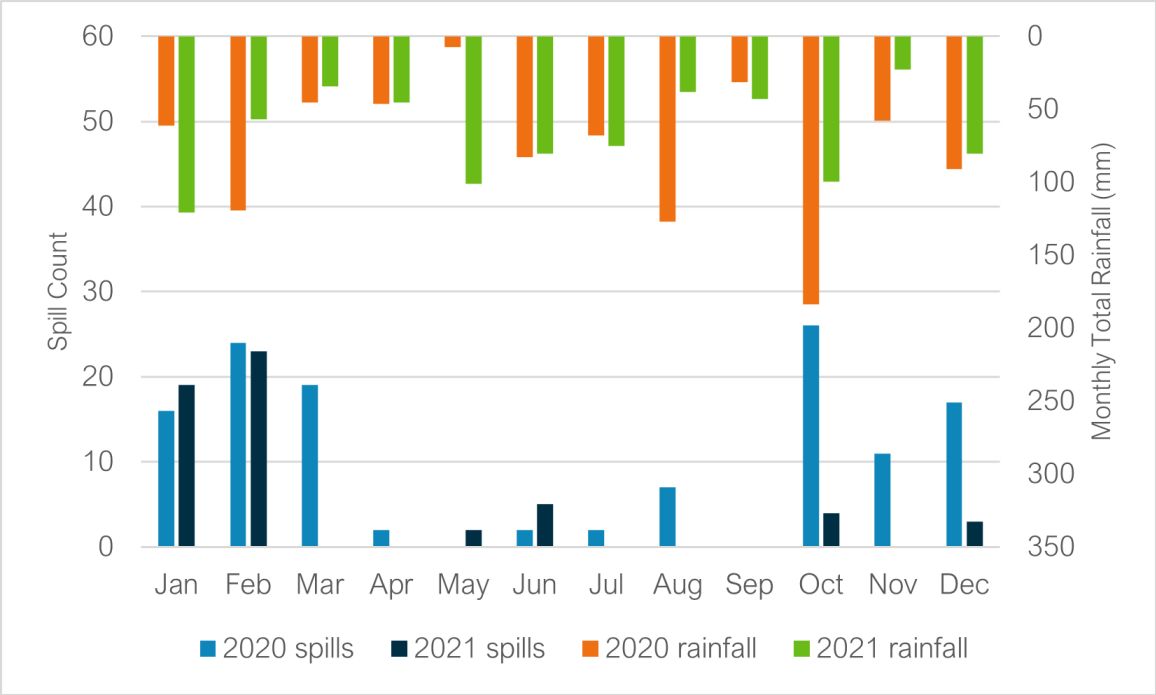
Table 7 below details the last 2 years performance for overflow 'Oxford STW'.

Table 7 – Event Duration Monitoring, overflow 'Oxford STW'

Overflow	2020		2021	
	Spills	Duration (hours)	Spills	Duration (hours)
Oxford STW	126	1822.48	56	891.52

A critical part of the assessment of EDM performance and its relation to groundwater inundation is to review the month-on-month spill performance, against previous years and the monthly total rainfall values to give context to the performance. Figure 8 below presents the EDM performance trend and rainfall for recent years.

Figure 8 – EDM Monthly Performance, overflow 'Oxford STW'



The trend in spill performance across the two recorded years does show variation in spills, despite similarities within the total monthly rainfall, particularly evident in December. The data suggests a wider relationship between rainfall, elevated groundwater levels and spill frequency. Despite broadly similar rainfall, significantly more spills were recorded at Oxford STW in December 2020 compared to December 2021. The indicator sites shown in Figure 5 suggest groundwater levels were higher in December 2020. Additionally, for 2021 the focus on spills is for January and February, when the indicator sites shown in Figure 5 suggest there was a spike in groundwater levels.

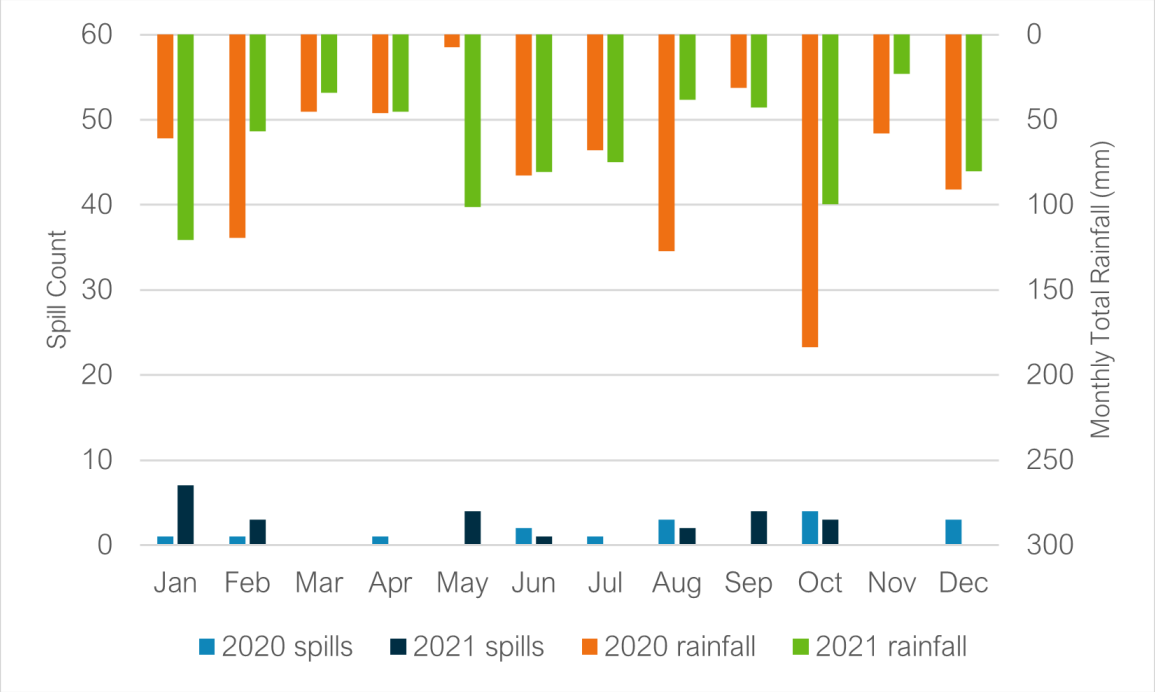
Table 9 below details the last 2 years performance for overflow 'Botley Road CSO'. Note that for 2020, a spill count of 16 is stated which is one less than the published count for 2020. The data has been revised/re-validated, and the revised spill count of 16 will be included with the 2020 resubmission.

Table 9 – Event Duration Monitoring, overflow 'Botley Road CSO'

Overflow	2020		2021	
	Spills	Duration (hours)	Spills	Duration (hours)
Botley Road CSO	16	91.20	24	86.74

A critical part of the assessment of EDM performance and its relation to groundwater inundation is to review the month-on-month spill performance, against previous years and the monthly total rainfall values to give context to the performance. Figure 10 below presents the EDM performance trend and rainfall for recent years.

Figure 10 – EDM Monthly Performance, overflow 'Botley Road CSO'



The data suggests a wider relationship between rainfall, elevated groundwater levels and spill frequency. Despite significantly lower rainfall in February 2021 compared to February 2020, more spills were recorded in February 2021. The indicator sites shown in Figure 5 suggest there was a spike in groundwater levels in February 2021. Additionally, despite broadly similar rainfall, spills were recorded at Botley Road CSO in December 2020, but not in December 2021. The indicator sites shown in Figure 5 suggest groundwater levels in the catchment were higher in December 2020. The data does also suggest a relationship between rainfall intensity and overflow spills, with some spills recorded at Botley Road CSO over the summer months in 2020 and 2021, when more intense rainfall events likely occurred.

