



# Groundwater Impacted System Management Plan

Bibury, River Coln

July 2021



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# Version control

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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 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<sup>1</sup> 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<sup>2</sup>. 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

<sup>1</sup> Sewers for Adoption makes an allowance for 10% of normal wastewater flow to allow for unaccounted flows such as groundwater infiltration.

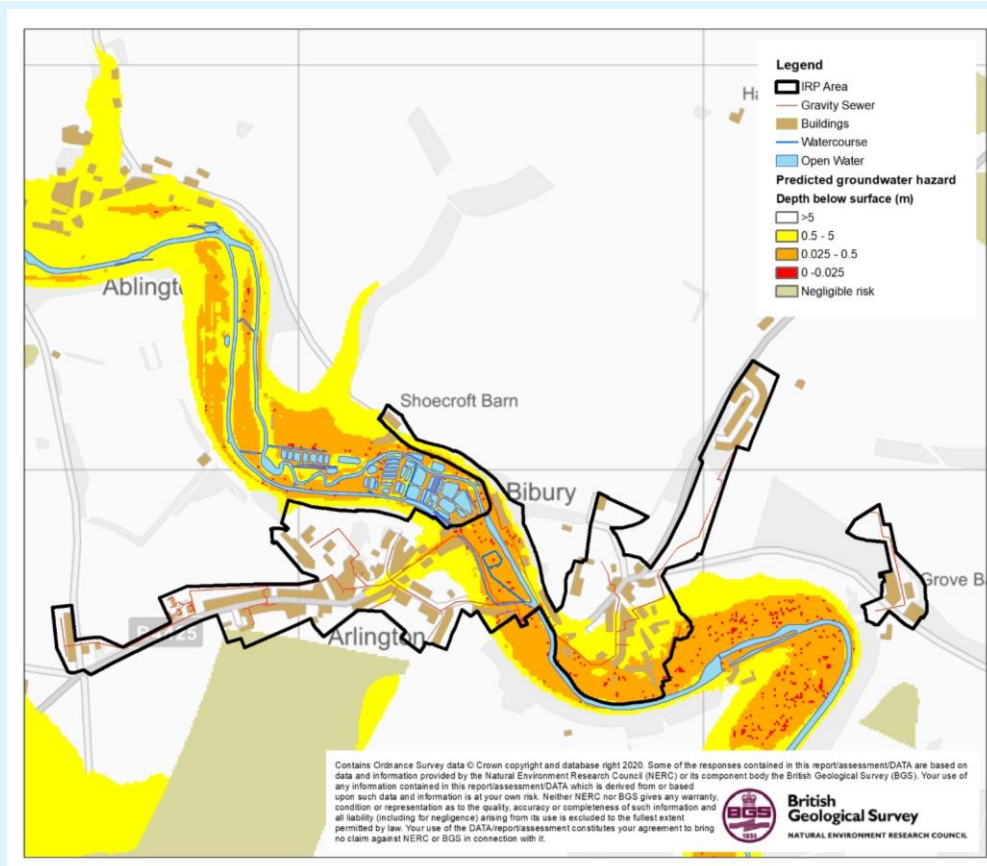
<sup>2</sup> On occasions it is possible to over-pump between manholes to isolate sections of sewer to survey, this is not always feasible when the flows involved are simply too great to over-pump or the location prohibits this approach.



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 Bibury catchment



1.0 – Bibury catchment

Bibury is located in Gloucester, England, approximately 6 miles north-east of Cirencester. Bibury serves a population equivalent<sup>3</sup> of 647 with a partially separate sewerage network totaling some 6.61 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 increase the risk of flooding. There's a strong link between rising river levels and rising groundwater levels, particularly adjacent to the River Coln, and the drainage issues some of our customers have experienced, including sewer flooding and restricted use of their toilets and bathrooms.

<sup>3</sup> 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.

In recent years the foul sewerage system in the Bibury system has on occasions become overwhelmed, following prolonged and heavy rainfall and raised groundwater levels. This has resulted in some properties suffering from sewer flooding and restricted toilet use.

The sewerage system is identified on the public sewer records as being a partially separate foul system, rather than a combined system. We believe that surface water run off from surrounding saturated fields may have entered the foul sewerage network during recent wet winters, causing the network to become overloaded and surcharge (mainly through submerged manholes).

Local operations investigations in 2020 identified an illegal discharge activity of pumped groundwater into the foul sewer network. This was resolved in 2020. Other discharges in the catchment have also been identified and are being addressed. This activity has improved the performance of the system.

