Groundwater Impacted System Management Plan

Cirencester (including South Cerney)

River Churn

January 2021

Thames Water

It's everyone's water

Version control

Version	Date	Amendment	Author	Checked	Reviewed
1-d1	Nov 2020	Draft for EA	NW and AJ	DJ	APH
1-d2	Jan 2021	Final Draft for EA	DJ	APH	JO
1-V1	Jan 2021	Version 1	DJ	APH	JO
1-V2	July 2021	Update to introductory text and infiltration potential figures	DJ	APH	JO
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Annual Update 2021	October 2021	Addition of the Annual Update 2021	DJ	APH	JO
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
Annual Update 2024	October 2024	Addition of the Annual Update 2024	MW/CW	DJ	DJ

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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 being significant and likely to lead the sewerage system, on occasion, becoming overwhelmed.

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 centered 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 'find and fix' approach to date lacks a degree of certainty of resolution and for this reason Thames Water in 2020 undertook 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 peak 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 through the price review process as service enhancement. In the meantime, we will continue to investigate sources of infiltration when it occurs and where feasible,undertake the work through our capitalmaintenance budgets. We refer to these as ‘quick win’ opportunities i.e. where wehave high degree of certainty of reducing point sources of infiltration and can do sowith reasonable costs and time.

The structure of this document has been created with input from the Environment Agency and structured around the Environment Agency’s Regulatory Position Statement (RPS) for ‘Discharges made from Groundwater Surcharged Sewers’ (Dated: December 2016). Sections covered in this document include our ‘Outline Plan’ with timescales, locations of anticipated ‘Unavoidable discharges’, 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. If we need to make an unavoidable discharge we will provide an authorisation document to the Environment Agency seeking their approval for any temporary discharge of groundwater surcharged sewers.'

Brief description of Cirencester catchment

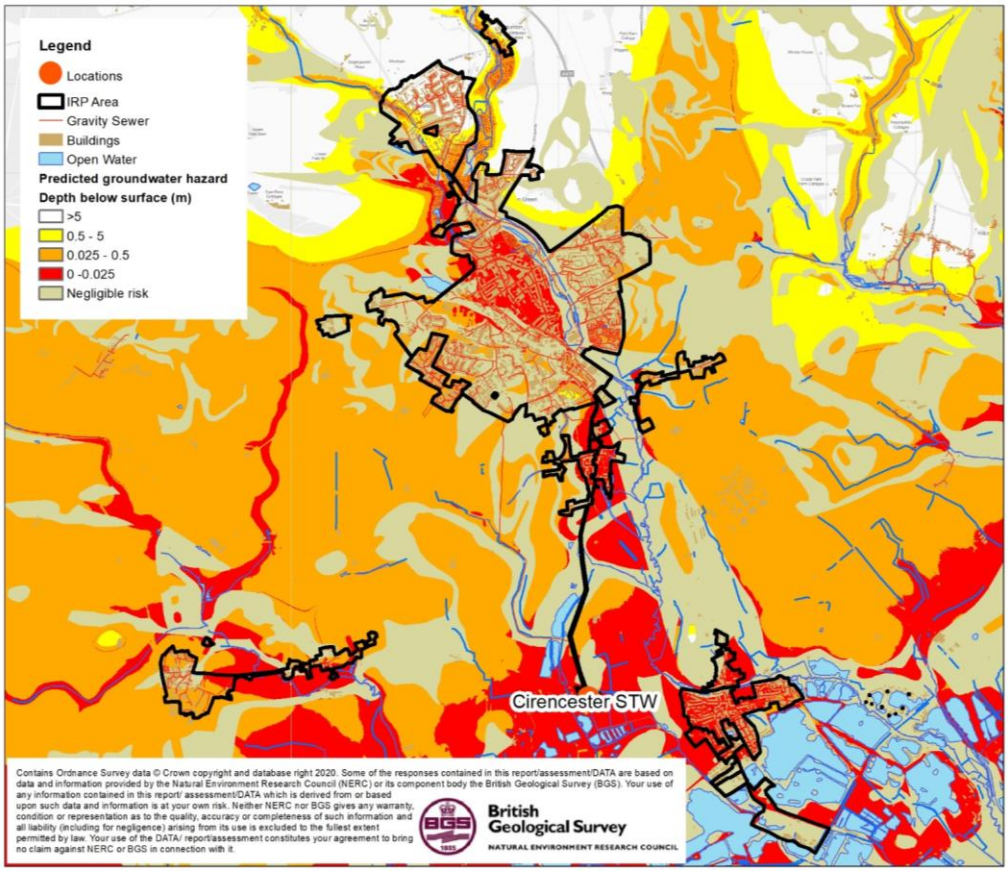


Figure 1.0 – Cirencester catchment

Cirencester lies on the River Churn in Gloucestershire, England, 13 miles North West of Swindon and 16 miles South East of Gloucester. Cirencester serves a populationequivalent[3] of 31,720 with a predominantly separate sewerage network totalling some131 km in length excluding private drains and sewers. The extent of the catchment is shown in Figure 1.0 above.

Problem characterisation

Groundwater has the potential to enter our sewers when levels are high, which reduces their capacity and increases the risk of the sewerage system becoming overwhelmed. There is a strong link between the rising river and groundwater levels across the Cirencester area and the drainage issues some of our customers have experienced, including sewer flooding and restricted use of their toilets and bathrooms. The Cirencester foul sewerage catchment is at particular risk of groundwater infiltration due to its geology, made up of permeable soils.

[3] Population equivalent based on 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 industrialfacilities and services to the individual pollution load in household sewage produced by oneperson in the same time.

In recent years the foul sewerage system in Cirencester and South Cerney has become overwhelmed for weeks at a time in some locations, following prolonged and heavy rainfall. This has resulted in some properties experiencing significant sewer flooding, spills out of many public and private manholes and periods of restricted toilet use.

The surveys we have carried out suggest that there is evidence of unwanted flows into the foul sewerage network, from both public and private drainage,when ground-water levels are high.
CCTV surveys of the local sewer network have identified issues and defects at, or near, Gloucester Road & Cheltenham Road, Gloucester Street, Spitalgate Lane, Victoria Road, Watermoor Road, Roman Road & City Bank Road, and Siddington Road & Cherry Tree Drive where groundwater is entering the sewer network. Surveys also show evidence of inundation from highways, public spaces and properties, surface water runoff from saturated fields and inundation from river water overflowing from the River Churn. Surface water misconnections (i.e. downpipes from roofs), into the foul sewerage network may also be a contributing factor, however further analysis is required to determine the extent to which this has contributed to sewer flooding.

Historically we have implemented a temporary overpump to an adjacent foul system on Station Road in South Cerney. This overpump allows us to reduce levels in the foul system in order to protect properties from flooding internally.

The root causes of sewer surcharges are therefore numerous and resolution of issues complex, requiring all stakeholders responsible for drainage in the catchment to work together to resolve them. Cirencester STW includes a storm land area to handle excess flows above the treatment capacity during storms that discharges to the Cerney Wick Brook, when it is full. We have already dedicated both a mobile treatment unit and a mobile pumping unit specifically for the Hereward Road and Blake Road area. The units will help us to prevent flooding or loss of drainage services for our customers in this area when required during wet weather conditions.

Our permit conditions for Cirencester STW state:

“The discharge shall only occur when and only for as long as the flow passed forward is equal to or greater than the overflow setting indicated due to rainfall and/or snowmelt. Off-line storm storage must be fully utilised before a discharge occurs. It shall only fill when the flow passed forward is equal to or greater than the overflow setting indicated due to rainfall and/or snow melt and shall be emptied and its contents returned to the continuation flow as soon as reasonably practicable. The minimum off-line storm storage required is specified in table S3.3.” (Table within the permit).

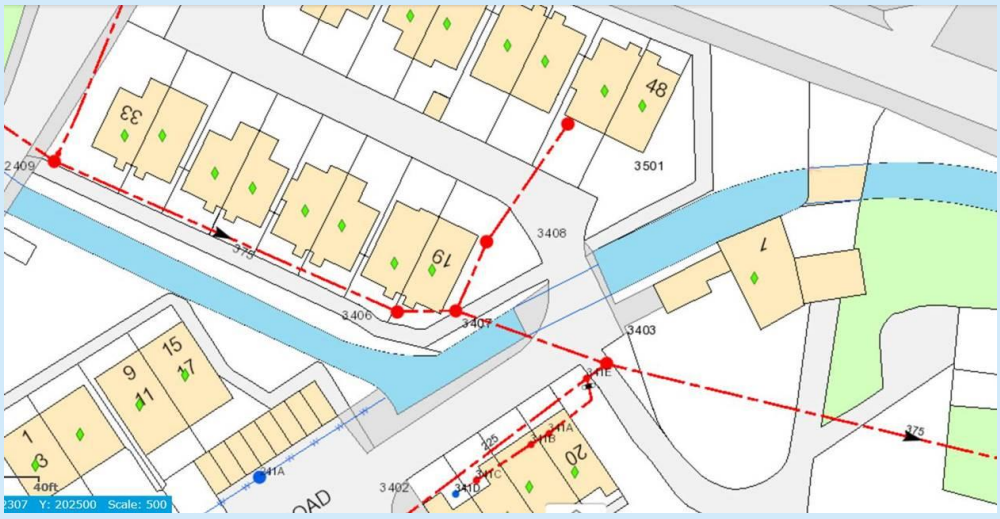
The Flood and Water Management Act 2010 places a responsibility on Lead Local Flood Authorities (LLFAs), to manage flood risk from surface and groundwater, plus a duty on all Risk Management Authorities (RMAs), to cooperate regarding flood risk. In our role as an RMA, Thames Water will work with Gloucestershire County Council as the lead local flood authorities, planning authorities, 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

Surcharges resulting from unwanted flows currently affect the Hereward Road and Blake Road area. The works identified within this plan should reduce groundwater infiltration and the risk of surcharges. However, in the short to medium terms these unavoidable discharges may continue to occur in times of high groundwater levels. The strategy to deal with temporary surcharges involves the deployment of an ATAC Biofilter at Hereward Road to treat wastewater prior to discharge into the River Churn (see table below for further details).

Anticipated unavoidable discharges

Location	20 Hereward Road, Cirencester, GL7 2EQ 
Discharges	10-20l/s
Likely Periods	When sewer surcharge places properties at risk of internal flooding and/or operation will reduce pollution risk through sewage escapes reaching watercourses.

Anticipated unavoidable discharges

Mitigation	In order to ensure the current system is working to maximum capability the following actions will be carried out: • Regular sewer investigations (and resultant sewer cleaning) to remove any blockages. • Ongoing investigations and remediation of priority infiltration sources as outlined in this document. • Identifying and taking actions to minimise where surface water ponding may be inundating manholes. • Tankering where appropriate in other areas of the system. In order to minimise the impact on the watercourse the discharges will be treated via an ATAC Biofilter which removes solids and biological loading from wastewater influents, whilst also adding dissolved oxygen into the effluent flow. Should flows stay within the sewer, and not reach the volume to discharge from the sewer, no discharge to the River Churn will take place.
Monitoring	During periods of discharge daily samples of water quality will be taken upstream and downstream to assess impact on the river amenity, use and quality. The following parameters at a minimum will be tested: - Biological Oxygen Demand - ammonia, - solids - phosphorus - and bacterial quality including E. Coli
Contact	If discharges occur the Environment Agency will be informed (by logging through the Agency's National Incident Communication Service). For any other reporting please use the Environment Agency pollution reporting number 0800 807060. In addition, local community representatives will be informed. If the ATACs are deployed, signage will be placed in the locality and local letter drops carried out to inform residents. An example of the type of signage and information displayed is shown in the appendix of this document.

General outline plan & timescale

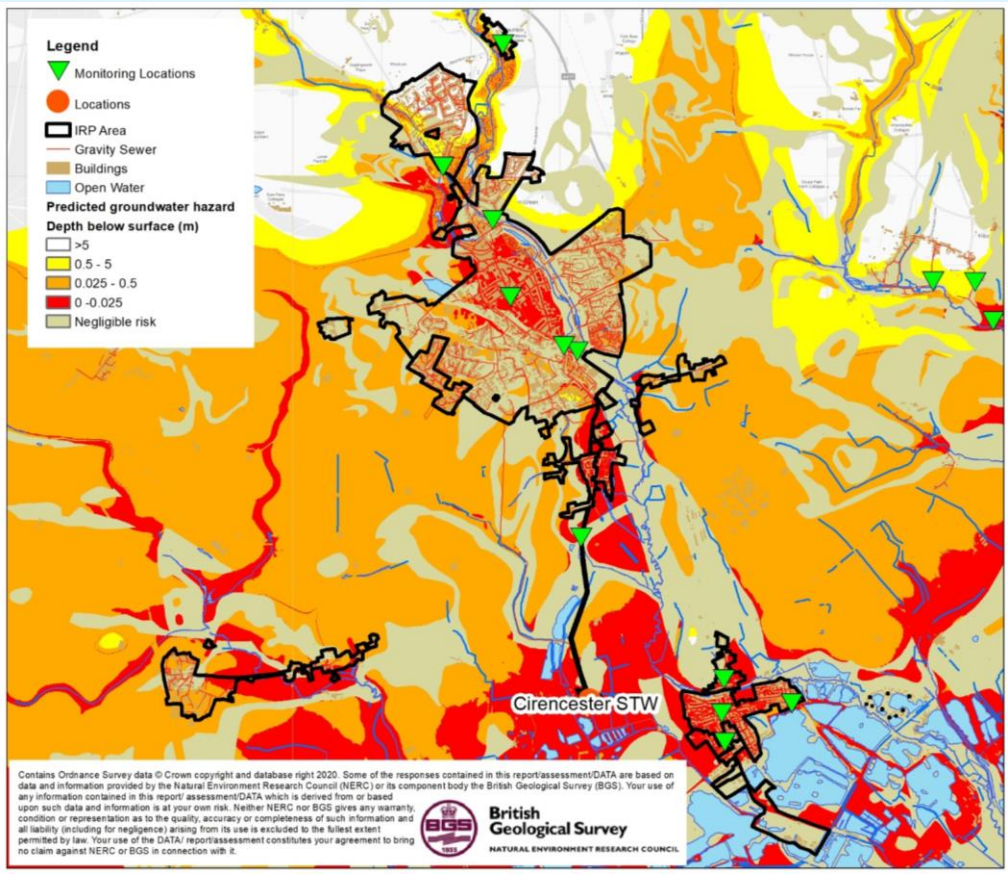


Figure 2.0 – Cirencester monitoring and infiltration zones

Key to bringing the impact of groundwater infiltration under control will be an enhanced monitoring regime. We have identified and have installed several telemetered depth monitor locations around the Cirencester system – see Figure 2.0.

Complementing 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 Cirencester 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 are being 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, should it be required, the system is found to be still experiencing excessive infiltration we would then look topotentially seal 'private' laterals and/or drains along with starting to seal the medium to low risk zones.

This document sets out an unconstrained approach to resolving the impact of groundwater infiltration within the system.

Investment to address infiltration will be assessed and prioritised against other drivers e.g., STW upgrades, both in the catchment and across the region at each price review.

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

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 to be targeted for sealing in the 56 systems identified as being impacted by infiltration.
Install monitors	2020/21 – 2021/22	Monitors have been installed in the zones 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, results of monitoring and successful submission of our plans for future investment.

Activity	When	Description
Minor works	2020-2023	As mentioned, if we detect minor works being required, we would 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.

Cirencester Infiltration Management Plan

As detailed above infiltration causes a range of issues.

As part of our current investment plan, we have projects to increase the flow to full treatment and storm capacity at Cirencester STW. The main driver for the upgrade is growth, however the rate of maximum observed infiltration is considered as part of the calculation for the new treatment flow rates. This work is programmed to be completed by 31/03/2024.