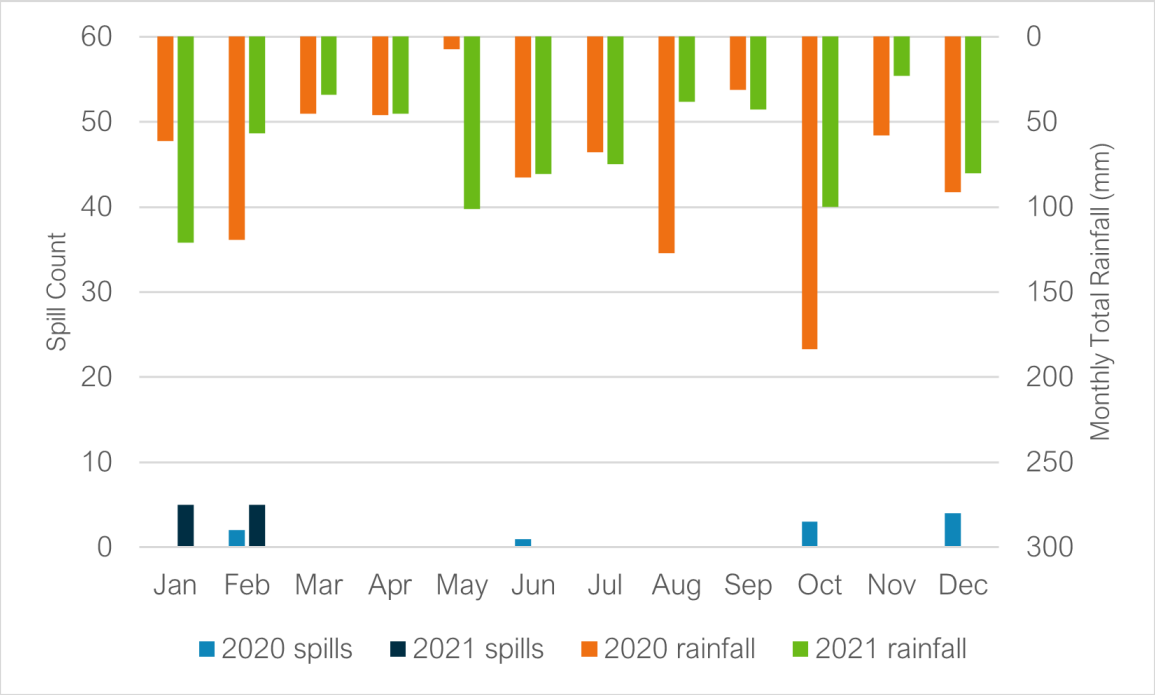
Table 11 below details the last 2 years performance for overflow 'North Hinksey Lane CSO'.

Table 11 – Event Duration Monitoring, overflow 'North Hinksey Lane CSO'

Overflow	2020		2021	
	Spills	Duration (hours)	Spills	Duration (hours)
North Hinksey Lane CSO	10	96.81	10	94.78

A critical part of the assessment of EDM performance and its relation to groundwater inundation is to review the month-on-month spill performance, against previous years and the monthly total rainfall values to give context to the performance. Figure 12 below presents the EDM performance trend and rainfall for recent years.

Figure 12 – EDM Monthly Performance, overflow 'North Hinksey Lane CSO'



The data suggests a wider relationship between rainfall, elevated groundwater levels and spill frequency. The trends shown in the data are similar to those shown in the EDM data for Botley Road CSO, displayed in Figure 10. Despite significantly lower rainfall in February 2021 compared to February 2020, more spills were recorded in February 2021. The indicator sites shown in Figure 5 suggest there was a spike in groundwater levels in February 2021. Additionally, despite broadly similar rainfall, spills were recorded at North Hinksey Lane CSO in December 2020, but not in December 2021. The indicator sites shown in Figure 5 suggest groundwater levels in the catchment were higher in December 2020.

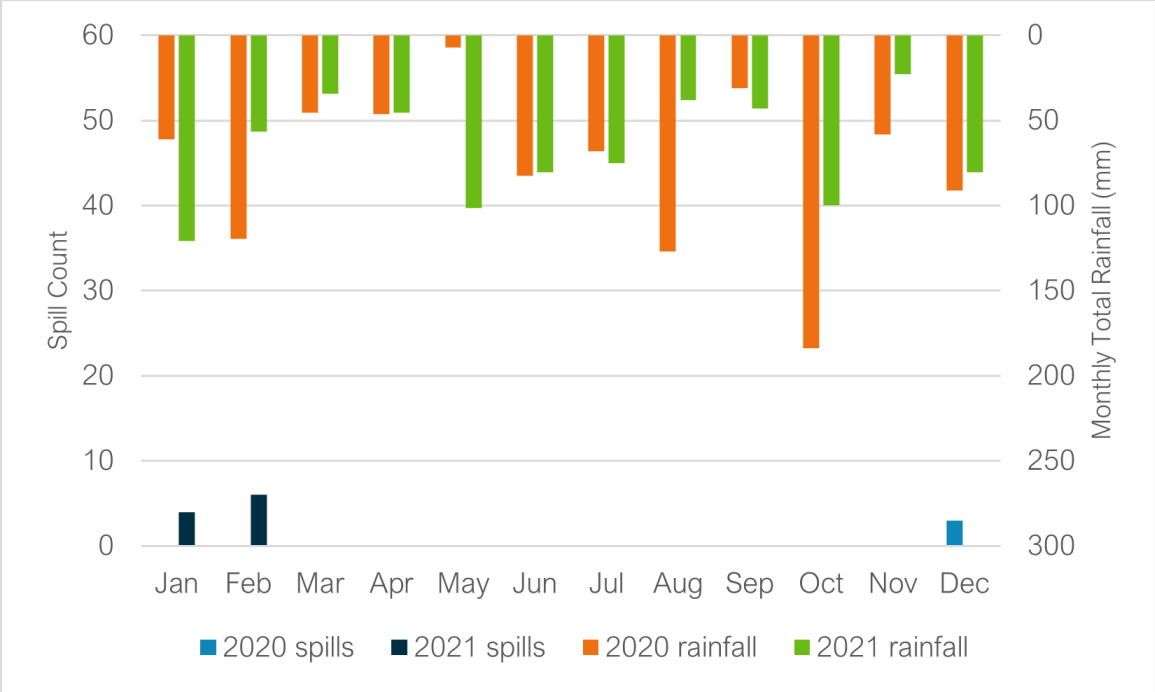
Table 13 below details the last 2 years performance for overflow 'Littlemore SPS'.

Table 13 – Event Duration Monitoring, overflow 'Littlemore SPS'

Overflow	2020		2021	
	Spills	Duration (hours)	Spills	Duration (hours)
Littlemore SPS	3	14	10	72.74

A critical part of the assessment of EDM performance and its relation to groundwater inundation is to review the month-on-month spill performance, against previous years and the monthly total rainfall values to give context to the performance. Figure 14 below presents the EDM performance trend and rainfall for recent years.