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.

Bibury STW is a 'treat all' site so does not have storm separation or a storm 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 Cotswolds District Council as Lower Tier 1 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

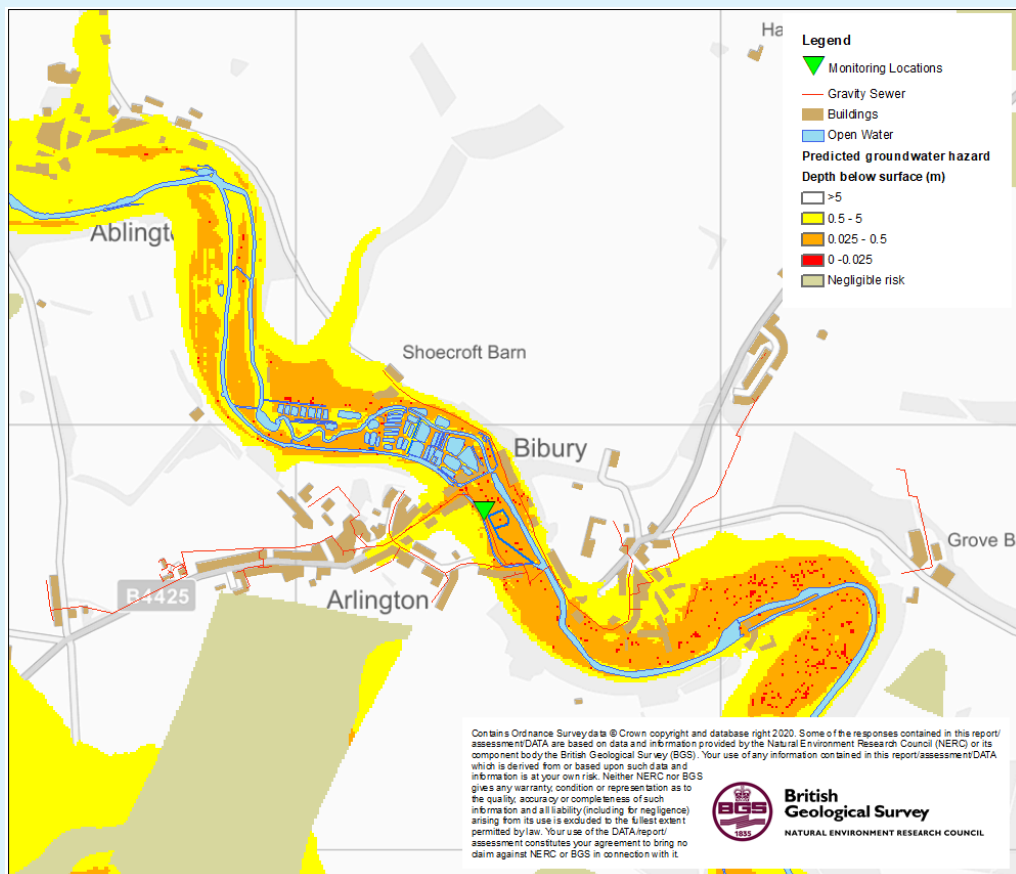


Figure 2.0 – Bibury monitoring and infiltration zones

Key to bringing the impact of groundwater infiltration under control is an enhanced monitoring regime. We have identified and have installed a telemetered depth monitor location in the Bibury system – see Figure 2.0.

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 Bibury 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 have been 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<sup>4</sup> of the high risk zones in AMP8<sup>5</sup>, 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<sup>6</sup> 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 Bibury.

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	2020	Monitors have now 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.

<sup>4</sup> 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.

<sup>5</sup> Asset Management Plan 8 – covering work between 2025-2030

<sup>6</sup> 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.

# Bibury 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 Bibury sewerage system is outlined below.

## High level approach statement

For Bibury 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<sup>7</sup> to address. To investigate the network, we have:
  - Undertaken a desktop analysis to determine infiltration high to low risk zones (October 2020);
  - Installed additional monitoring to back up the analysis 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.

To investigate the network, we will:

- 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.