In the intervening period we intend to continue to monitor the network for potential sources of infiltration that may improve the performance prior to upgrade of the sewage treatment works.

High level approach statement

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

1. Our programme for implementation of the upgrade of Cirencester STWs is due for completion by 2024.

2. Implementation of a permanent and less intrusive over pumping system at Station Road in South Cerney by March 2022.

3. In parallel to the progression of the STWs solution to deal with the infiltration received we will investigate the network with a view to identifying sources of ingress of infiltration that are cost effective[5] to address.

   To investigate the network, we/will:

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

   - Installed additional monitoring to back up the analysis (a) and to aide focusing of locations for identification of infiltration (2020 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 sewersand manholes (ongoing).

   - Review results of Winter 2019/20 and 2020/21 with historic data to build up evidence to support interventions in the network (Summer 2021).

4. Where interventions can be undertaken as part of normal sewer maintenance activities these will becommunicated and progressed. 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. However, where viable opportunities are identified these will be included in our AMP9 (2030-35) programme of investment. Significant investment needs may need to be included in our future investment cycles.
   .

[5] 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 JBA Consulting have been supporting by undertaking an exercise involving assessing groundwater elevation data to determine which areas of the network are potentially below the groundwater table during high groundwater periods.

Site investigations, undertaken by DeneTech and our Customer Field Services (Thames Water Operations) have included '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 have been installed in the catchment in 2020 (see Figure 2.0). 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.

To 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 (manholes) points on the network, make use of pumps to manage flows as described for South Cerney, or deploy settlement tanks to part treat sewage before release to the environment.

With regard to Cirencester, we are considering the deployment of an ATAC unit as detailed in the sections above. We would only look to deploy this mitigation either where all other approaches have ceased to be effective or where property flooding and / or pollution would be a likely risk had we not undertaken the mitigations.

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

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

The three tables below summarise the findings of the survey and implementation work identified in the 2019/20 period. The final table summarises our current known plans for remediating groundwater infiltration issues.

The table below presents a summary of the JBA groundwater infiltration analysis which identifies the sewers and manholes which are likely to be vulnerable to groundwater infiltration

Sewer Length by Groundwater Infiltration Risk Zones

Risk category	Description	Length (km)	Percentage
High	Predicted groundwater extreme >1m above pipe invert	35.94	37.3
Medium	Predicted groundwater extreme 0-1m above pipe invert	2.36	2.4
Low	Predicted groundwater extreme 0-1m below pipe invert	8.43	8.8
Very Low	Predicted groundwater extreme >1m below pipe invert	49.60	51.5
Total		96.33[6]	100.0

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	392	11.3
Medium	Inundation risk in 1% AEP fluvial or pluvial event	33	1.0
Low	Inundation risk in 0.1% AEP fluvial or pluvial event	151	4.3

[6]Total of sewer length is for length of mapped sewers only and will not include unmapped S105a transferred sewers in all cases.

Risk category	Description	Number	Percentage
Very Low	All other manholes	2882	83.4
Total		3459	100.0

2019/20 Implementation Works

Activities	Value	Comment
Sewer Lining Length (m)	2450m	This work was completed in September – December 2020. In addition to the lengths lined we have carried out 19 patch repairs.
Infiltration Points Targeted (no.)	49	
Manhole Sealing (no.)	4	

Future Works

	Priority 2020/2021	Known follow On Work
Survey	Plans to be developed when further monitoring can be undertaken or analysed - we will carry out further surveys across the winter periods where viable	
Sewer Lining		
Manhole Sealing – Infiltration Ingress		
Manhole Sealing – Pluvial and Fluvial Ingress		
Sewage Treatment Works Upgrade	See Main Text	
South Cerney (Temporary over pump arrangement)	Implementation of a permanent and less intrusive over pumping system at Station Road in South Cerney – due for completion by March 2022.	

Example information and signage

Below is an example of the type of signage you would expect to see if we needed to deploy the ATAC biofilter.

Your reference ~~number~~
BB973534

thameswater.co.uk

0800 316 9800
We're open 24/7

03 April 2020

Working in Aldbourne

This ATAC Eco filter is a mobile sewage filtering unit which will operate 24 hours a day.

How it works?
The Eco filter works using the same basic principles as our traditional Sewage Treatment Works. A pump will feed dirty water into the unit so it can be filtered. Any contaminants within the water are broken down and once water has passed through the Eco filter it can safely be returned to the environment.

Why is this needed?
The high groundwater levels experienced recently have caused extra water to enter our sewers and overwhelm them causing sewer flooding. This is one of the measures being put in place to address the issue and by installing this unit, we will improve the quality of the water which we are not able to prevent from escaping.

What does it look like?

Outside view:

Dirty water entering the filter unit to be treated and then pumped to the top of the unit

Treated water leaving the unit and returning to the environment

Page 1 of 2

Inside view:

Dirty water being pumped into the unit and working its way through the filter system.

Glossary of terms

AEP – Annual Exceedance Potential

AMP – Asset Management Plan

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 2021

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Introduction

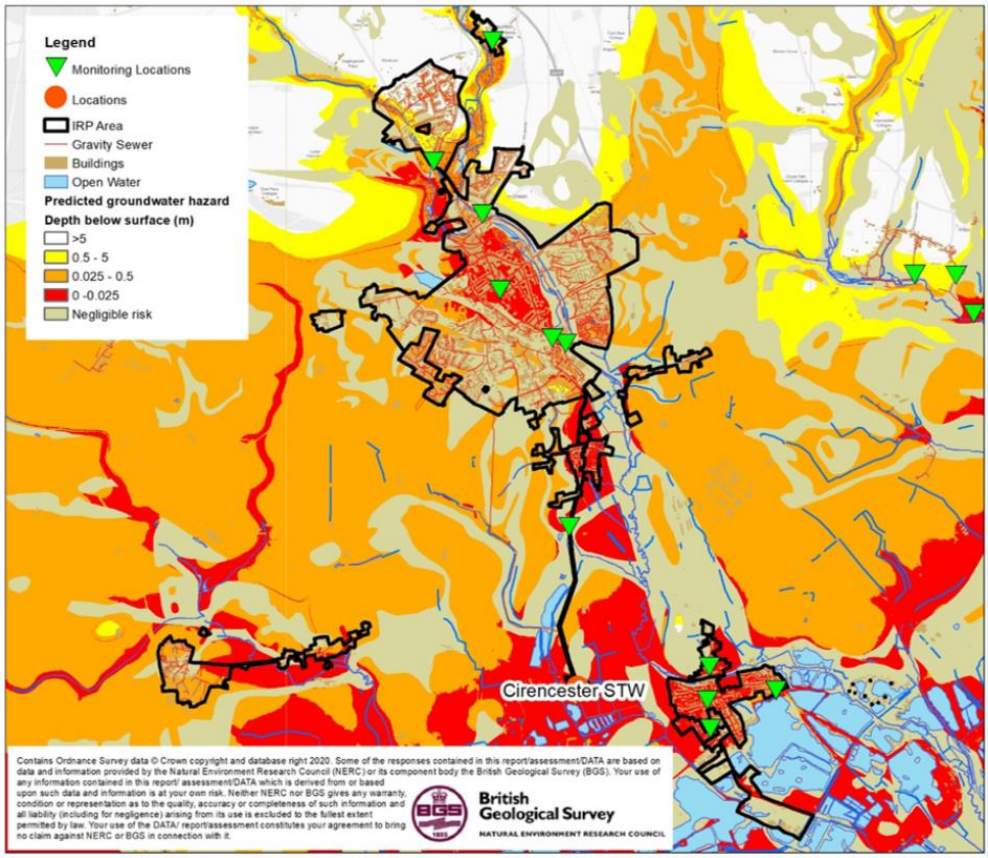

Figure 1 – Cirencester monitoring and infiltration zones

This addendum to the Cirencester Groundwater Impacted System Management Plan 2020 (GISMP) provides an update on performance/work undertaken in the period from September 2020 to September 2021 (the UK Hydrological Year [1]) 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 next steps

[7] Happy New Water Year! | National River Flow Archive (ceh.ac.uk)

2020-21 Hydrological Review

This section summaries the hydrological conditions at Cirencester in the period.

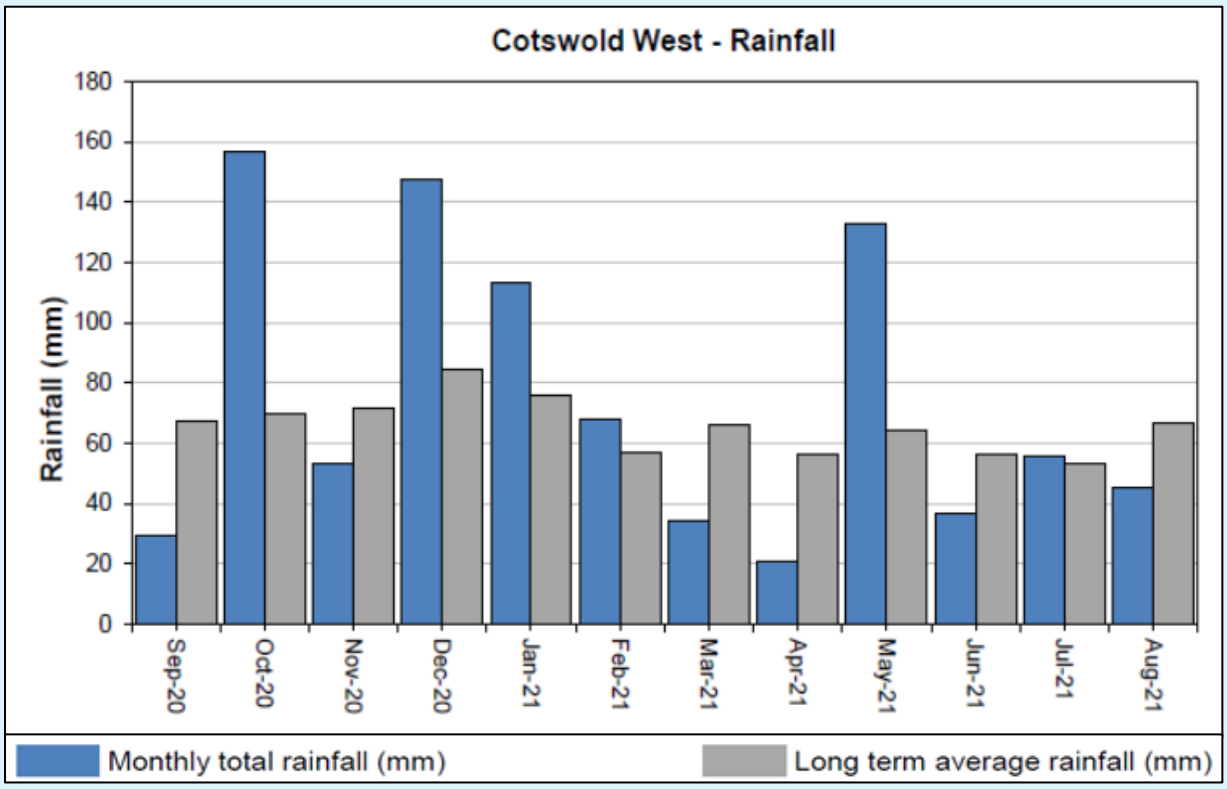

Figure 2 – Monthly rainfall depths local to the system

Cirencester is situated in the Cotswold West water resources area. Figure 2 shows the monthly rainfall total depths against the long-term average rainfall in the location of Cirencester over the period taken from the *Environment Agency Water Situation Report August 2021*[8]

The graph indicates that monthly rainfall at times in the last year has significantly exceeded long-term averages, this was especially notable in the winter period.

Figure 3 shows the location of the British Geological Survey (BGS) monitoring borehole at Ampney Crucis which has been monitoring groundwater since 1959. Figures 4 and 5 show river levels in the River Churn at Cirencester which are a good indication of local groundwater levels over time. Figure 6 and 7 present the last two and last ten years of groundwater level data overlain on expected ranges. This shows how recent groundwater levels have compared against the expected range, they show that generally over the last two winters groundwater levels have been notably higher, with the peak groundwater levels close to or within the exceptional high range.

[8]*Environment Agency Water Situation Report August 2021:* *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1016481/Thames_Water_Situation_Report_August_2021.pdf*

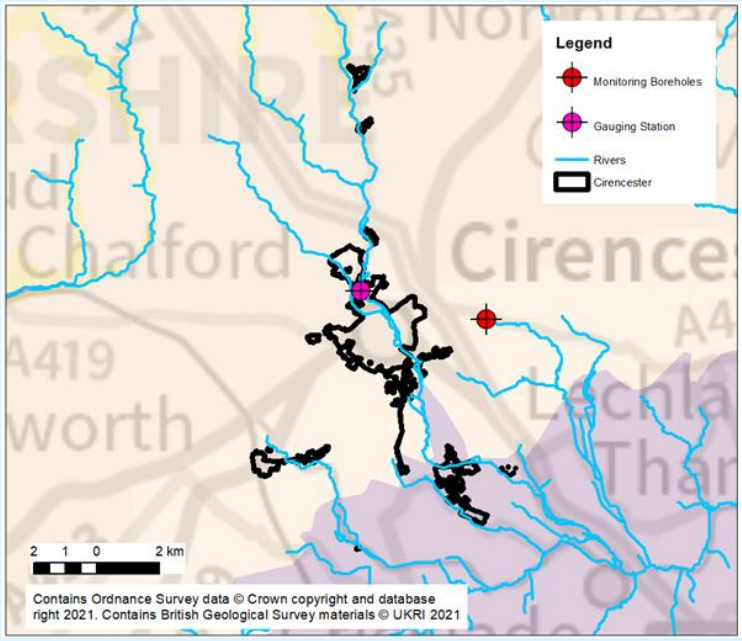

Figure 3 – Location of Ampney Crucis Monitoring Borehole Relative to Cirencester

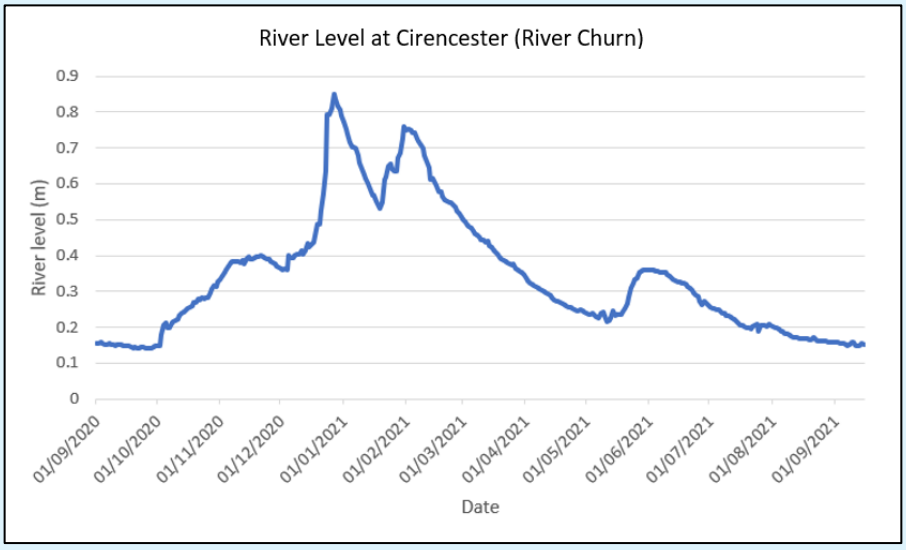

Figure 4 – 2020-2021 River levels at Cirencester (River Churn) – River Levels UK (riverlevels.uk).