Figure 14 – EDM Monthly Performance, overflow 'Littlemore SPS'



The data suggests a wider relationship between rainfall, elevated groundwater levels and spill frequency. The trends shown in the data are similar to those shown in the EDM data for Botley Road CSO and North Hinksey Lane CSO, displayed in Figures 10 and 12. Despite significantly lower rainfall in February 2021 compared to February 2020, no spills were recorded in February 2020, however spills were recorded at the overflow in February 2021. The indicator sites shown in Figure 5 suggest there was a spike in groundwater levels in February 2021. Additionally, despite broadly similar rainfall, spills were recorded at Littlemore SPS in December 2020, but not in December 2021. The indicator sites shown in Figure 5 suggest groundwater levels in the catchment were higher in December 2020.

Investigations & Interventions

This section details the activities that have been undertaken within the catchment within the Hydrological Year 2021-22.

Monitor Installations

The sewer depth monitor (SDM) programme supports long term groundwater understanding within GISMP catchments. Currently, there are a total of 26 monitors installed within the Oxford catchment. There are currently 2 further monitor installs planned.

The data from these will be cross-referenced with other long-term records (where available) within the catchment.

Remediation Works Undertaken this Hydrological Year

Table 15 below provides a summary of the investigations and remediation works undertaken or planned within the Oxford catchment in the 2021-22 Hydrological Year.

Table 15 – Works Undertaken in the 2021/22 Hydrological Year

Investigation/ remediation type	Number/ length undertaken
CCTV survey	N/A
Look and lift survey	N/A
Sewer lining	N/A
Patch lining	N/A
Manhole sealing	N/A

With the seasonal trends in groundwater being low in comparison with previous years and the SDM installations ongoing, the larger scale survey, identification and remediation of the sewerage network has not been possible within the 2021/2022 Hydrological Year.

Summary

Rainfall in the Oxford catchment over the 2021/22 hydrological year has been below average, with groundwater levels in the aquifer beneath Oxford not reaching the levels seen in previous years which triggered groundwater ingress into the sewerage network and elevated flow/depth readings at monitoring sites. This is indicated in the lower number of EDM spills recorded at the four overflows in December 2021, in comparison to December 2020, when recorded groundwater levels were higher.

Lift and look and CCTV surveys will continue throughout the remaining wet winter periods within this AMP7 period (2020- 2025) with the aim of finding further priority locations for remediation and investigating/justifying the need for future larger scale lining as part of our 2024 Price Review (PR) process if required.

Addendum - Annual Update 2023

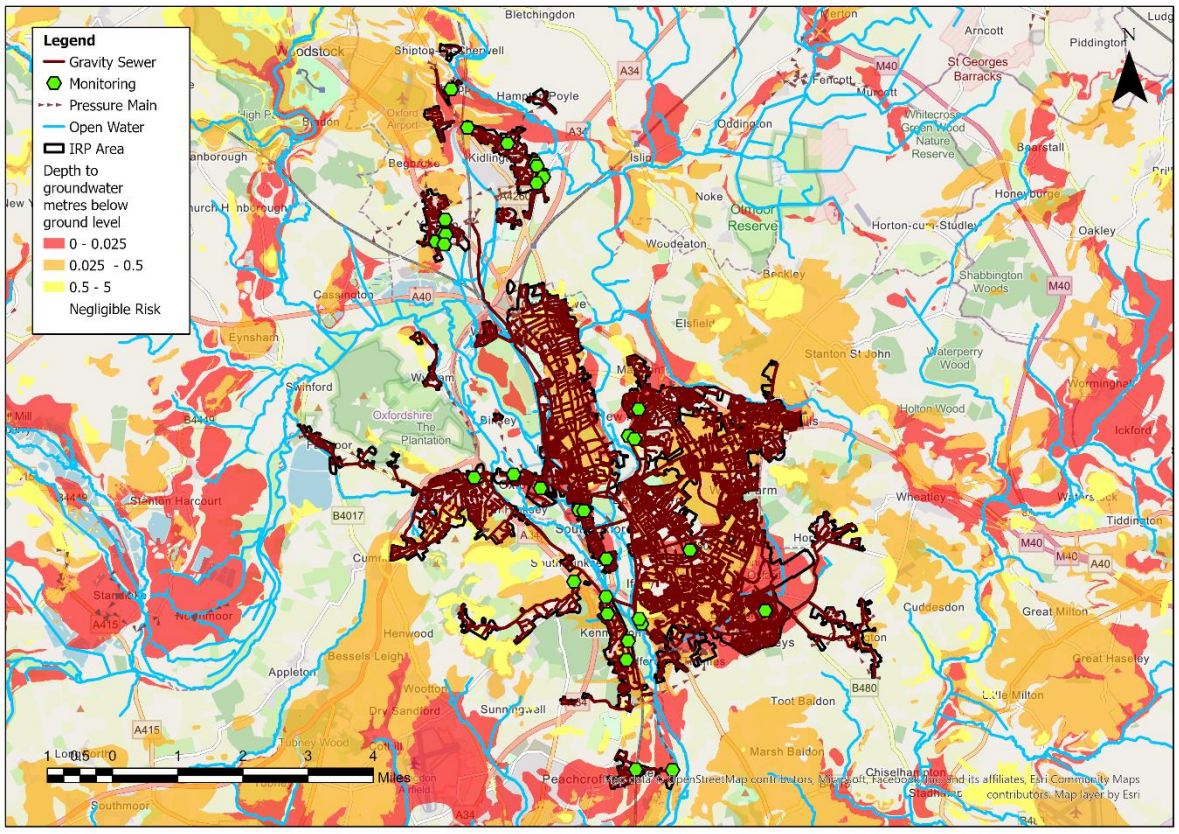
Table of contents

Overview

This addendum to the Oxford Groundwater Impacted System Management Plan 2021 (GISMP) provides an update on work undertaken in the Hydrological Year October 2022 to September 2023. The key points covered include:

- Hydrological conditions
- Performance of the sewerage system
- Mitigation / remedial measures progressed over the last year and those being planned
- Summary and plan for 2023/24

Figure 1 – Oxford Monitoring Plan



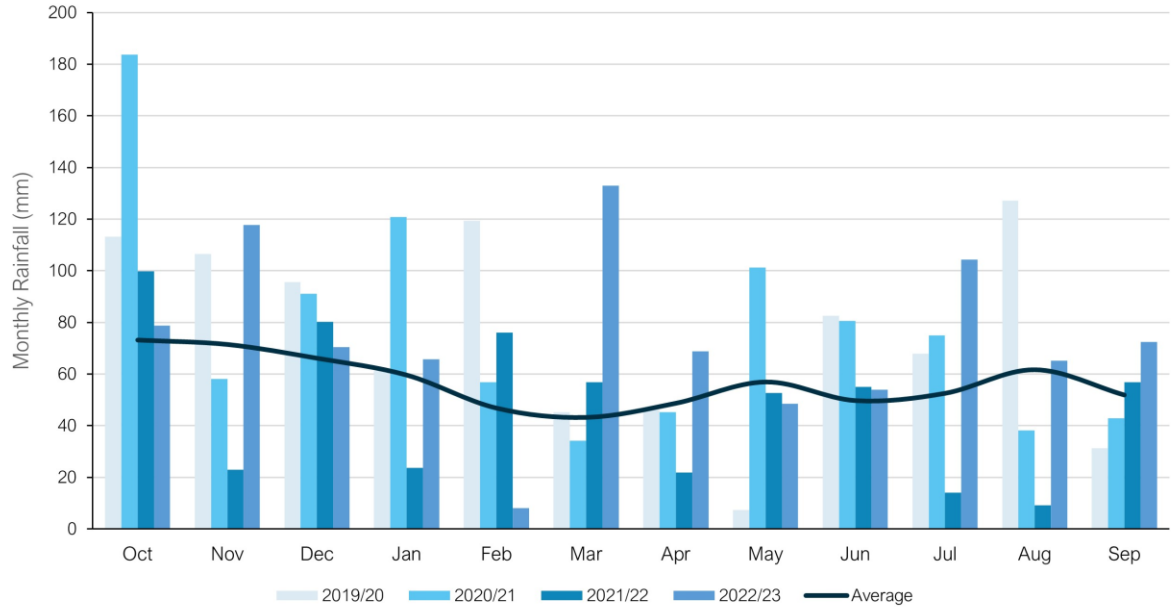
Hydrological Review – 2022-2023

This section summaries the hydrological conditions within the Oxford catchment within the period under investigation and provides comparison against previous year's performance to put the annual performance into context. The hydrological review has been undertaken based on the Hydrological Year which runs October 1st to September 30th.