<sup>7</sup> 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 have now 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. 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 Bibury 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	1.22	26.4
Medium	Predicted groundwater extreme 0-1m above pipe invert	0.09	1.9
Low	Predicted groundwater extreme 0-1m below pipe invert	0.23	5.0
Very Low	Predicted groundwater extreme >1m below pipe invert	3.08	66.7
Total		4.62	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	7	5.2
Medium	Inundation risk in 1% AEP fluvial or pluvial event	1	0.7
Low	Inundation risk in 0.1% AEP fluvial or pluvial event	6	4.5
Very Low	All other manholes	120	89.6
Total		134	100.0

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

Lift and Look and CCTV surveys have not yet commenced in the Bibury 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

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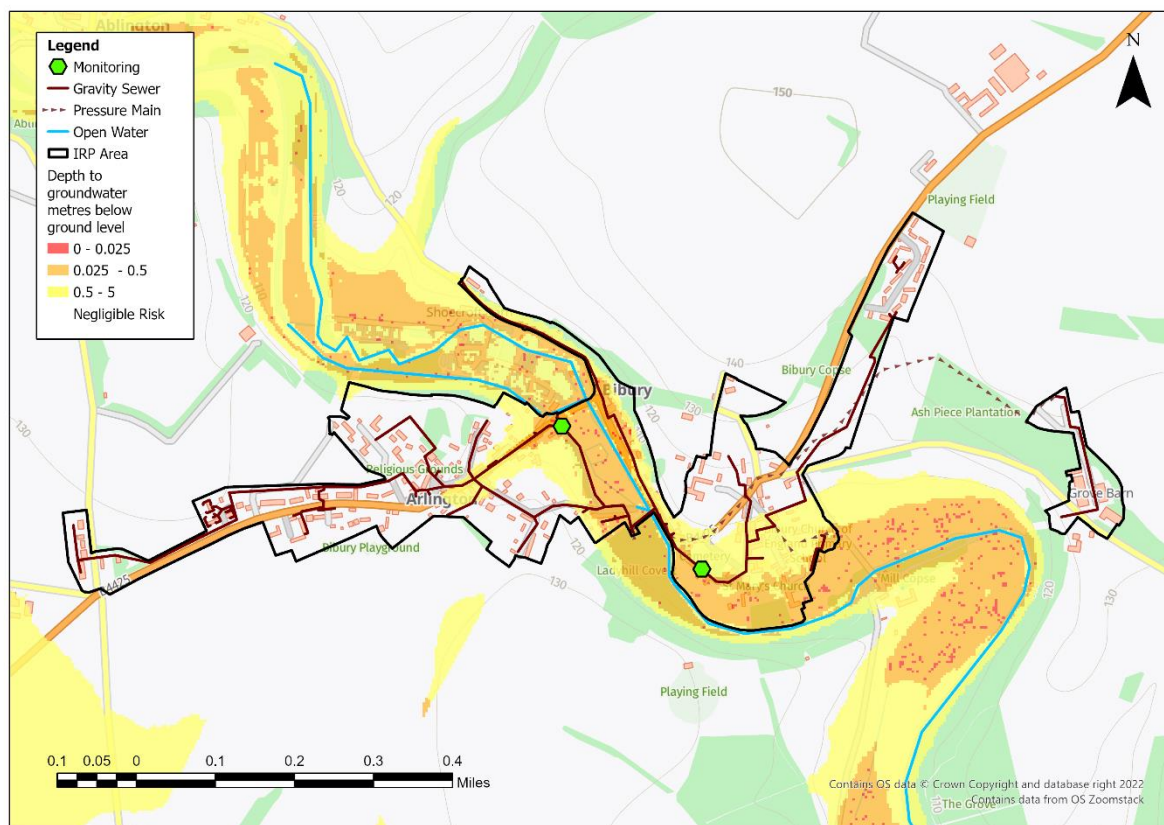
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## Overview

This addendum to the Bibury 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 – Bibury Monitoring Plan