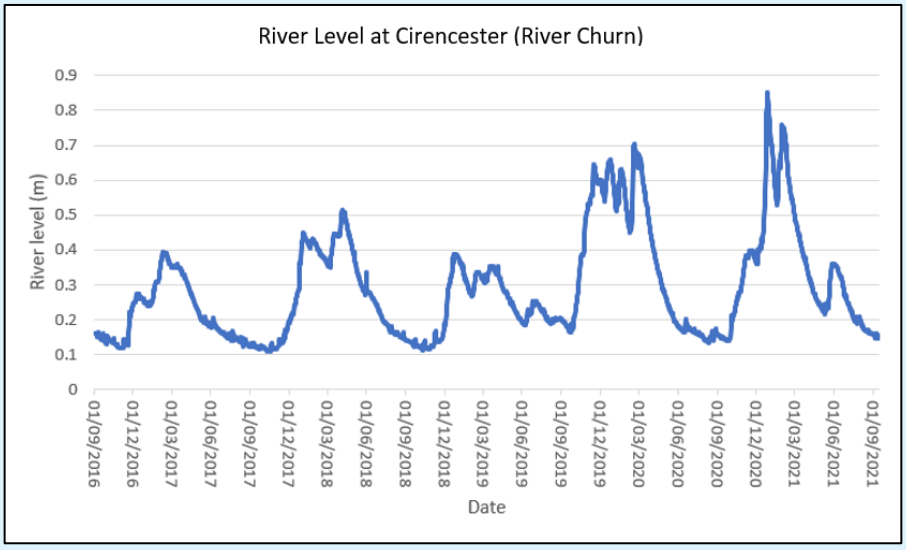

Figure 5 – 2016-2021 River levels at Cirencester (River Churn) – River Levels UK (riverlevels.uk).

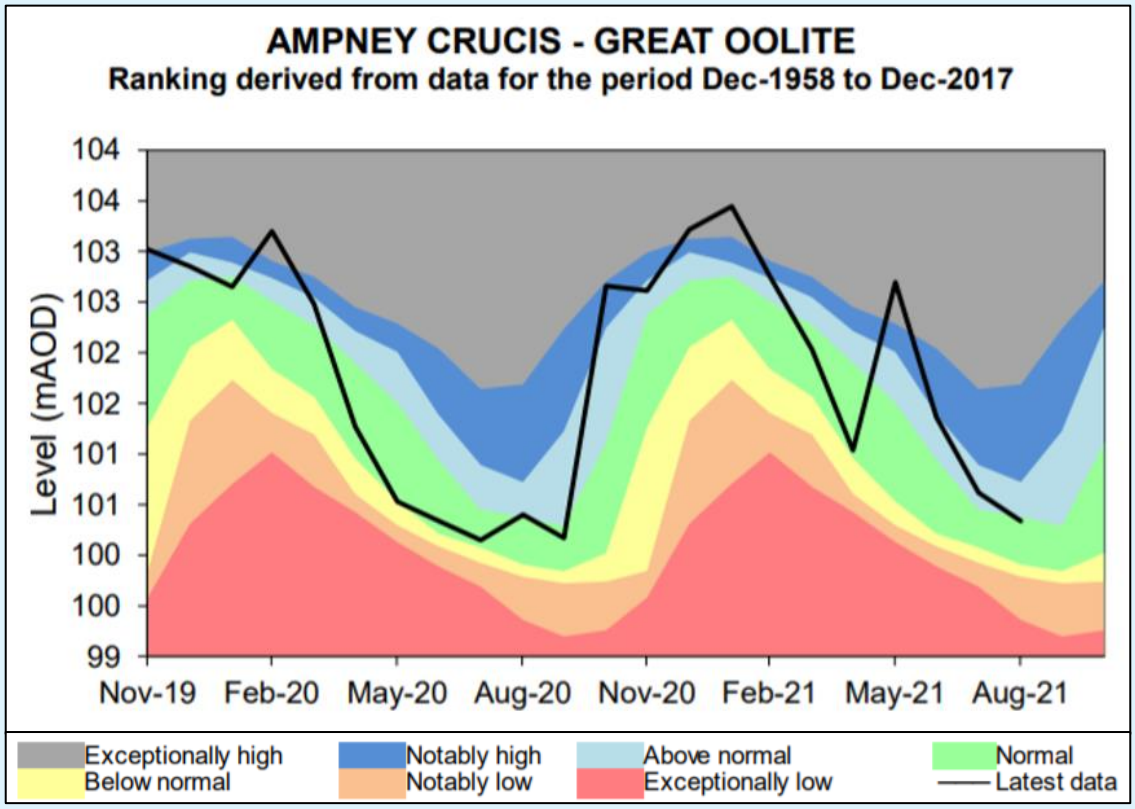

Figure 6 – 2019-2021 Groundwater levels at Ampney Crucis. (*Environment Agency Water Situation Report August 2021)*

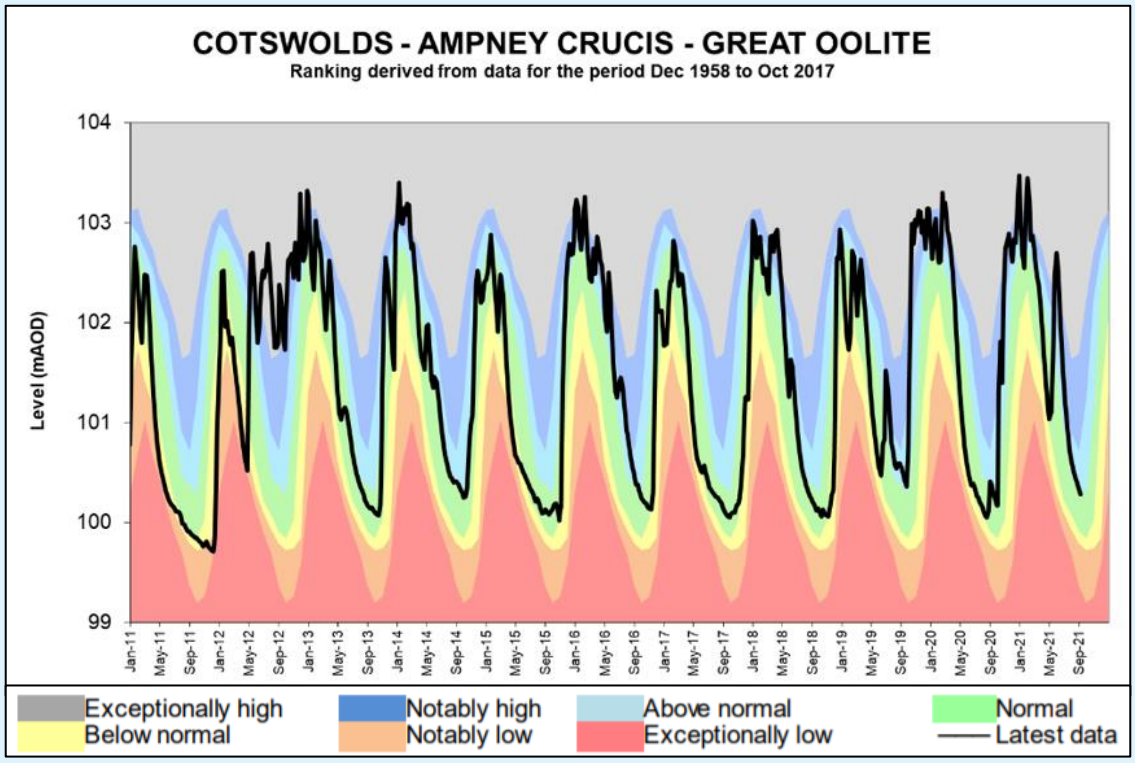

Figure 7 – 2011-2021 Groundwater levels at Ampney Crucis. (*Environment Agency Water Situation Report August 2021)*

(*Environment Agency Water Situation Report August 2021):* *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1016481/Thames_Water_Situation_Report_August_2021.pdf*

Investigations & remedial work undertaken in the period and future work

The two tables below in summary provide an update on recent survey and remediation work undertaken during the period.

Remediation works in period

Activities	Value	Comment
Sewer Lining Length (m)	980m of sewer lining (Drainage Strategy identified lining) is due to be completed by November 2021	Remaining work subject to site conditions being suitable.
Manhole Sealing (no.)	1 manhole is due to be sealed by November 2021 (Drainage strategy identified sealing)	

Future Works

Activity	Planned work in 2021/22	Known follow On Work
Survey	Further survey to be completed over the winter period	To be confirmed
Sewer Lining	To be defined from surveys in 2021/22	To be confirmed
Manhole Sealing – Infiltration Ingress	To be defined from surveys in 2021/22	To be confirmed
Manhole Sealing – Pluvial and Fluvial Ingress	Plan to be developed based on at risk manholes identified in JBA analysis.	
Sewage Treatment Works Upgrade	As part of our current AMP7 investment plan, we have projects to increase the flow to full treatment and storm capacity at Cirencester STW. The main driver for the upgrade is growth, however the rate of maximum observed infiltration is considered as part of the calculation for the new treatment flow rates. This work is programmed to be completed by 31/03/2024.	
South Cerney (Temporary over pump arrangement)	Implementation of a permanent and less intrusive over pumping system at Station Road in South Cerney – due for completion by Autumn 2022.	

2020-21 Infiltration Review

This section looks at the impact of infiltration in Cirencester over the period.

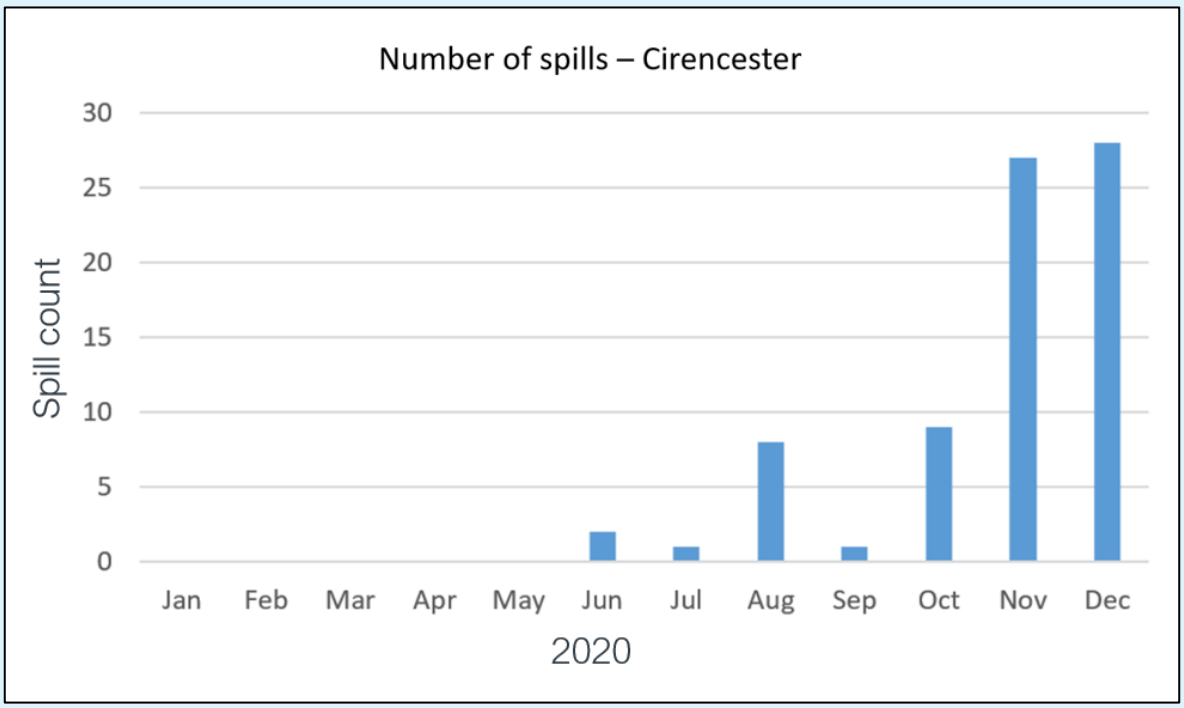

Figure 8 – Number of spills (discharge count) at Cirencester STW (taken from Event Duration monitor (EDM) Data).*

Figure 8 shows the number of spills per month the from Cirencester Sewage Treatment Works (STW). November and December saw the greatest number of discharges (spills). In the summer, the number of spills were significantly less, highlighting the influence of groundwater infiltration/winter flows on the system. This Combined Sewer Overflow location has met the trigger for the EA's Storm Outfall Overflow Assessment Framework (SOAF) and is currently under further investigation with regards to root cause and impact.

The ATAC bio-filter arrangement outlined in the original GISMP report for Cirencester in Herewerd Road was not deployed in the winter of 2020/21. Tankering was used in areas to assist with high flows in the system, however in many areas of Cirencester extensive property flooding occurred as a result of groundwater ingress, rainfall, and river water inundation into the foul system as a result of the River Churn being out of bank. We will work with the Environment Agency to look at ways of best protecting customers from sewer flooding as we work to find a permanent solution.

*2020 verified and audited EDM data. Data prior to 1st April was not included in our 2020 data submission for Cirencester due to known data issues. 2021 calendar year data is awaiting verification before being published.

Summary

The winter of 2020-21 was a particularly wet winter with groundwater levels in the aquifer beneath Cirencester notably high for long periods and exceptionally high in some cases. This was reflected in the discharges (spill) occurring at the Sewage Treatment Works (STW) captured by the Event Duration Monitoring (EDM) Data.

Impacts of groundwater infiltration on the foul system have led to the requirement for tankering in some areas to try to manage high flows, but unfortunately property flooding still occurred. River water ingress (inundation through manholes) due to rivers/watercourses breaching their banks also occurred further exacerbating the problems during the winter.

Remedial measures continue to be implemented and lift and look and CCTV surveys will continue throughout the remaining wet winter periods with the aim of finding further priority locations for remediation and investigating/justifying the need for future larger scale lining as part of our Price Review (PR) process if required.

Historically we have implemented a temporary over pump to an adjacent foul system on Station Road in South Cerney. This over pump allows us to reduce levels in the foul system in order to protect properties from flooding internally. A permanent and less intrusive solution for this area is in detailed design and due to be implemented by Autumn 2022.

In addition, as part of our current investment plan, we have projects to increase the flow to full treatment and storm capacity at Cirencester STW. The main driver for the upgrade is growth, however the rate of maximum observed infiltration is considered as part of the calculation for the new treatment flow rates. This work is programmed to be completed by 31/03/2024.

Cirencester continues to be a system that presents a significant challenge to management of groundwater and inundation from surface water during the winter period. In parallel to tackling groundwater infiltration as a permanent solution we will have to look at possible localized possibly interim solutions to avoid the risk of property flooding in the area.