Catchment Rainfall

Representative Radar rainfall has been used to generate monthly data at catchment level for comparison with average data generated by local Met Office Weather Station Records. Figure 2 presents the comparison of this data for the last four hydrological years to support longer term trends within the local system.

Figure 2 – Monthly Rainfall Performance



Average Values taken from Met Office Weather Station at Oxford based on the period 1991-2020

The total rainfall for the 2022/23 hydrological year is 30% above the annual average total. Total rainfall values are presented in Table 3 below.

Table 3 –Total Rainfall Based on Hydrological Year

Average (mm)	2019/20 (mm)	2020/21 (mm)	2021/22 (mm)	2022/23 (mm)
682	903	928	569	887

Groundwater / Local River Level

The Oxford catchment is situated in the Thame, Ock and Cotswolds East water resources areas. It primarily sits in the Oxford Clay and West Walton Formation of interbedded coarse/fine grained sediment and the Beckley Sand Member of interbedded coarse/ fine grained sediment. These are not designated principal aquifers within the UK.

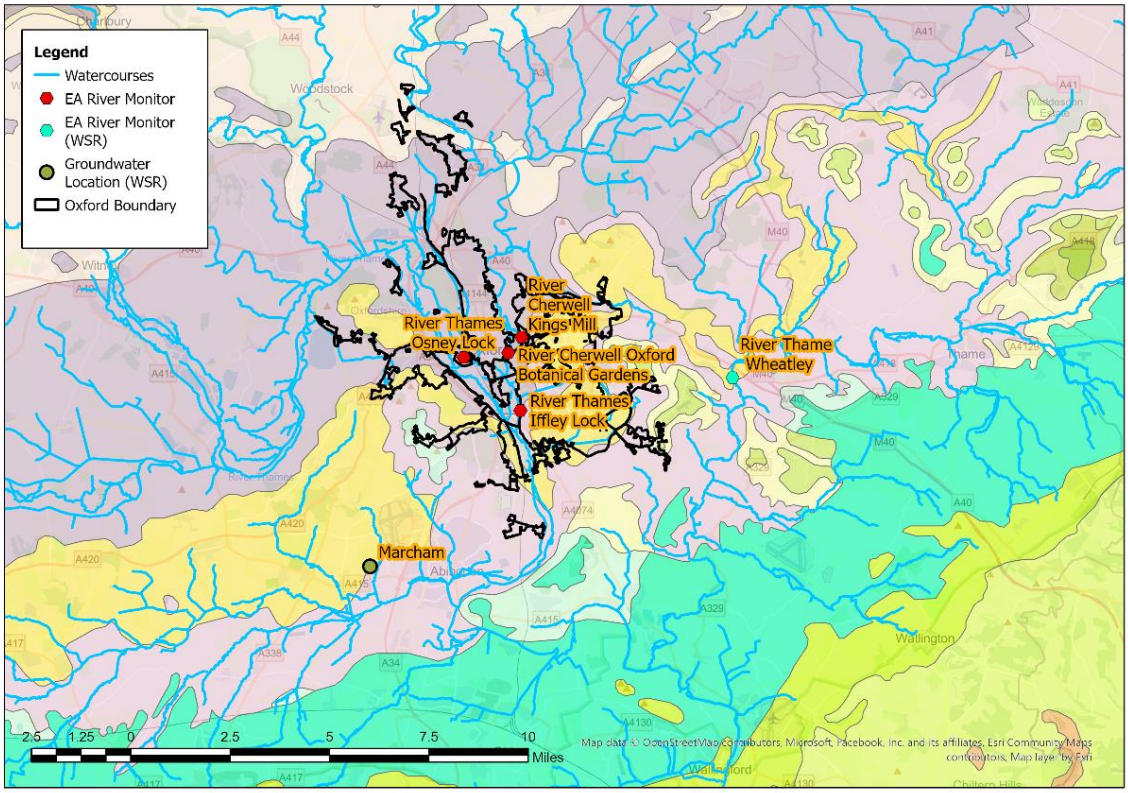
The Environment Agency has gauging stations on local watercourses measuring stage, and observation boreholes (OBH) measuring groundwater levels locally to the catchment which can be used to provide indicative local groundwater performance.

From previous investigations we have identified the following sites as good indicators of groundwater levels within the catchment.

- River Cherwell, Oxford Botanical Gardens
- River Cherwell, Kings Mill
- River Thames, Iffley Lock
- River Thames, Osney Lock

These sites are illustrated in the figure below, alongside the closest groundwater reference station and closest gauging station from the Water Situation Report.

Figure 4 – Local Monitoring Stations



The following figures represent the last three hydrological years of level information at the indicator sites to build a picture of the relative conditions prevalent in the current year. It is presented against both the daily total rainfall values for the catchment and a rolling 15-day total rainfall.