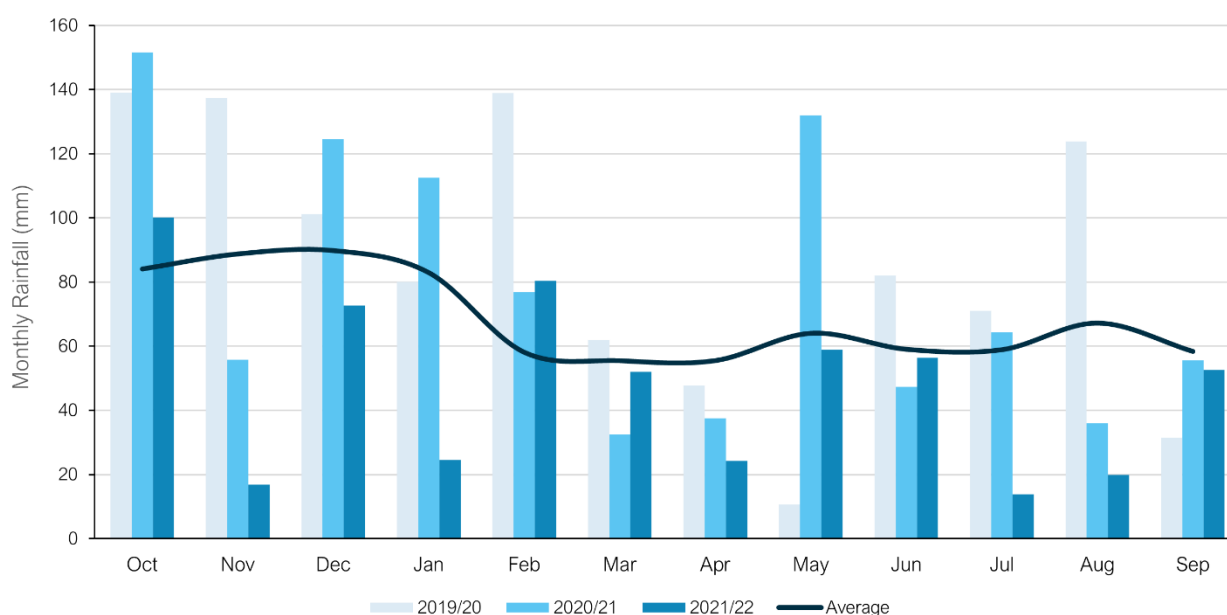
## Hydrological Review – 2021-2022

This section summaries the hydrological conditions within the Bibury 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 1<sup>st</sup> to September 30<sup>th</sup>.

### 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 29% 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	1025	927	581

## Groundwater / Local River Level

The Bibury catchment is situated in the Cotswolds West water resource areas. It primarily sits in the Taynton Limestone Formation of carbonate material forming beds, the White Limestone Formation of carbonate material forming beds and the Signet Member (Limestone) forming beds. These are designated principal aquifers within the UK.

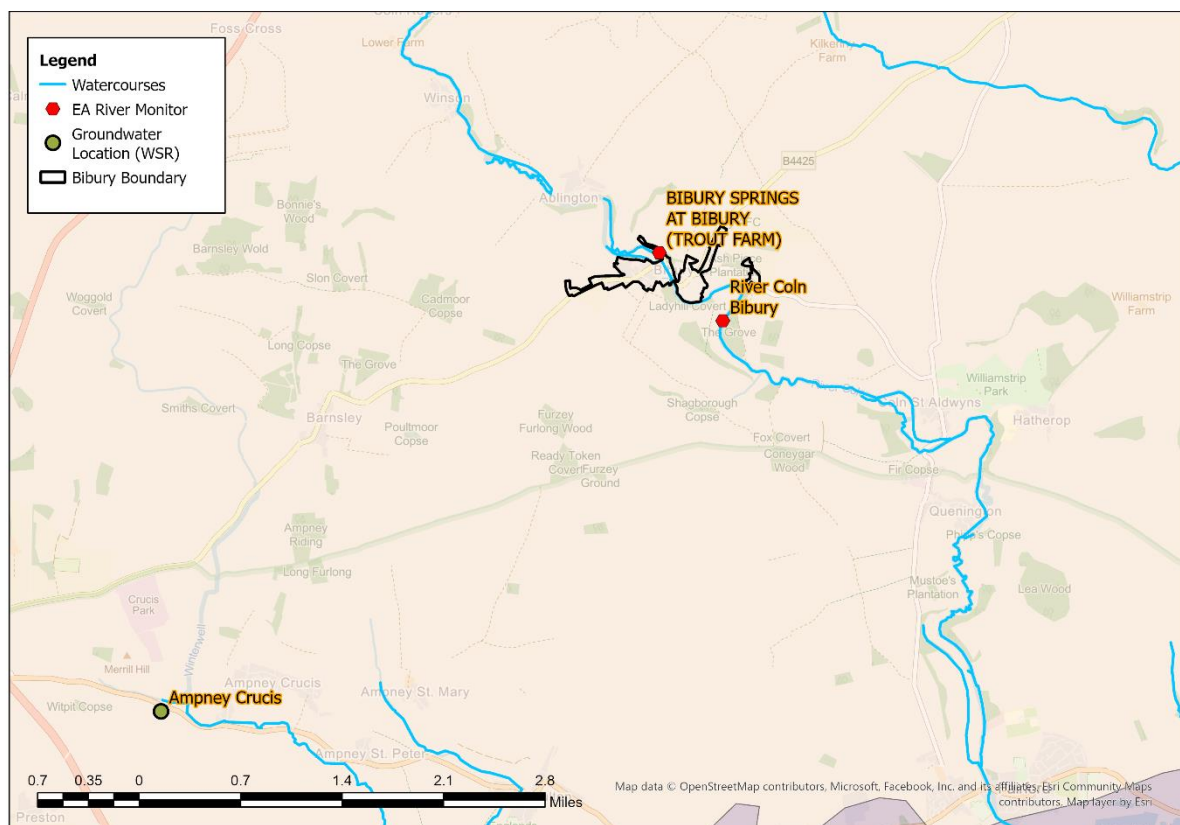
The Environment Agency has gauging stations on local watercourses measuring stage and observation boreholes measuring groundwater levels locally to the catchment which can be used to provide indicative local groundwater performance.