Addendum – Annual Update 2022

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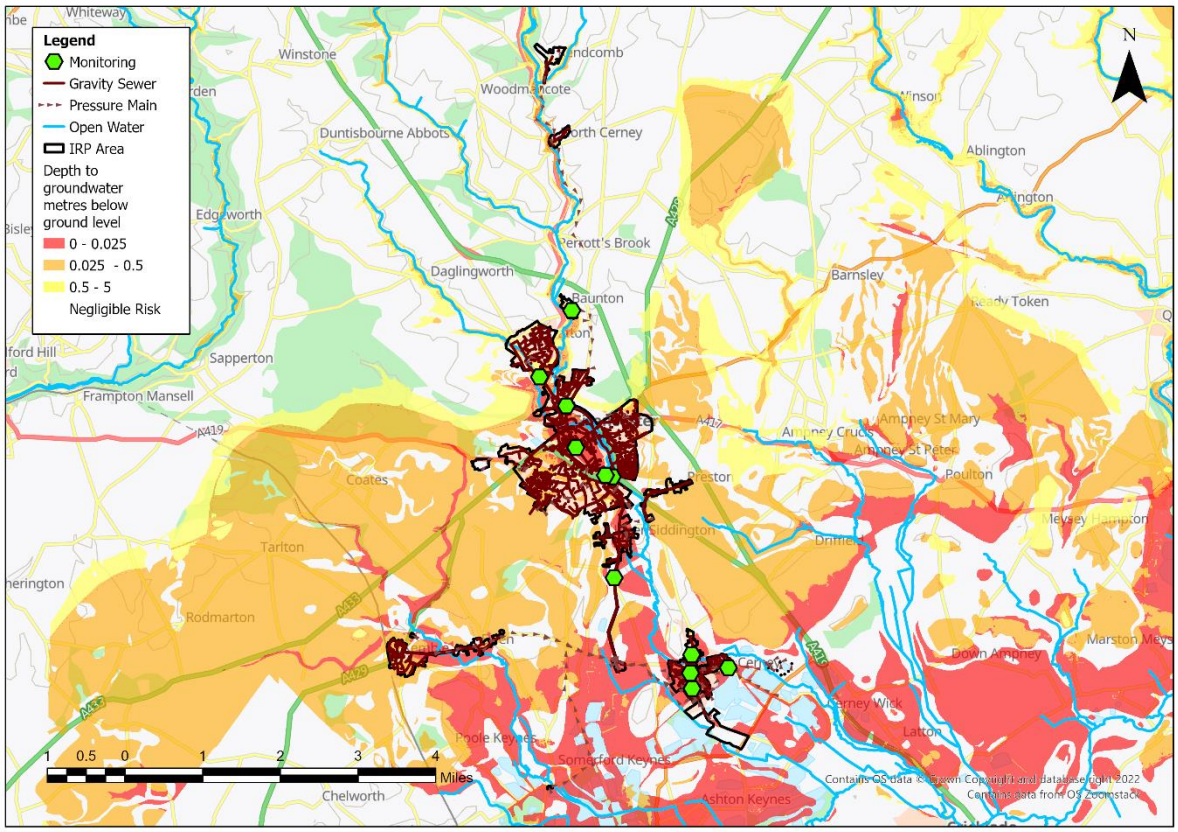
Overview

This addendum to the Cirencester 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 – Cirencester Monitoring Plan



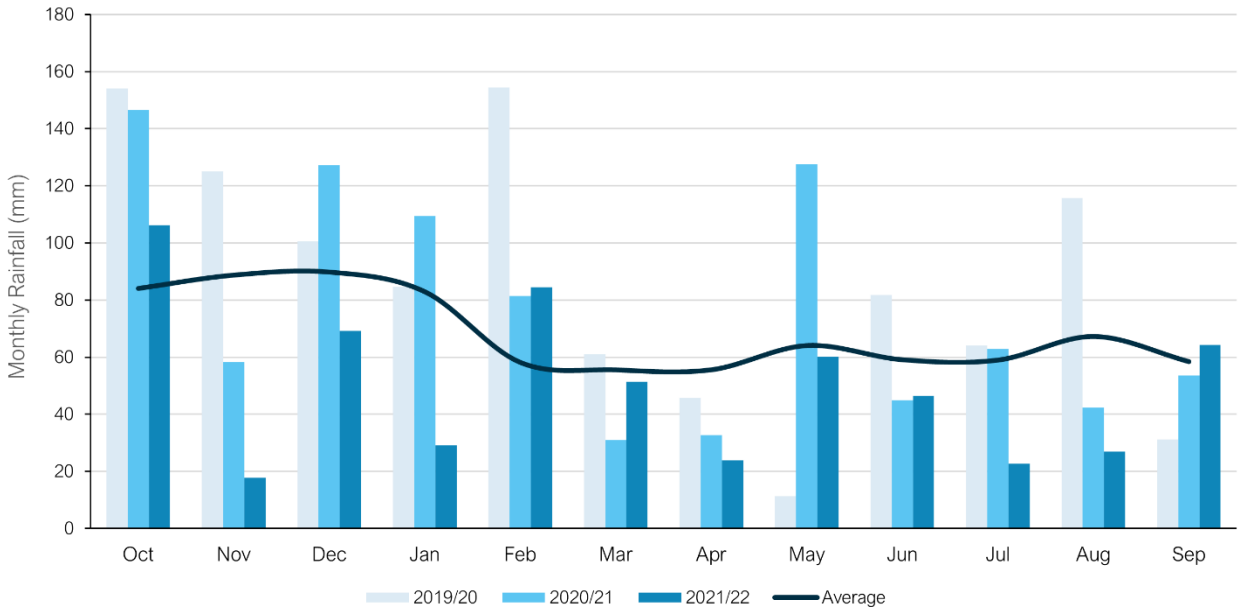
Hydrological Review – 2021-2022

This section summarises the hydrological conditions within the Cirencester 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 Cirencester based on the period 1991-2020

The total rainfall for the 2021/22 hydrological year is 26% 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)
823	1030	918	611

Groundwater / Local River Level

The Cirencester catchment is situated in the Cotswolds West and Upper Thames water resources areas. It primarily sits in the Forest Marble Formation of mudstone and limestone and the Kellaways Clay Member of mudstone. The Forest Marble Formation – Limestone is a designated principal aquifer within the UK.

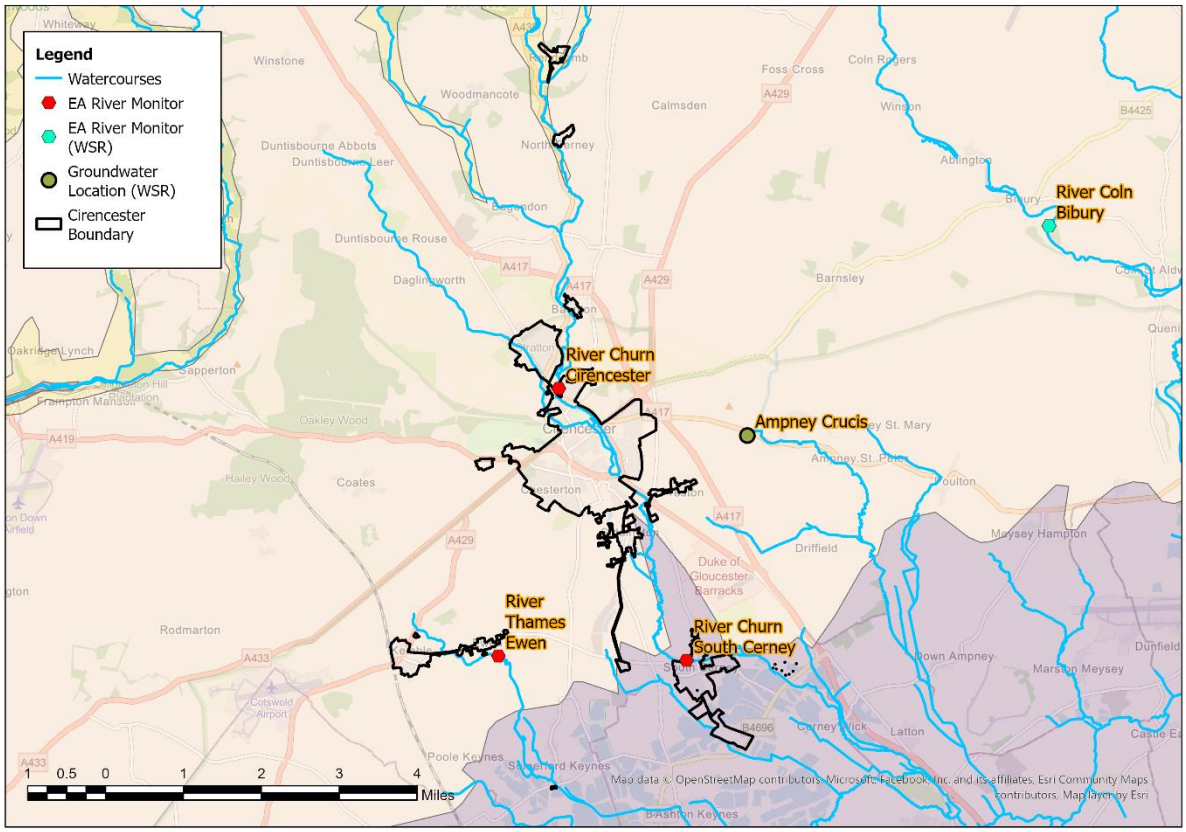
The Environment Agency has gauging stations on local watercourses measuring stage and observation boreholes measuring groundwater levels locally to the catchment which can be used to provide indicative local groundwater performance.

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

- River Churn, Cirencester.
- River Churn, South Cerney.
- River Thames, Ewen.

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 – River Churn, Cirencester

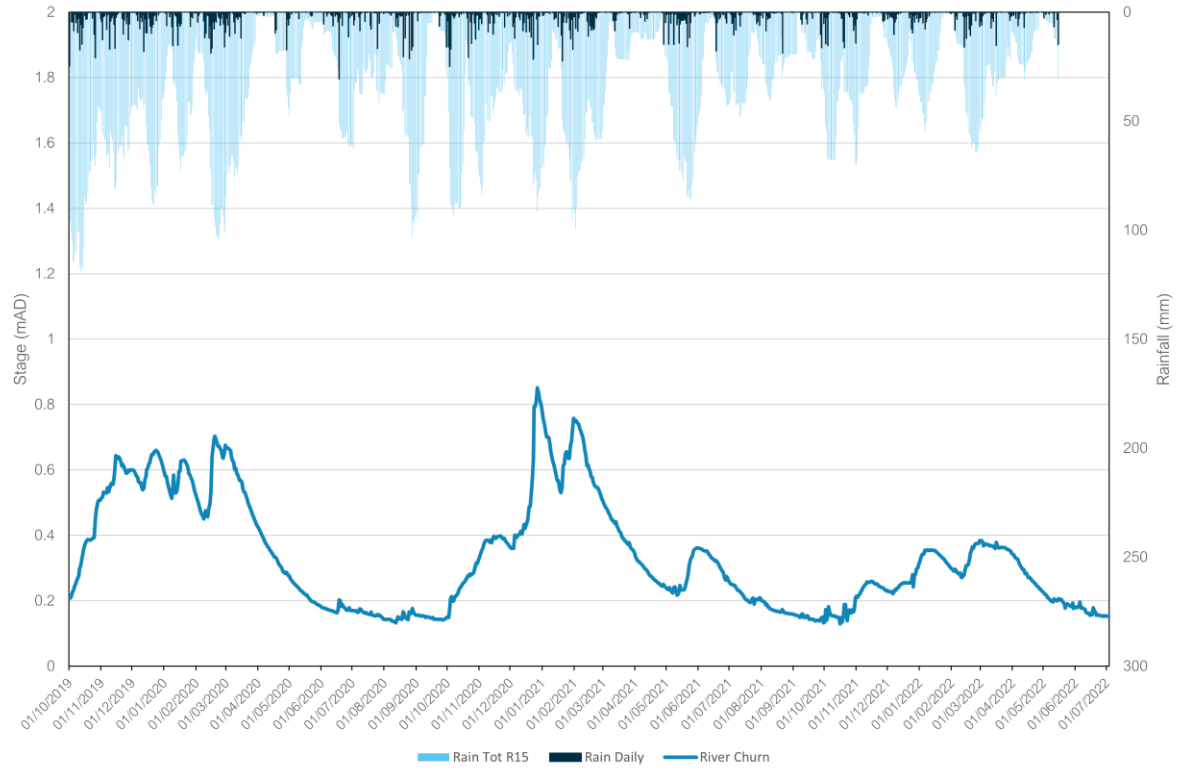


Figure 5B – River Churn, South Cerney

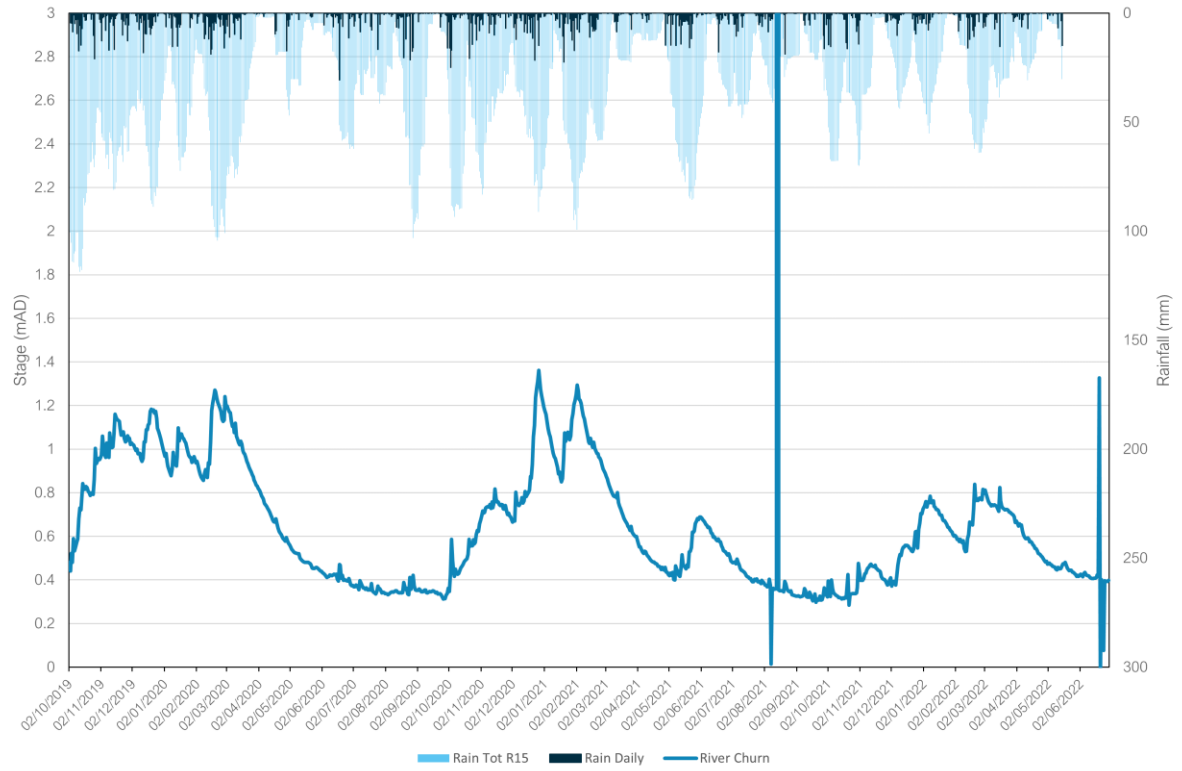
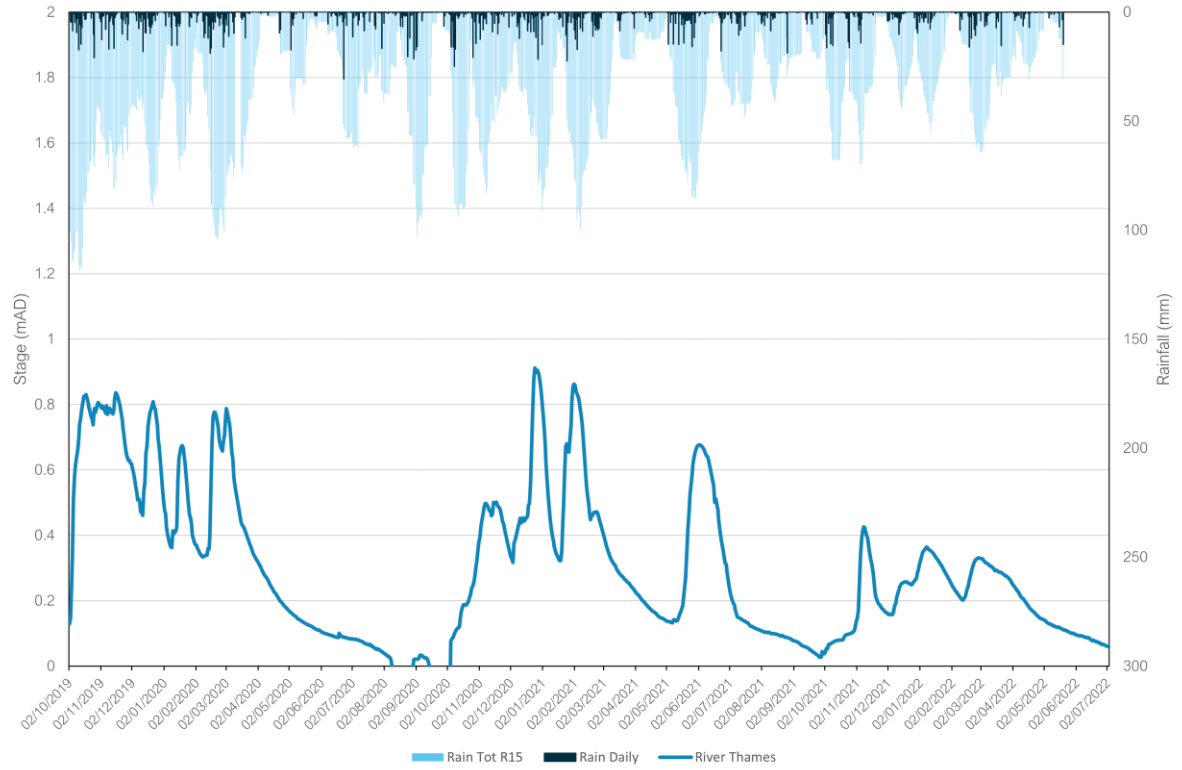
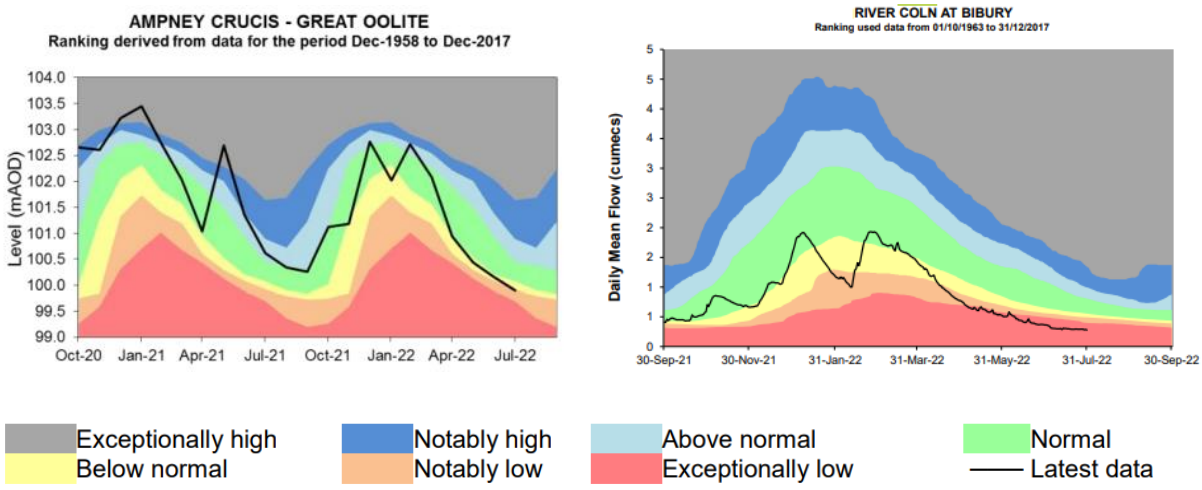