Figure 5A – Cherwell at Oxford Botanical Gardens

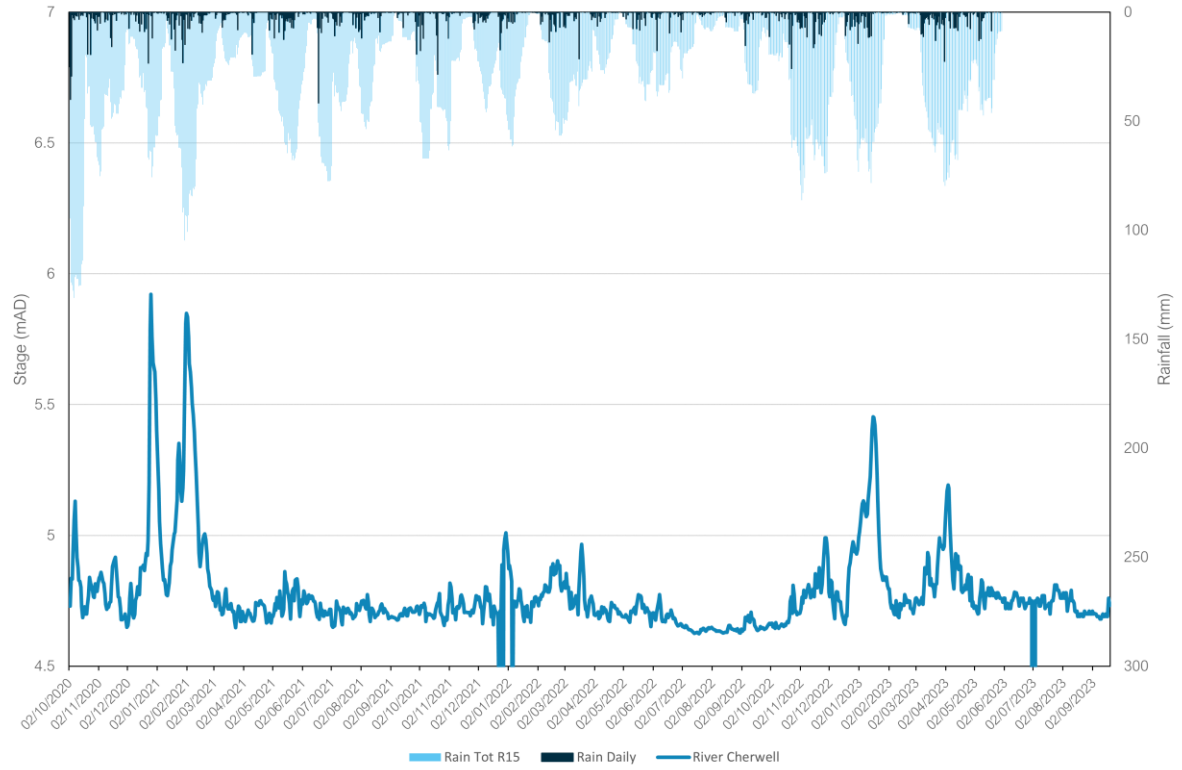


Figure 5B – Cherwell at Kings Mill

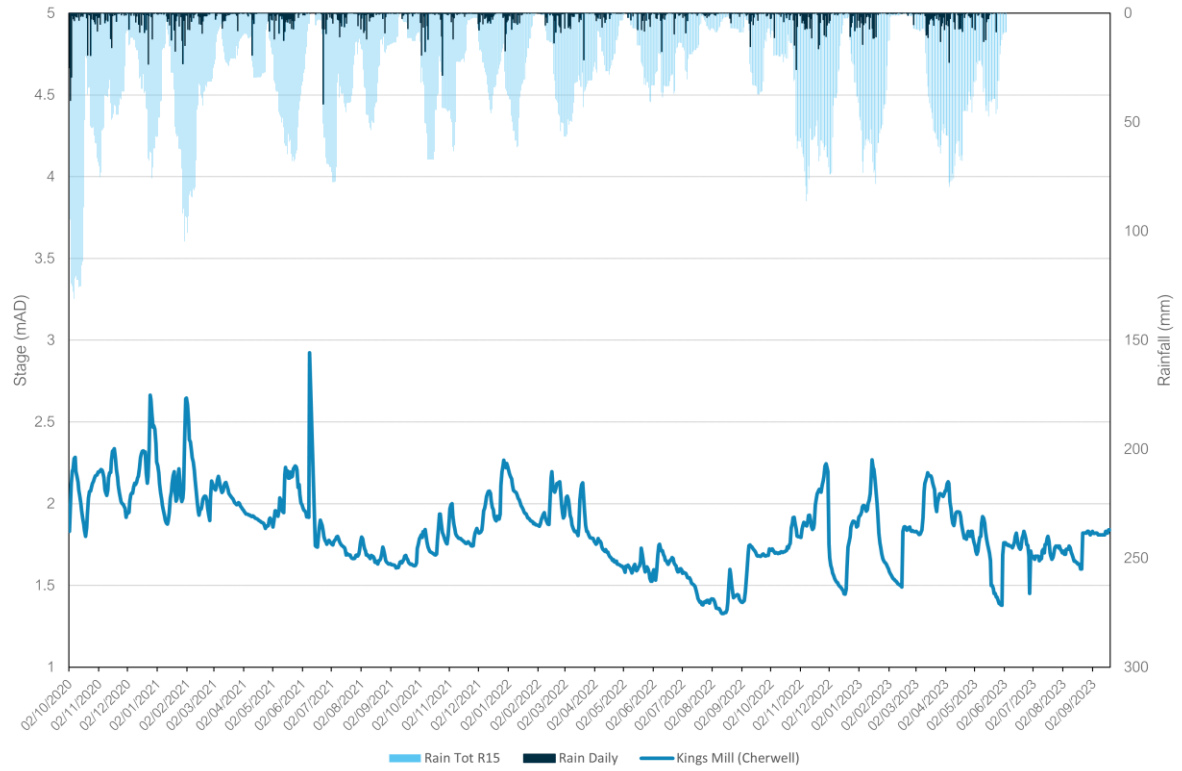


Figure 5C – Thames at Iffley Lock

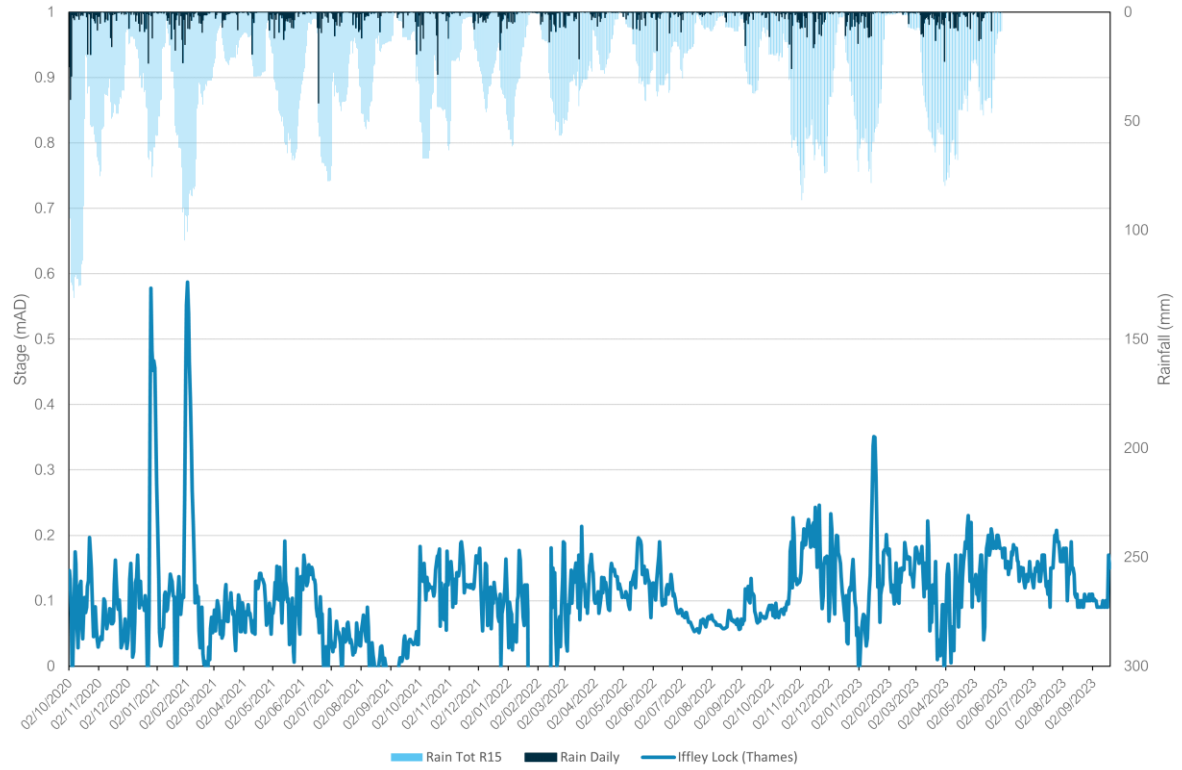
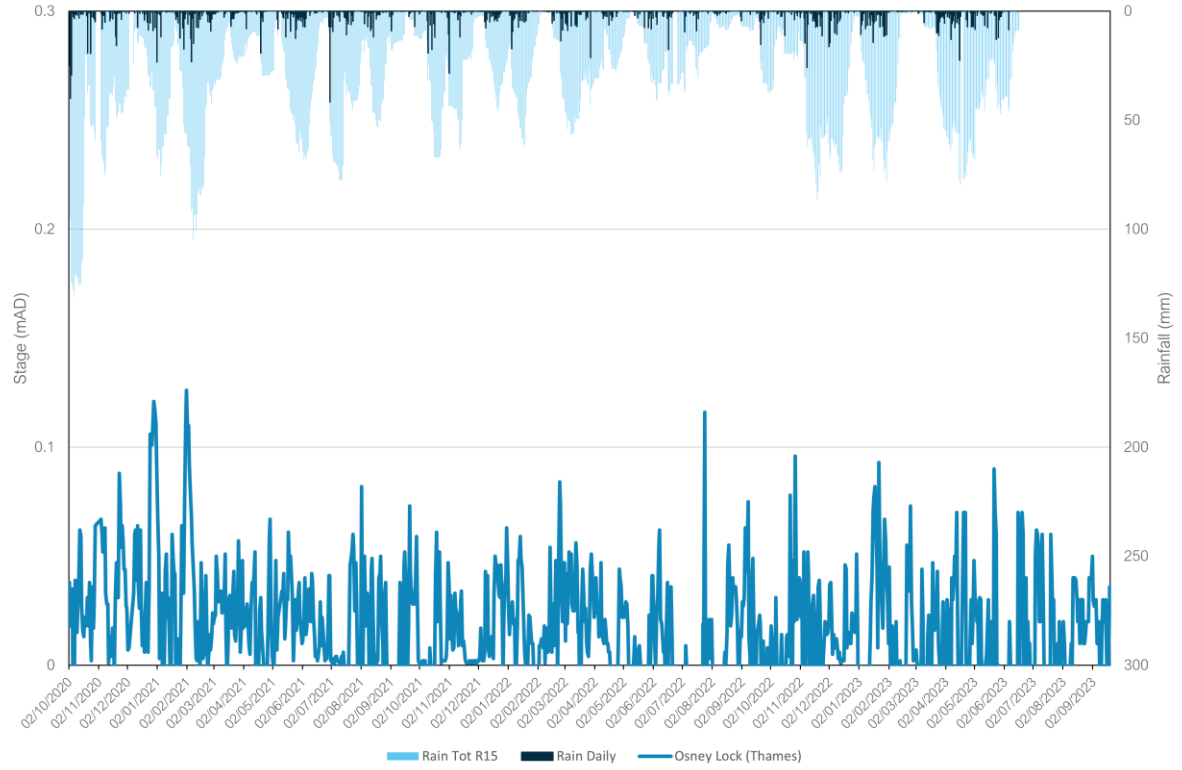
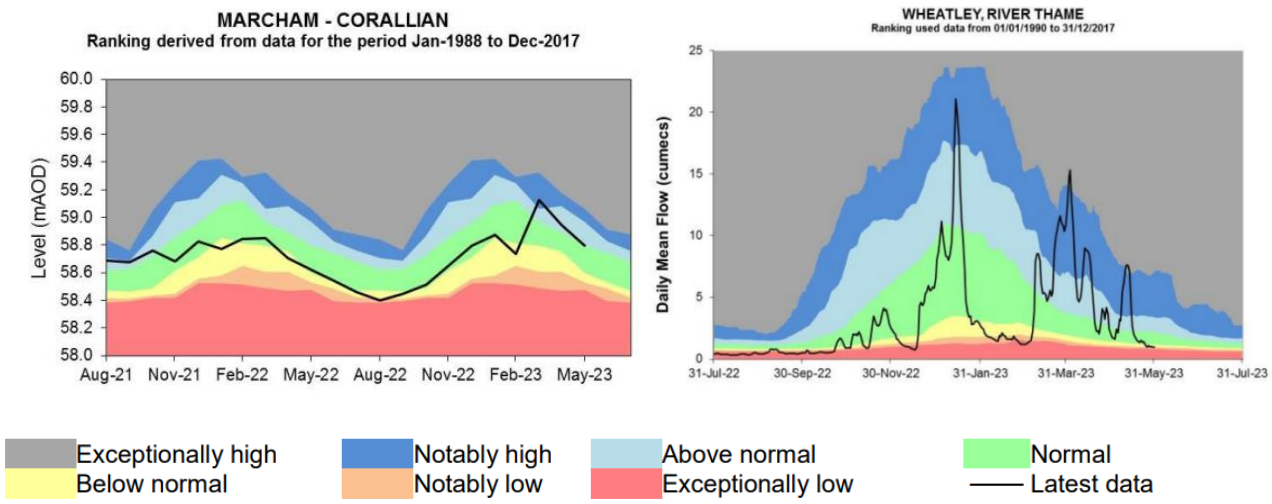


Figure 5D – Thames at Osney Lock



In addition to these specific stations, the wider groundwater context is illustrated in the Water Situation Report for the Thame. Whilst the Oxford catchment does not sit within a principal aquifer, the closest groundwater reference station is Marcham. This site shows groundwater levels generally at or just above below normal level