Figure 5C – River Thames, Ewen



In addition to these specific stations, the wider groundwater context is illustrated in the Water Situation Report for Cotswolds West. The nearest groundwater reference station is Ampney Crucis. 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 Bibury on the River Coln.

Figure 6 – Water Situation Report



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

Network Performance

Within the Cirencester catchment there is one site detailed within the Environment Agency Consents Database which has an Event Duration Monitor (EDM) fitted.

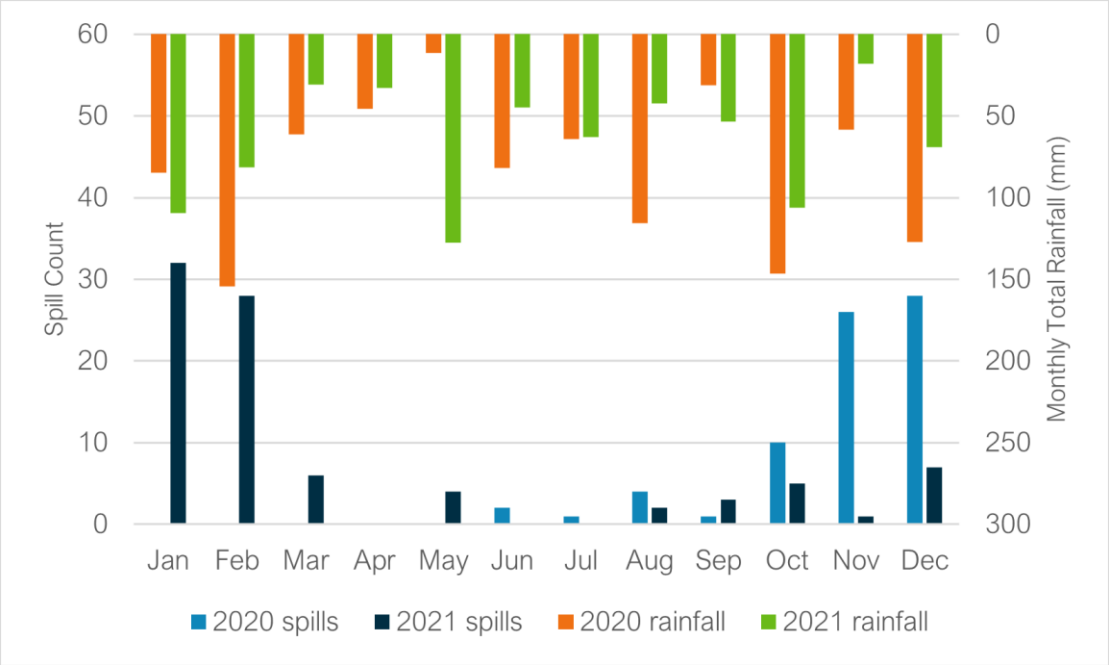
Table 7 below details the last 2 years performance of overflows within the catchment.

Table 7 – Event Duration Monitoring

Overflow	2020		2021	
	Spills	Duration (hours)	Spills	Duration (hours)
Cirencester STW	72	735.33	88	1216.07

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. Note that as the EDM monitor was installed in 2020, the 2020 spill count only includes spills from April 2020.

Figure 8 – EDM Monthly Performance



The trend in spill performance across the two recorded years does show variation in spills, with an overall focus on spills during the autumn and winter months. The data suggests a wider relationship between rainfall, elevated groundwater levels and spill frequency. The number of EDM spills recorded at Cirencester STW in November 2020 (26 spills) was similar to December 2020 (28 spills), despite December 2020 having a significantly greater total rainfall amount. As the indicator sites suggest groundwater levels in the catchment were similar across both months, the relatively high number of spills recorded in November 2020 is indicative of the role of groundwater infiltration.

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 11 monitors installed within the Cirencester 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 9 below provides a summary of the investigations and remediation works undertaken or planned within the Cirencester catchment in the 2021-22 Hydrological Year.

Table 9 – Works Undertaken in the 2021/22 Hydrological Year

Investigation/ remediation type	Number/ length undertaken
CCTV survey	791 metres undertaken, further planned by end of November 2022.
Look and lift survey	4 manholes
Sewer lining	220 metres in South Cerney*
Patch lining	4
Manhole sealing	4 manholes
Manhole sealing plates	N/A
Manhole covers and frames replaced	3 manholes

*Rollover from last hydrological year as lining was not able to be undertaken by end of November 2021 as originally planned.

Although the seasonal trends in groundwater have been low in comparison with previous years and the SDM installations are generally not showing significant groundwater presence, targeted surveys and appropriate remedial action have been undertaken where groundwater levels have allowed.

Summary

Rainfall in the Cirencester catchment over the 2021/22 hydrological year has been below average, with groundwater levels in the aquifer beneath Cirencester not reaching the levels seen in previous years which triggered groundwater ingress into the sewerage network and elevated flow/depth readings at monitoring sites.

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

Addendum - Annual Update 2023

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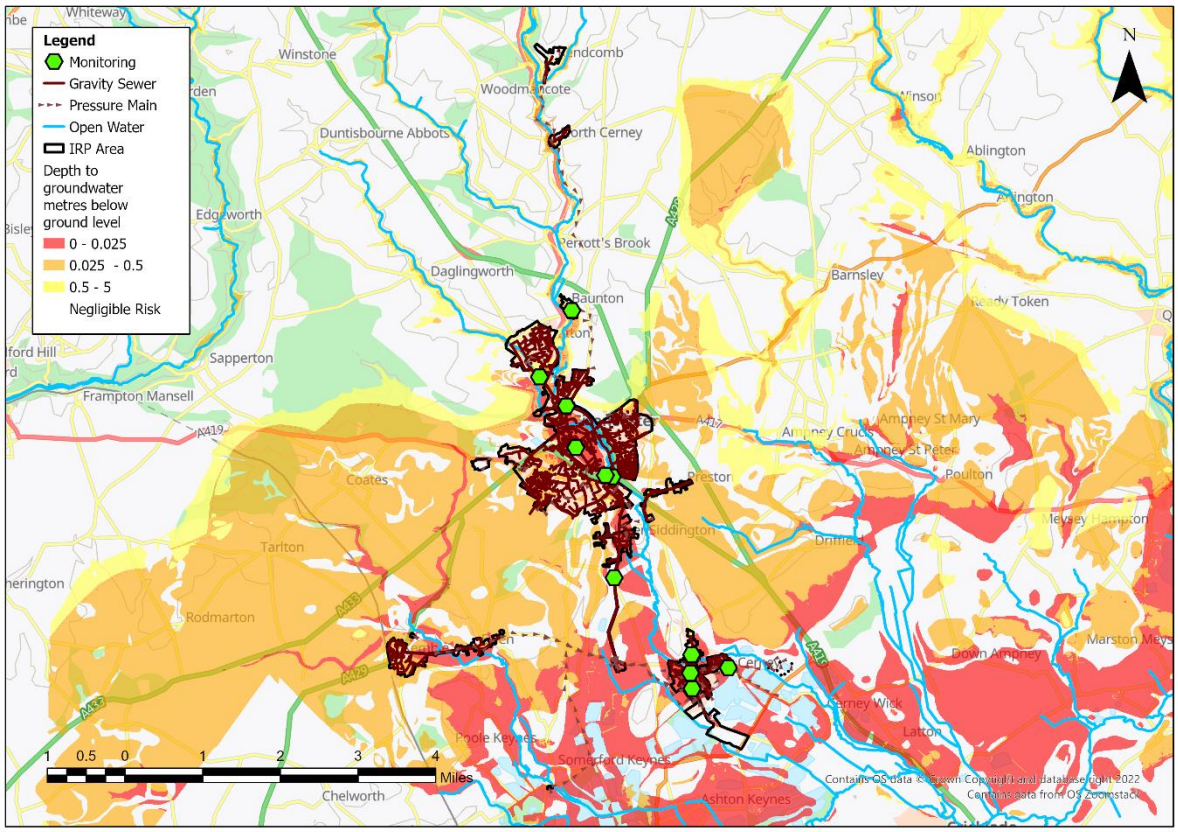
Overview

This addendum to the Cirencester Groundwater Impacted System Management Plan 2021 (GISMP) provides an update on performance 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 – Cirencester Monitoring Plan



Hydrological Review – 2022-2023

This section summarises the hydrological conditions across the Cirencester 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.

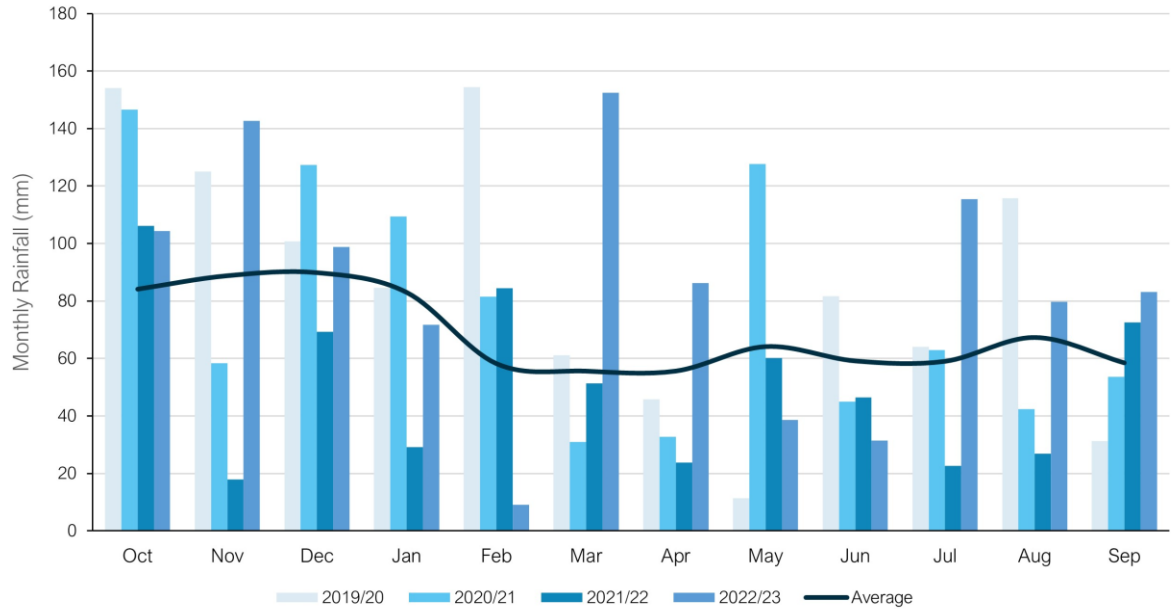


Figure 2 – Monthly Rainfall Performance

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

The total rainfall for the 2022/23 hydrological year is 23% 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)
823	1030	918	611	1014

Groundwater / Local River Level

The Cirencester catchment is situated in the Cotswolds West and Upper Thames water resources areas. It primarily sits in the Forest Marble Formation of mudstone and limestone and the Kellaways Clay Member of mudstone. The Forest Marble Formation – Limestone is a designated principal aquifer within the UK.

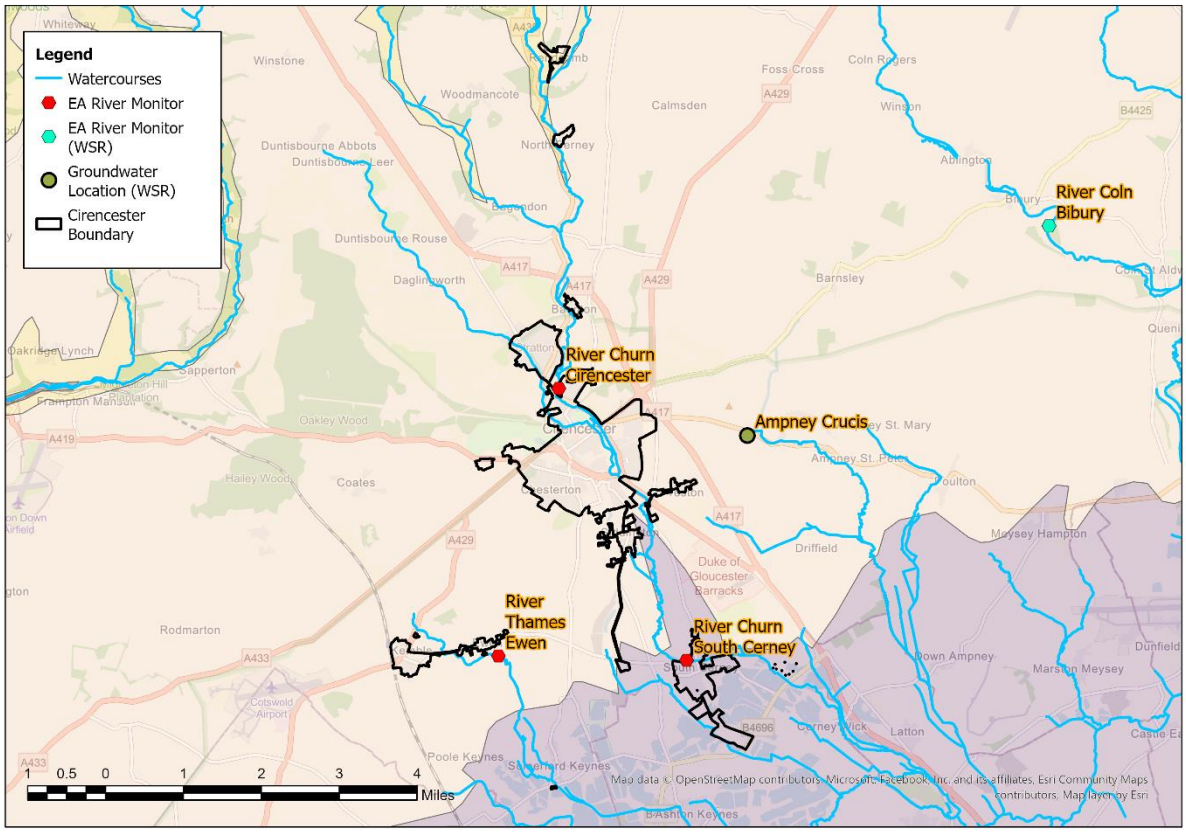
The Environment Agency has gauging stations on local watercourses measuring stage, and observation boreholes (OBH) measuring groundwater levels locally to the catchment which can be used to provide indicative local groundwater performance.

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

- River Churn, Cirencester.
- River Churn, South Cerney.
- River Thames, Ewen.

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 – River Churn, Cirencester

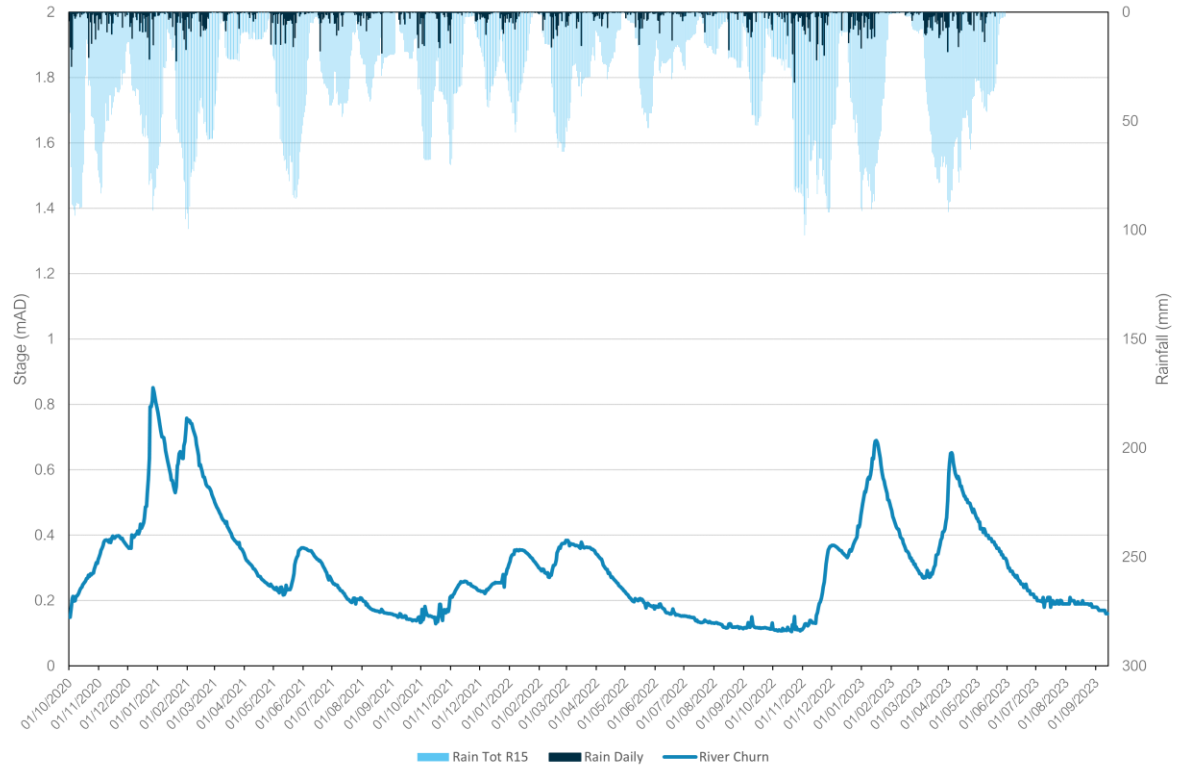


Figure 5B – River Churn, South Cerney

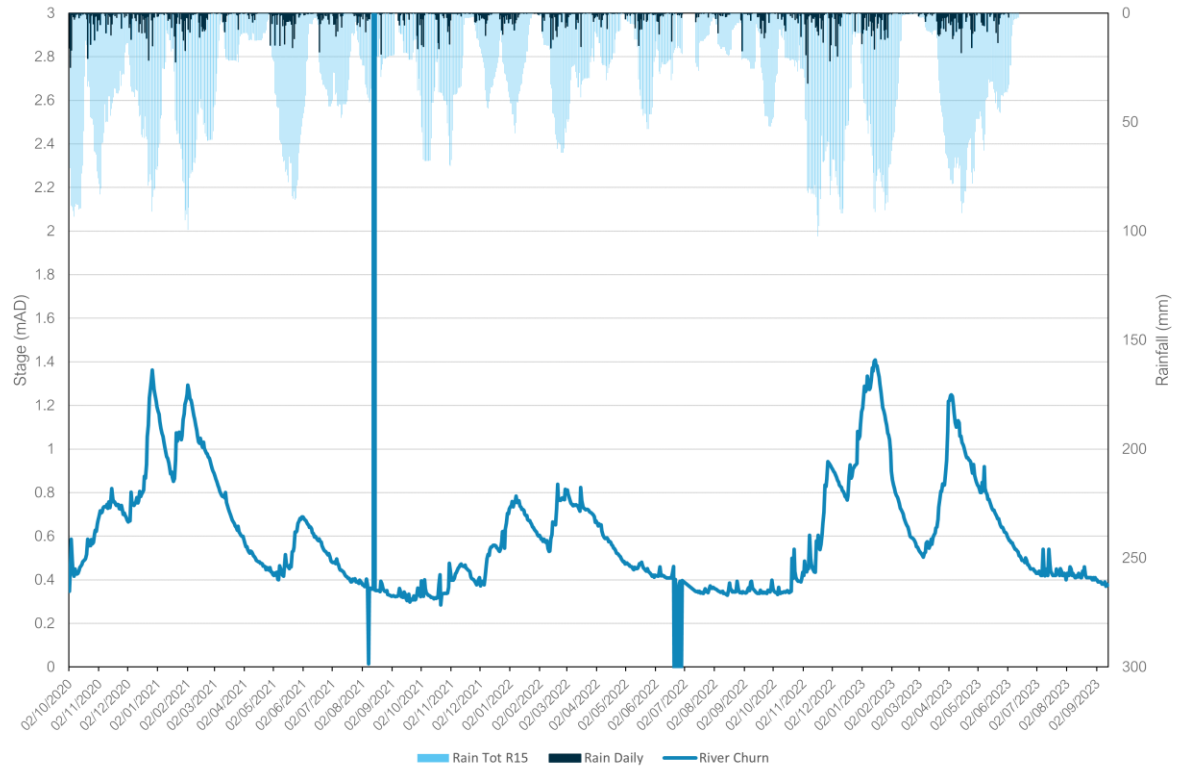
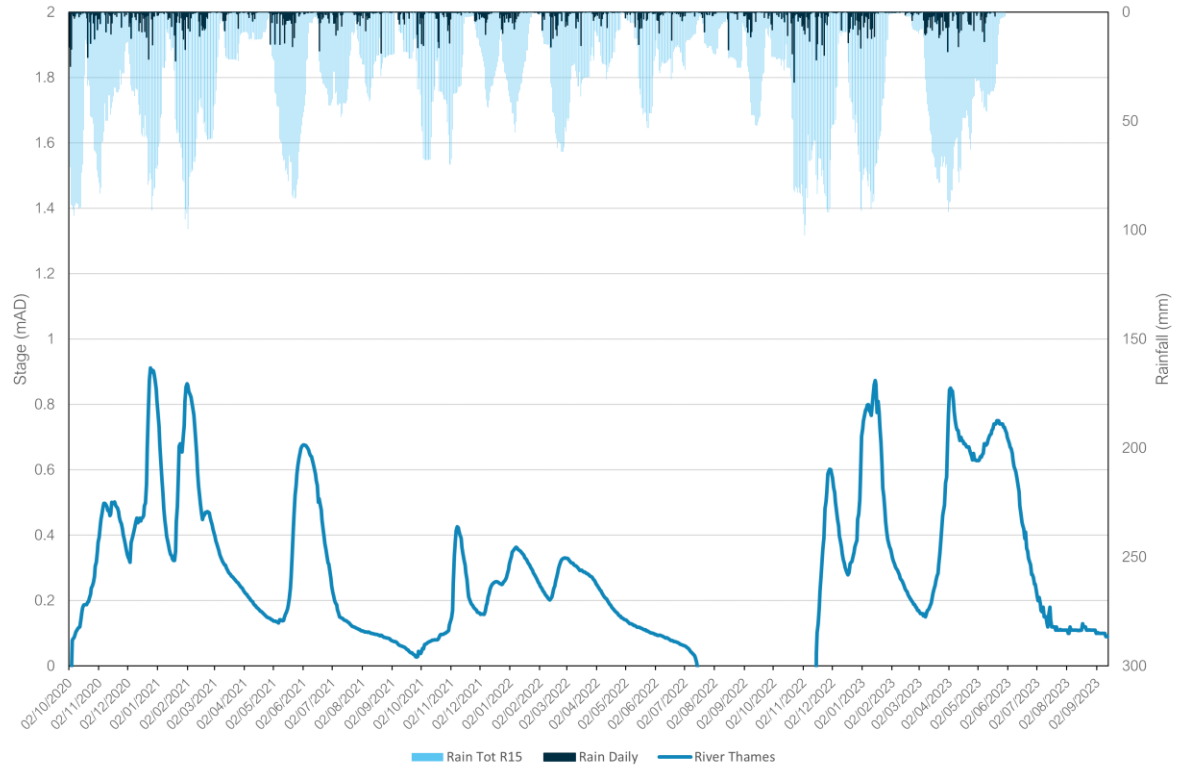
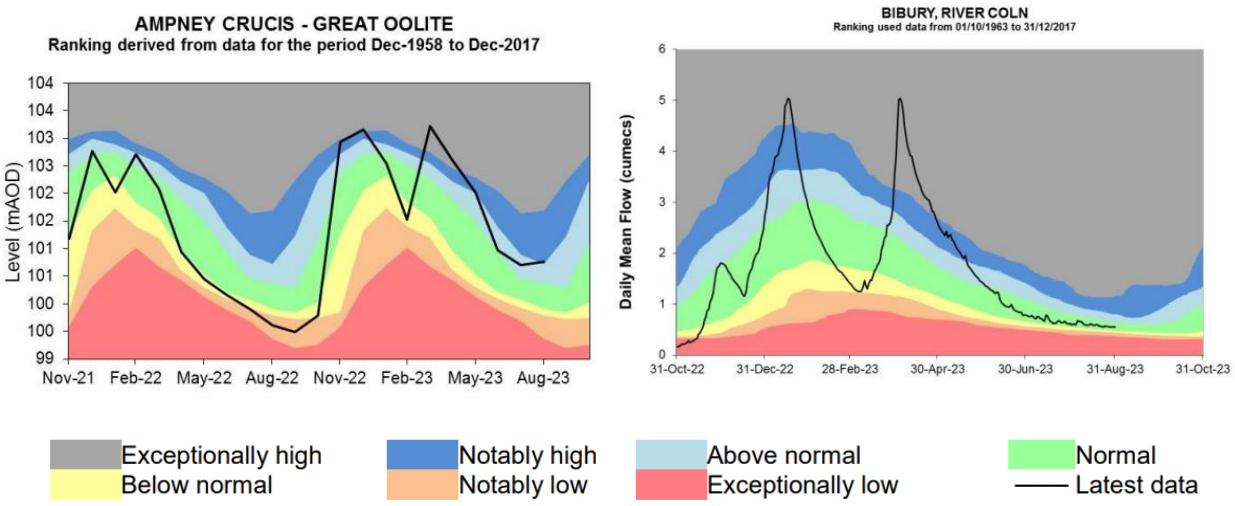


Figure 5C – River Thames, Ewen



In addition to these specific stations, the wider groundwater context is illustrated in the Water Situation Report for Cotswolds West. The nearest groundwater reference station is Ampney Crucis. This site shows groundwater levels generally at normal, below normal and notably low levels in 2022. Groundwater levels are observed to rise towards the end of the year to reach above normal and notably high levels. For 2023, observed groundwater levels have been higher than the equivalent periods in 2022.

Figure 6 – Water Situation Report



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

Network Performance

Within the Cirencester catchment there is one site detailed within the Environment Agency Consents Database which has an Event Duration Monitor (EDM) fitted.

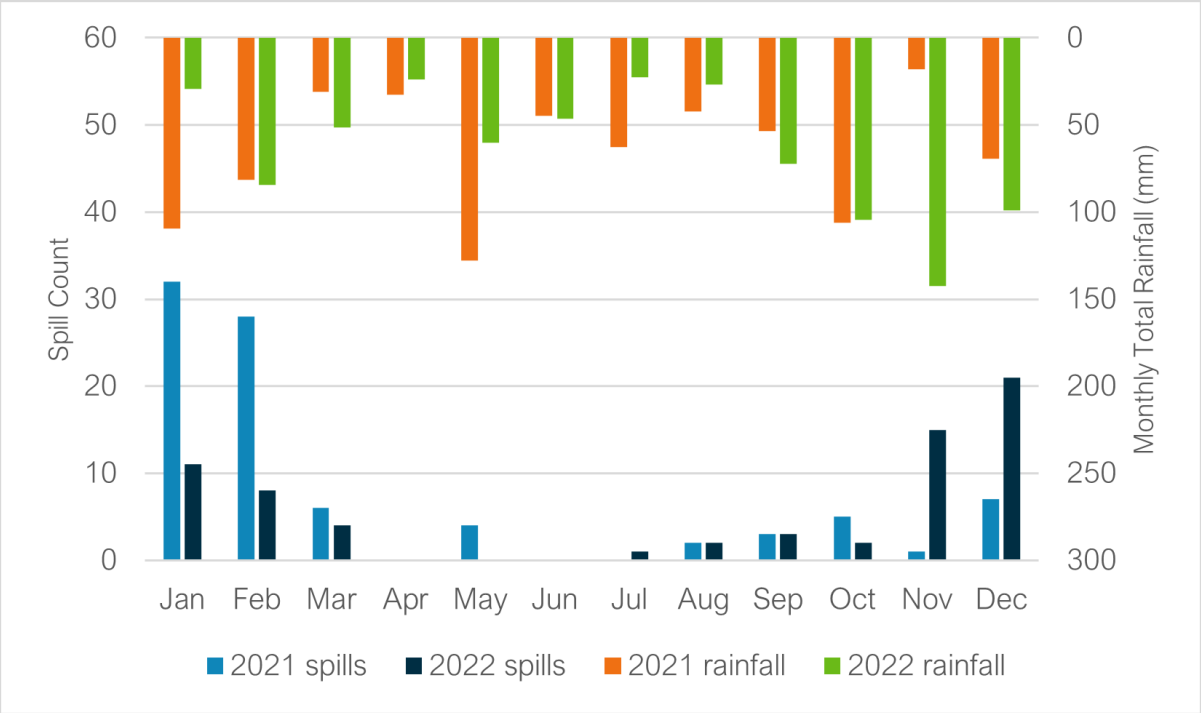
Table 7 below details the last 2 years performance of overflows within the catchment.