in 2022. For 2023, groundwater levels have generally been higher than the equivalent periods in 2022, and have been observed at normal, above normal and (briefly) notably high levels. This can be seen in the figure below alongside the river indicator location at Wheatley on the River Thame.

Figure 6 – Water Situation Report



Extract from - [Water Situation Report (publishing.service.gov.uk)]

Network Performance

Within the Oxford catchment there are four sites detailed within the Environment Agency Consents Database which have an Event Duration Monitor (EDM) fitted.

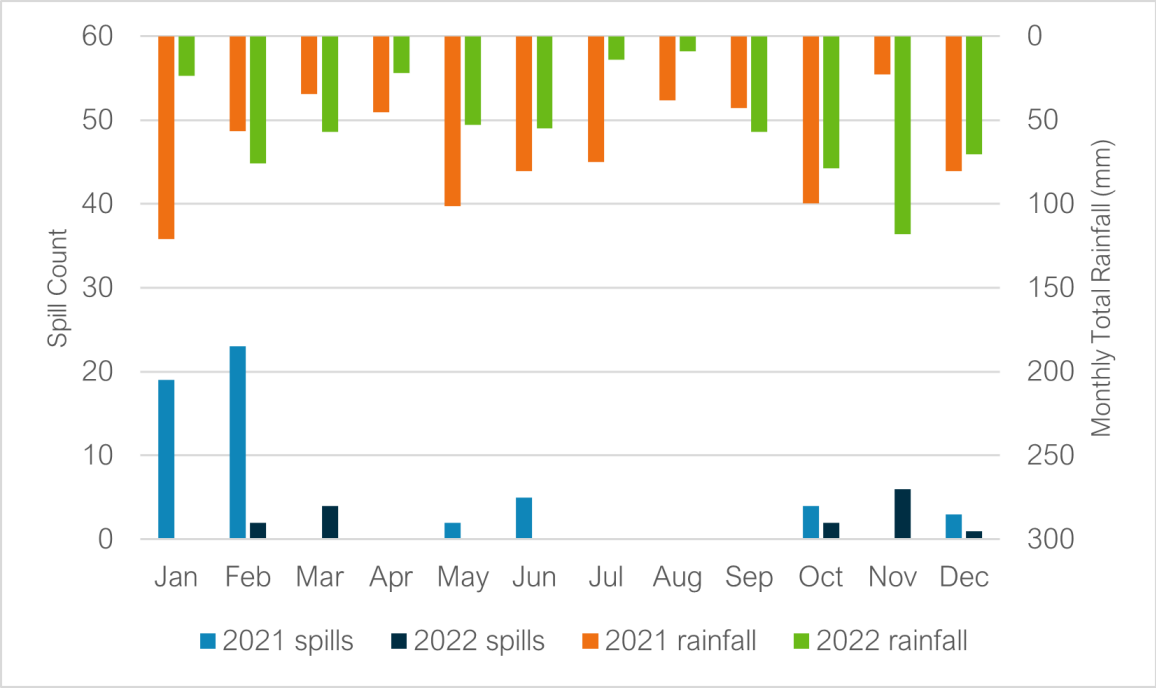
Table 7 below details the last 2 years performance for overflow 'Oxford STW'.