Table 7 – Event Duration Monitoring

Overflow	2021		2022	
	Spills	Duration (hours)	Spills	Duration (hours)
Cirencester STW	88	1216.07	67	405.91

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



The trend in spill performance across the two recorded years does show variation in spills, with an overall focus on spills during the autumn and winter months. The data suggests a wider relationship between rainfall, elevated groundwater levels and spill frequency. A significant number of spills were recorded at Cirencester STW in November and December 2022. The indicator site data shown in Figure 5, suggests groundwater levels in the catchment became elevated during this period, with Figure 6 suggesting that they reached notably high levels. Similarly, despite similar rainfall totals, significantly more spills were recorded at Cirencester STW in February 2021 compared to February 2022. The indicator site data shown in Figure 5, suggests groundwater levels in the catchment were higher in February 2021.

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 11 monitors installed within the Cirencester 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 9 below provides a summary of the investigations and remediation works undertaken or planned within the Cirencester catchment in the 2022-23 Hydrological Year, as well as works undertaken in the 2021-22 Hydrological Year.

Table 9 – Works Undertaken in the 2021/22 Hydrological Year & in the 2022/23 Hydrological Year

Investigation/ remediation type	Number/ length undertaken 21/22	Number/ length undertaken 22/23
CCTV survey	791 metres	~80 metres
Look and lift survey	4 surveys	10 surveys
Sewer lining	730 metres* 220 metres in South Cerney**	6 metres
Patch lining	4	N/A
Manhole sealing	5 manholes	N/A
Manhole sealing plates	N/A	N/A
Manhole flood plates	N/A	3 installed & 3 outstanding
Manhole covers and frames replaced	3 manholes	N/A

*Shorter length than 980 m originally proposed as scope refined by Engineering.
**Rollover from previous hydrological year.

Cirencester STW is to be upgraded at a cost of more than £22 million. This project will provide a major increase in treatment capacity, and an increase in storm tank capacity, reducing the need for untreated discharges to the environment.

Summary

This hydrological year (October 2022 – September 2023), groundwater levels in the Cirencester catchment have generally been higher than the previous hydrological year, with the observed EDM spills in November and December 2022 suggesting groundwater infiltration plays a role on the number of spills in the catchment. The EDM data for 2023 will be analysed once available to continue to examine the relationship between groundwater levels and overflow spills in the Cirencester catchment.

Lift and look and CCTV surveys will be undertaken in the remaining wet winter periods if conditions allow. 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 Price Review (PR) process if required.

Addendum - Annual Update 2024

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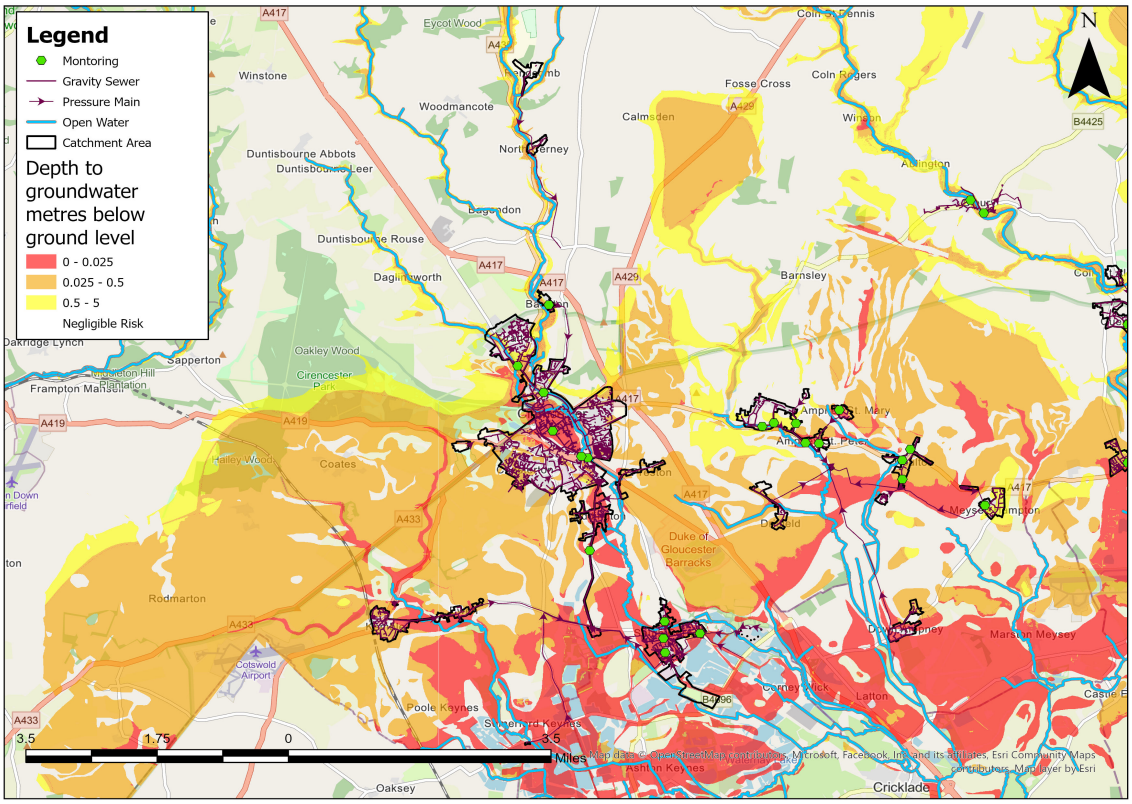
Overview

This addendum to the Cirencester Groundwater Impacted System Management Plan 2021 (GISMP) provides an update on performance in the Hydrological Year October 2023 to September 2024. 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 2024/25

Figure 1 – Cirencester Monitoring Plan



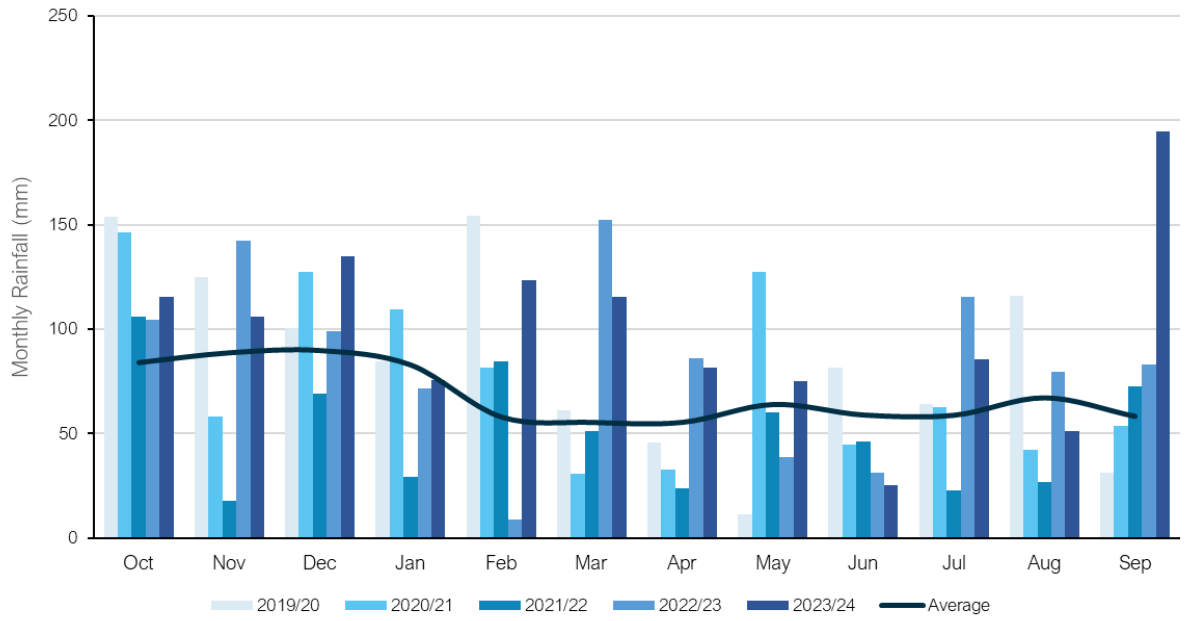
Hydrological Review – 2023-2024

This section summarises the hydrological conditions across the Cirencester 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 five hydrological years to support longer term trends within the local system.

Figure 2 – Monthly Rainfall Data



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

The total rainfall for the 2023/24 hydrological year is 44% 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)	2023/24 (mm)
823	1030	918	611	1014	1185

Groundwater / Local River Level

The Cirencester catchment is situated in the Cotswolds West and Upper Thames water resources areas. It primarily sits in the Forest Marble Formation of mudstone and limestone and the Kellaways Clay Member of mudstone. The Forest Marble Formation – Limestone is a designated principal aquifer 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 Churn, Cirencester.
- River Churn, South Cerney.
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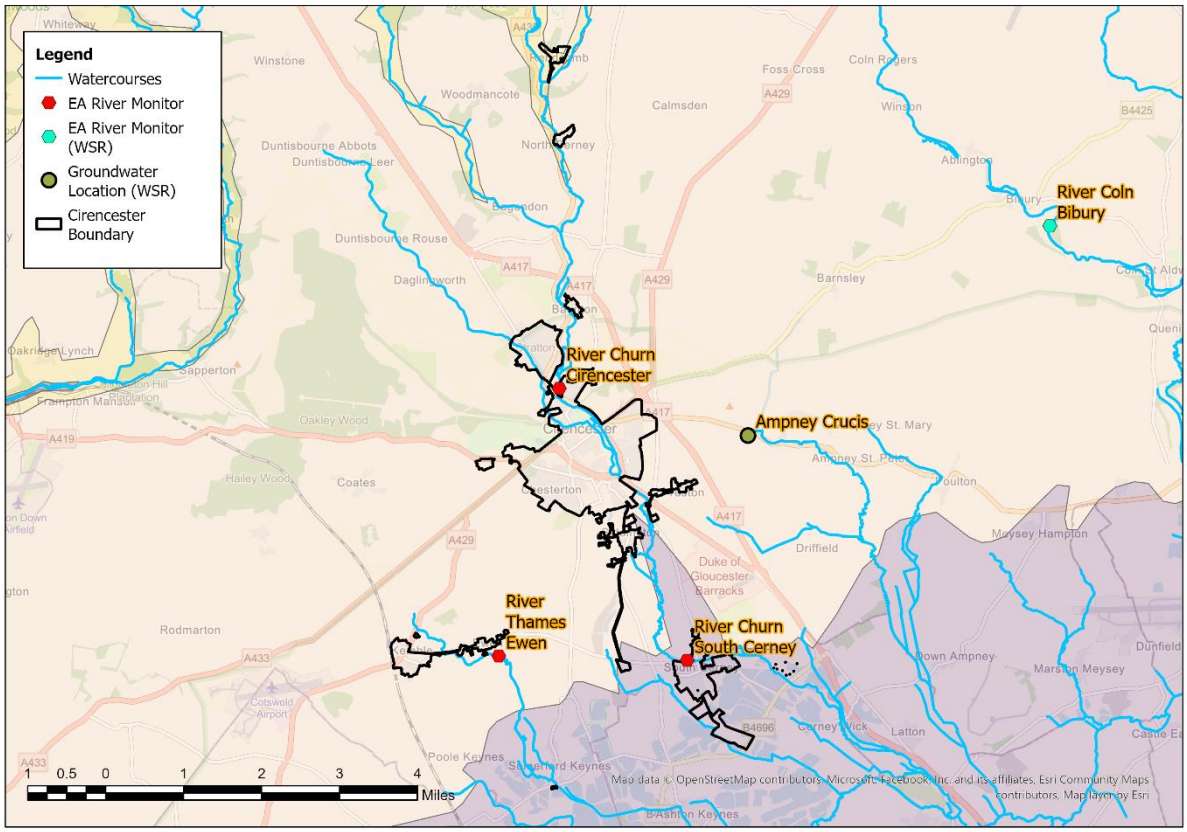
These sites are illustrated in Figure 4, alongside the closest groundwater reference station and closest gauging station from the Water Situation Report.

Figure 4 – Local Monitoring Stations



Figures 5A-5C 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 – River Churn, Cirencester

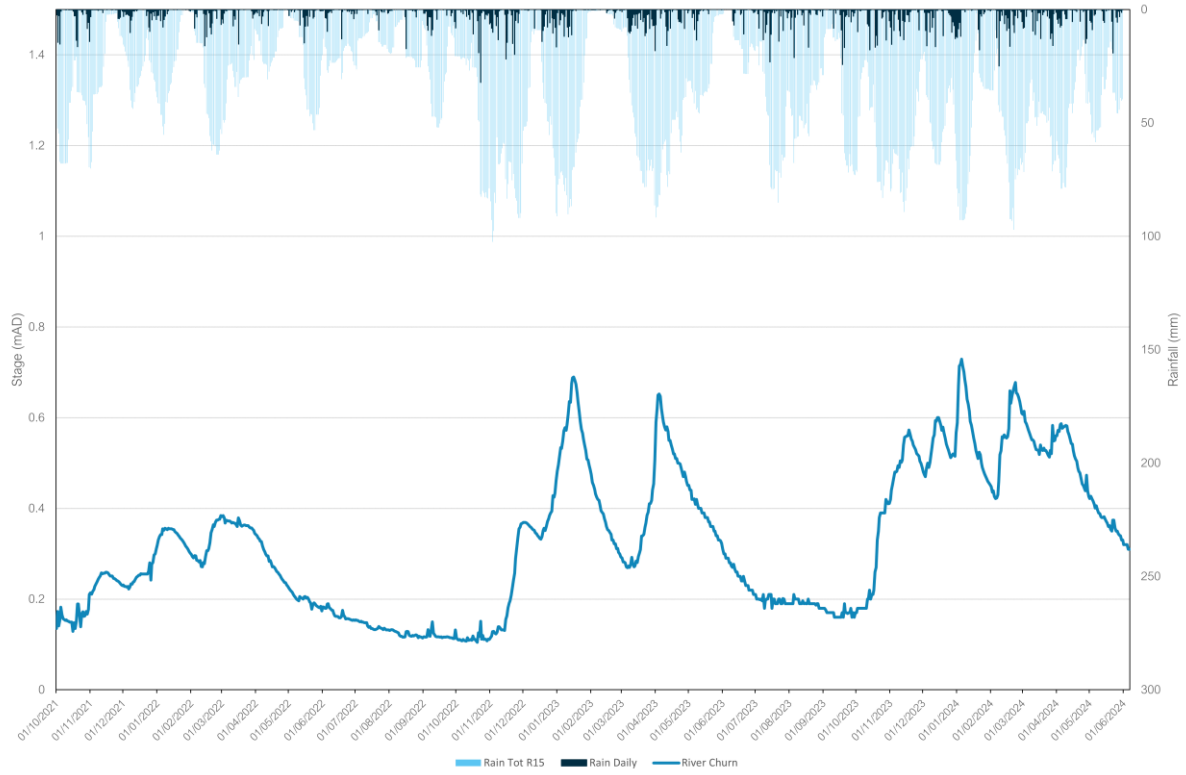


Figure 5B – River Churn, South Cerney

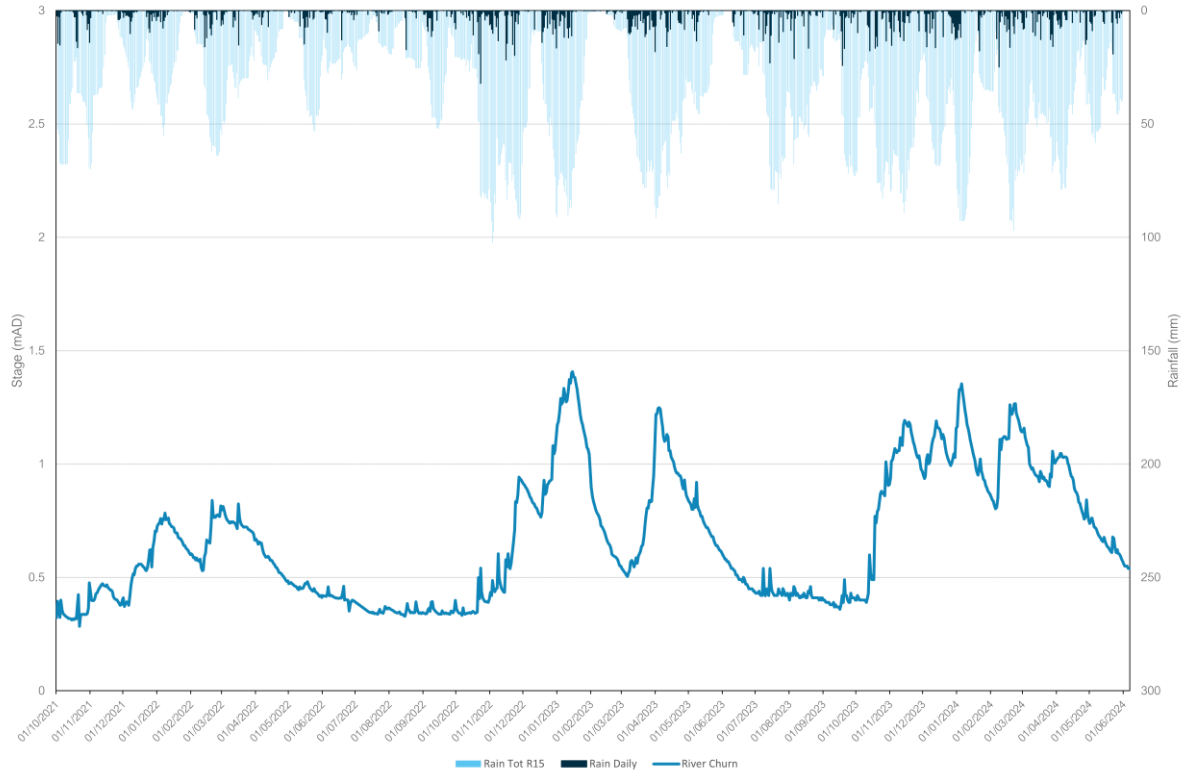
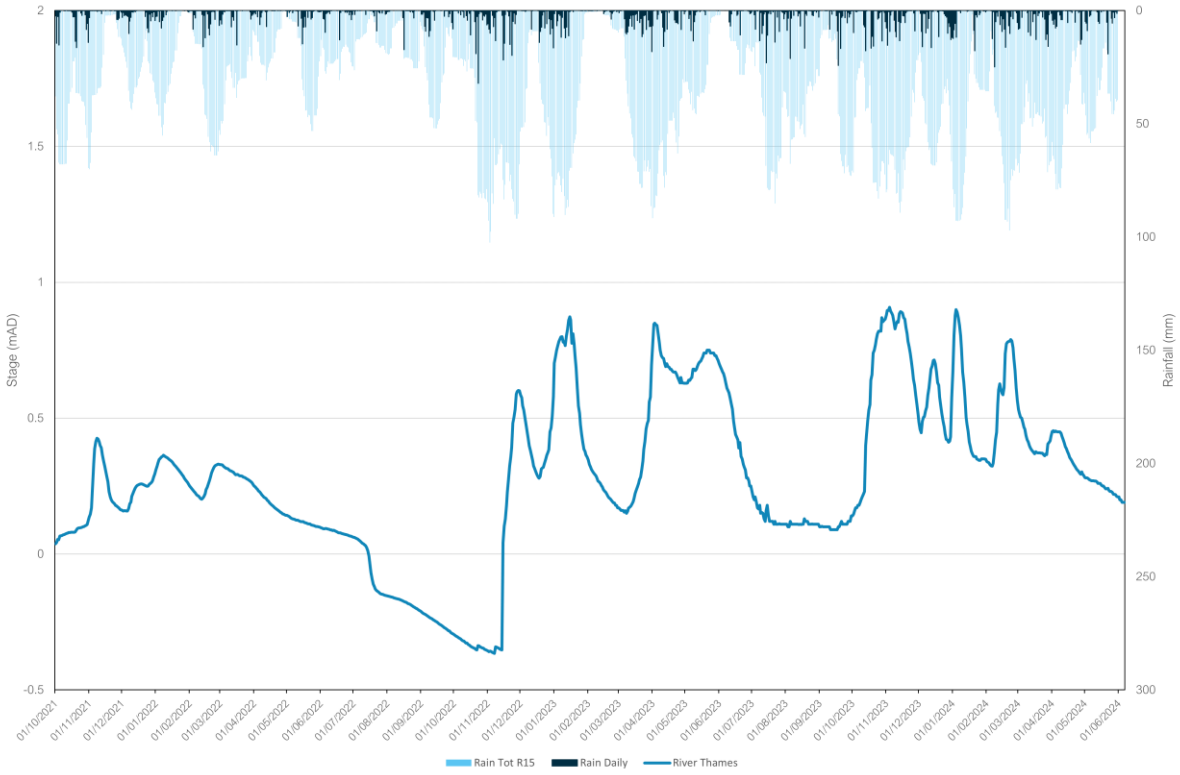
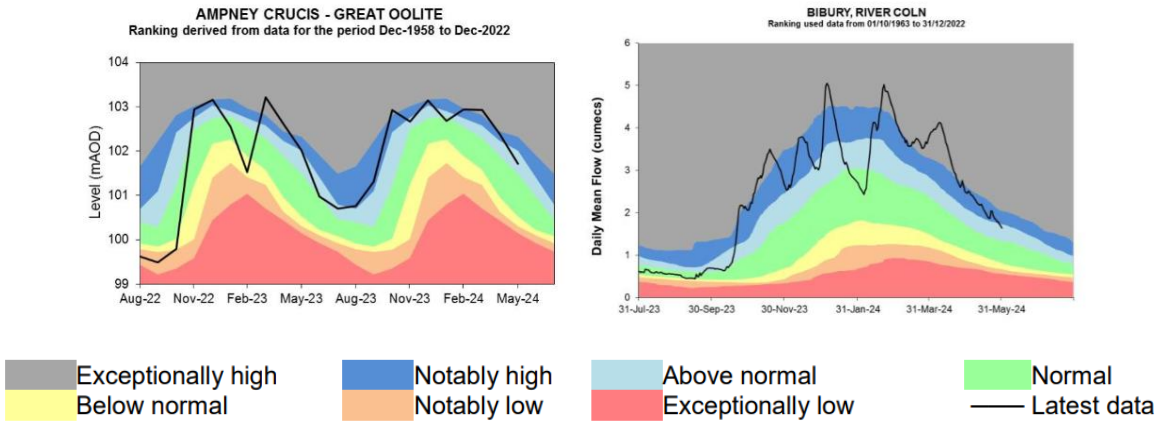


Figure 5C – River Thames, Ewen



In addition to these specific stations, the wider groundwater context is illustrated in the Water Situation Report for Cotswolds West. The nearest groundwater reference station is Ampney Crucis. This site shows groundwater levels from March through to the end of year in 2023 to be at above normal, notably high and exceptionally high levels. Groundwater levels in 2024 can be observed to sustain above normal / notably high levels throughout the January – May period. This can be seen in Figure 6 alongside the river indicator location at Bibury on the River Coln.

Figure 6 – Water Situation Report



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

Network Performance

Within the Cirencester catchment there is one site detailed within the Environment Agency Consents Database which has an Event Duration Monitor (EDM) fitted.

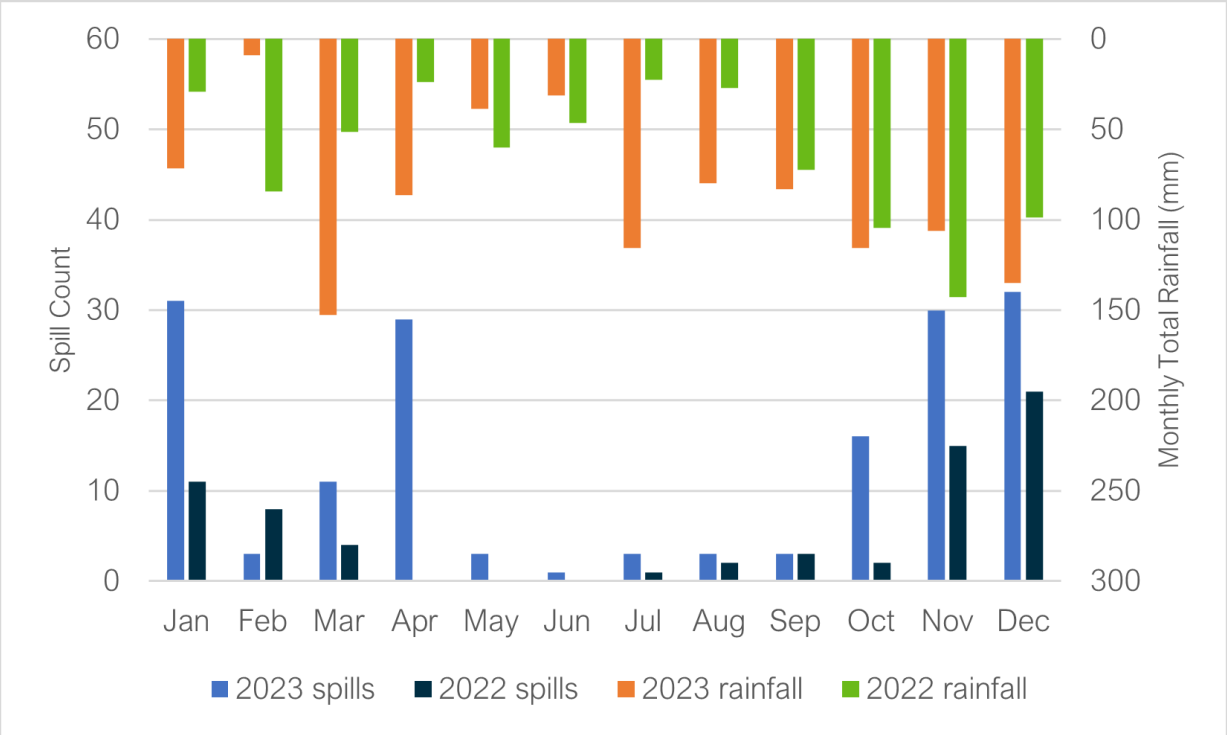
Table 7 below details the last 2 years performance of overflows within the catchment.

Table 7 – Event Duration Monitoring

Overflow	2022		2023	
	Spills	Duration (hours)	Spills	Duration (hours)
Cirencester STW	67	405.91	165	2870.75

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



The trend in spill performance across the two recorded years does show variation in spills, with an overall focus on spills during the winter, spring and autumn months. A high number of spills were recorded in January and April 2023, coinciding with periods of elevated groundwater levels (see Figures 5 and 6). Additionally, despite rainfall totals being similar in October / November 2022, compared to the same months in 2023, a significantly higher number of spills were recorded across November and December 2023. The indicator site data shown in Figure 5, suggests groundwater levels were generally more elevated during these months in 2023. Overall, the data suggests a wider relationship between rainfall, elevated groundwater levels and spill frequency in the catchment. The fact that spills occurred through the summer months in 2022 and 2023, also suggests spills occurring in the catchment as a direct response to rainfall, outside of periods of elevated groundwater levels.

Investigations & Interventions

This section details the activities that have been undertaken within the catchment within the Hydrological Year 2023-24.

Monitor Installations

The sewer depth monitor (SDM) programme supports long term groundwater understanding within GISMP catchments. Currently, there are a total of 11 monitors installed within the Cirencester 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 9 below provides a summary of the investigations and remediation works undertaken or planned within the Cirencester catchment in the 2023-24 Hydrological Year, as well as works undertaken in the previous two hydrological years.

Table 9 – Works Undertaken in the 2023/2024 Hydrological Year, 2022/23 Hydrological Year & in the 2021/22 Hydrological Year

Investigation/ remediation type	Number/ length undertaken 21/22	Number/ length undertaken 22/23	Number/ length undertaken 23/24
CCTV survey	791 metres	~80 metres	500 metres Additional 1.7 kilometres
Look and lift survey	4 surveys	10 surveys	11 surveys
Sewer lining	730 metres* 220 metres in South Cerney**	6 metres	N/A
Patch lining	4	N/A	N/A
Manhole sealing	5 manholes	N/A	3 manholes
Manhole sealing plates	N/A	N/A	N/A
Manhole flood plates	N/A	3 installed	3 installed
Manhole covers and frames replaced	3 manholes	N/A	N/A

*Shorter length than 980 m originally proposed as scope refined by Engineering.
**Rollover from previous hydrological year.

Tankering was undertaken within the catchment during the 2023/24 Hydrological Year. A total of 134 days of flow management was required at Blakes Road.

An additional 1.7 kilometres of CCTV survey was undertaken in the catchment over the autumn 2023 period. The purpose of these surveys was to assess the structural condition of sewers predicted to be at high risk of groundwater infiltration, rather than to identify locations of groundwater infiltration into the network. Over 90% of the network surveyed was found to be in an acceptable structural condition.

Cirencester STW is to be upgraded at a cost of more than £22 million. This project will provide a major increase in treatment capacity and treatment capacity via land treatment, as well as an increase in storm tank capacity, reducing the need for untreated discharges to the environment. This project is expected to be completed in 2024. Note, delivery dates are being managed at a

programme level, delivery dates stated are based upon current views and are subject to change.

It is expected that the Cirencester catchment will meet all government targets for storm overflows by 2030-2035.

Summary

This hydrological year (October 2023 – September 2024), indicator site data suggests that groundwater levels in the Cirencester catchment have remained elevated for more prolonged periods than in the previous hydrological year. EDM data for 2023, suggesting groundwater infiltration plays a role on the number of spills in the catchment. The EDM data for 2024 will be analysed onceavailable to continue to examine the relationship between groundwater levels and overflow spills in the Cirencester catchment.

Lift and look and CCTV surveys will be undertaken in remaining wet winter periods if conditions allow and subject to funding and available capacity. Theaim of this is to find further priority locations for remediation and investigating/justifying the needfor future larger scale lining as part of our Price Review (PR) process if required.

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