Table 7 – Event Duration Monitoring, overflow 'Oxford STW'

Overflow	2021		2022	
	Spills	Duration (hours)	Spills	Duration (hours)
Oxford STW	56	891.52	15	163.94

A critical part of the assessment of EDM performance and its relation to groundwater infiltration, is to review the month-on-month spill performance against previous years and the monthly total rainfall values to give context to the performance. Figure 8 below presents the EDM performance trend and rainfall for recent years.

Figure 8 – EDM Monthly Performance, overflow 'Oxford STW'



The trend in spill performance across the two recorded years does show variation in spills. The data suggests a wider relationship between rainfall, elevated groundwater levels and spill frequency. Despite a higher rainfall total in February 2022, significantly more spills were recorded at Oxford STW in February 2021. The indicator site data shown in Figure 5, suggests groundwater levels in the catchment were higher in February 2021, with Figure 6 suggesting groundwater levels in the catchment were around below normal level in February 2022.

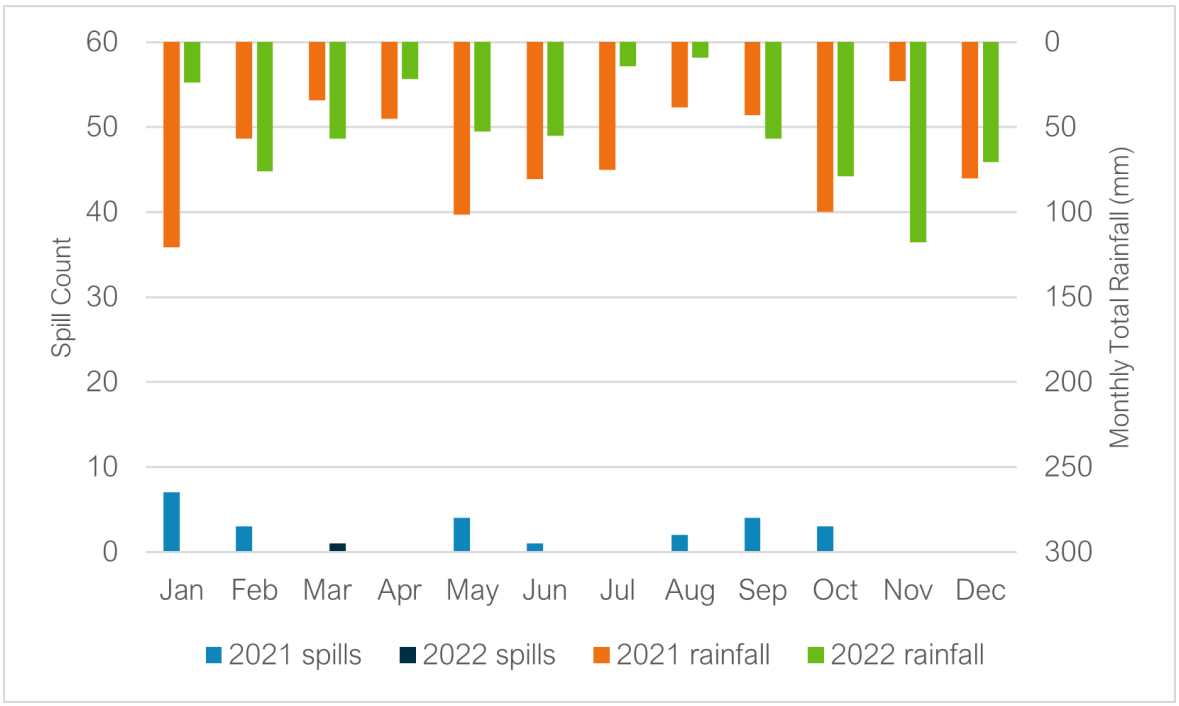
Table 9 below details the last 2 years performance for overflow 'Botley Road CSO'.

Table 9 – Event Duration Monitoring, overflow 'Botley Road CSO'

Overflow	2021		2022	
	Spills	Duration (hours)	Spills	Duration (hours)
Botley Road CSO	24	86.74	1	3.73

A critical part of the assessment of EDM performance and its relation to groundwater Infiltration, is to review the month-on-month spill performance against previous years and the monthly total rainfall values to give context to the performance. Figure 10 below presents the EDM performance trend and rainfall for recent years. Note that the spill count of 24 reported for 2021, is slightly higher than the value of 22 included in the Annual Return, and a spill count of one is reported for 2022, compared to the value of zero included in the Annual Return. The spill counts were revised/ re-validated, and the values reported here are the post-validation values.

Figure 10 – EDM Monthly Performance, overflow 'Botley Road CSO'



The data is indicative of a potential relationship between rainfall, elevated groundwater levels and spill frequency. Despite a higher rainfall total in February 2022 compared to February 2021, no spills were recorded at Botley Road CSO in February 2022, however three spills were recorded in February 2021. The indicator site data shown in Figure 5, suggests groundwater levels in the catchment were higher in February 2021, with Figure 6 suggesting groundwater levels in the catchment were around below normal level in February 2022. However, a significant number of spills were also recorded in the catchment outside of periods of elevated groundwater levels, indicative of spills occurring in the catchment during prolonged or intense rainfall events outside of periods of significant groundwater infiltration into the network.

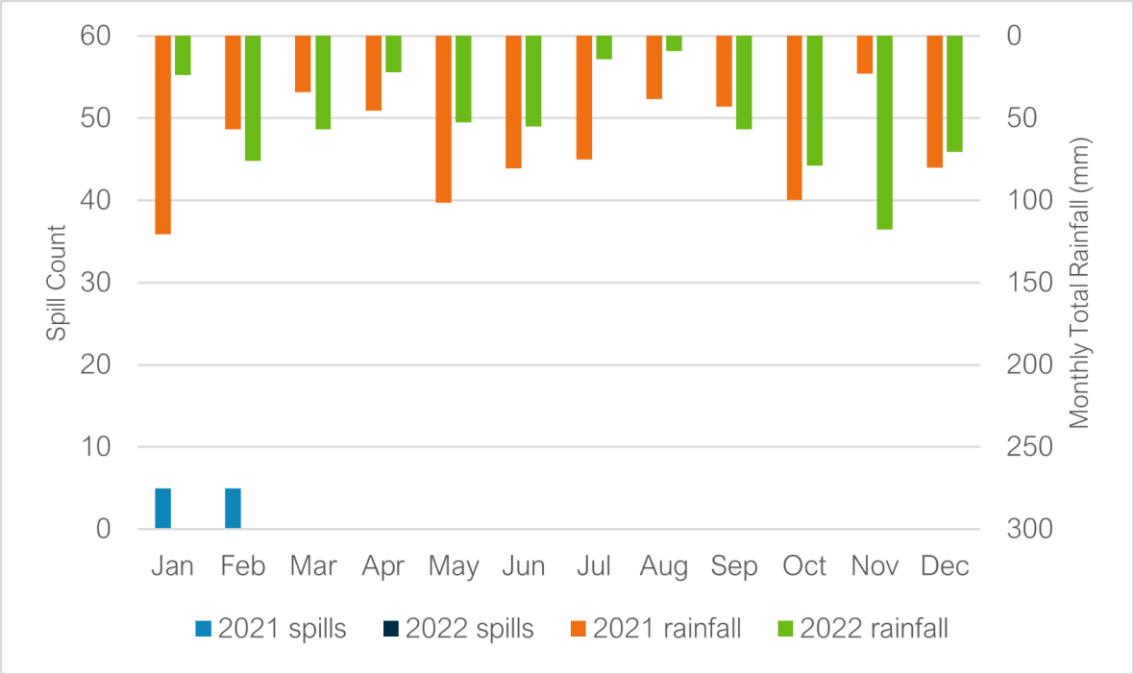
Table 11 below details the last 2 years performance for overflow 'North Hinksey Lane CSO'.

Table 11 – Event Duration Monitoring, overflow 'North Hinksey Lane CSO'

Overflow	2021		2022	
	Spills	Duration (hours)	Spills	Duration (hours)
North Hinksey Lane CSO	10	94.78	0	0

A critical part of the assessment of EDM performance and its relation to groundwater Infiltration, is to review the month-on-month spill performance against previous years and the monthly total rainfall values to give context to the performance. Figure 12 below presents the EDM performance trend and rainfall for recent years.

Figure 12 – EDM Monthly Performance, overflow 'North Hinksey Lane CSO'



The data suggests a wider relationship between rainfall, elevated groundwater levels and spill frequency. Spills were recorded in the first two months of 2021 only, when the indicator site data shown in Figure 5 suggests groundwater levels in the catchment were particularly elevated.

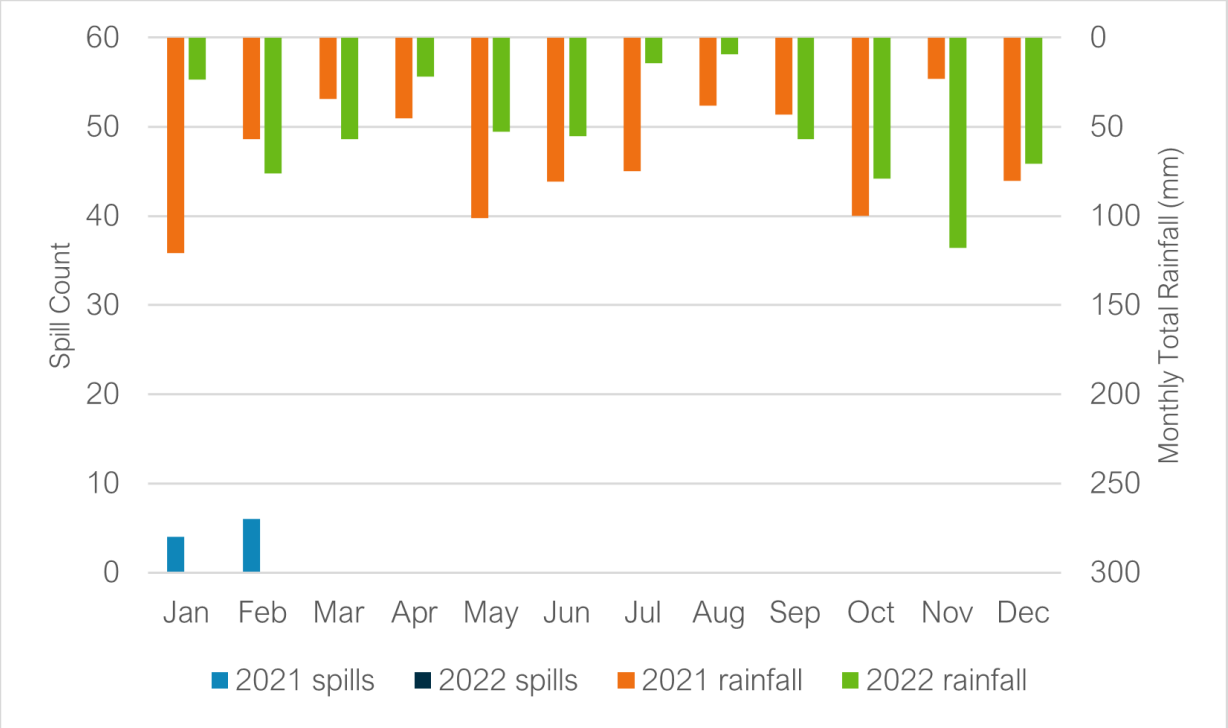
Table 13 below details the last 2 years performance for overflow 'Littlemore SPS'.

Table 13 – Event Duration Monitoring, overflow 'Littlemore SPS'

Overflow	2021		2022	
	Spills	Duration (hours)	Spills	Duration (hours)
Littlemore SPS	10	72.74	0	0

A critical part of the assessment of EDM performance and its relation to groundwater infiltration, is to review the month-on-month spill performance against previous years and the monthly total rainfall values to give context to the performance. Figure 14 below presents the EDM performance trend and rainfall for recent years.

Figure 14 – EDM Monthly Performance, overflow 'Littlemore SPS'



The data suggests a wider relationship between rainfall, elevated groundwater levels and spill frequency. Similar to North Hinksey Lane CSO, spills were recorded in the first two months of 2021 only, when the indicator site data shown in Figure 5 suggests groundwater levels in the catchment were particularly elevated.

Investigations & Interventions

This section details the activities that have been undertaken within the catchment within the Hydrological Year 2022-23.

Monitor Installations

The sewer depth monitor (SDM) programme supports long term groundwater understanding within GISMP catchments. Currently, there are a total of 33 monitors installed within the Oxford catchment. There are currently no further monitor installs planned.

The data from these will be cross-referenced with other long-term records (where available) within the catchment.

Remediation Works Undertaken this Hydrological Year

Table 15 below provides a summary of the investigations and remediation works undertaken or planned within the Oxford catchment in the 2022-23 Hydrological Year, as well as works undertaken in the 2021-22 Hydrological Year.

Table 15 – Works Undertaken in the 2022/23 Hydrological Year & in the 2021/22 Hydrological Year

Investigation/ remediation type	Number/ length undertaken 21/22	Number/ length undertaken 22/23
CCTV survey	N/A	N/A
Look and lift survey	N/A	N/A
Sewer lining	N/A	N/A
Patch lining	N/A	N/A
Manhole sealing	N/A	N/A

No interventions/ investigations were carried out in the catchment in the 2022/23 Hydrological Year. However, the system will continue to be monitored and investigations/ interventions carried out as appropriate and when conditions allow.

A major upgrade is planned for Oxford STW, costing more than £130m. This will provide a significant increase in treatment capacity, larger storm tanks and a higher quality of treated effluent going to the river. A completion date is yet to be confirmed.

Summary

Indicator site data suggests groundwater levels in the Oxford catchment were generally lower in 2022 than in 2021, with EDM data indicative of the role of groundwater infiltration on spills in the catchment. This hydrological year (October 2022 – September 2023), indicator site data suggests groundwater levels have reached higher levels than the previous hydrological year, and EDM data for 2023 will be analysed once available to continue to examine the relationship between groundwater levels and overflow spills in the catchment.

Lift and look and CCTV surveys will be undertaken in remaining wet winter periods if conditions allow, within this AMP7 period (2020- 2025). The aim of this is to find further priority locations for remediation and investigating/justifying the need for future larger scale lining as part of our 2024 Price Review (PR) process if required.

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