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

- River Coln, Bibury
- Bibury Springs, Bibury Trout Farm.

These sites are illustrated in the figure below, alongside the closest groundwater reference station and closest gauging station from the Water Situation Report. The closest gauging station from the WSR is also the River Coln at Bibury.

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 Coln, Bibury

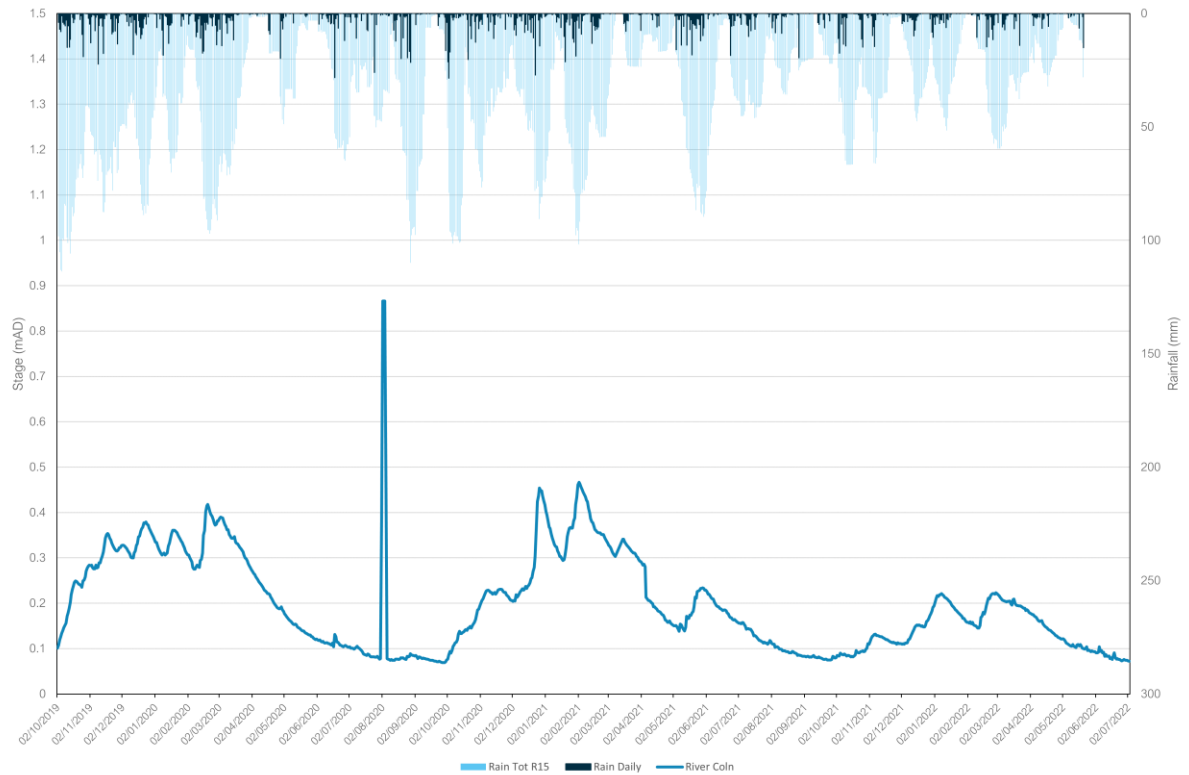
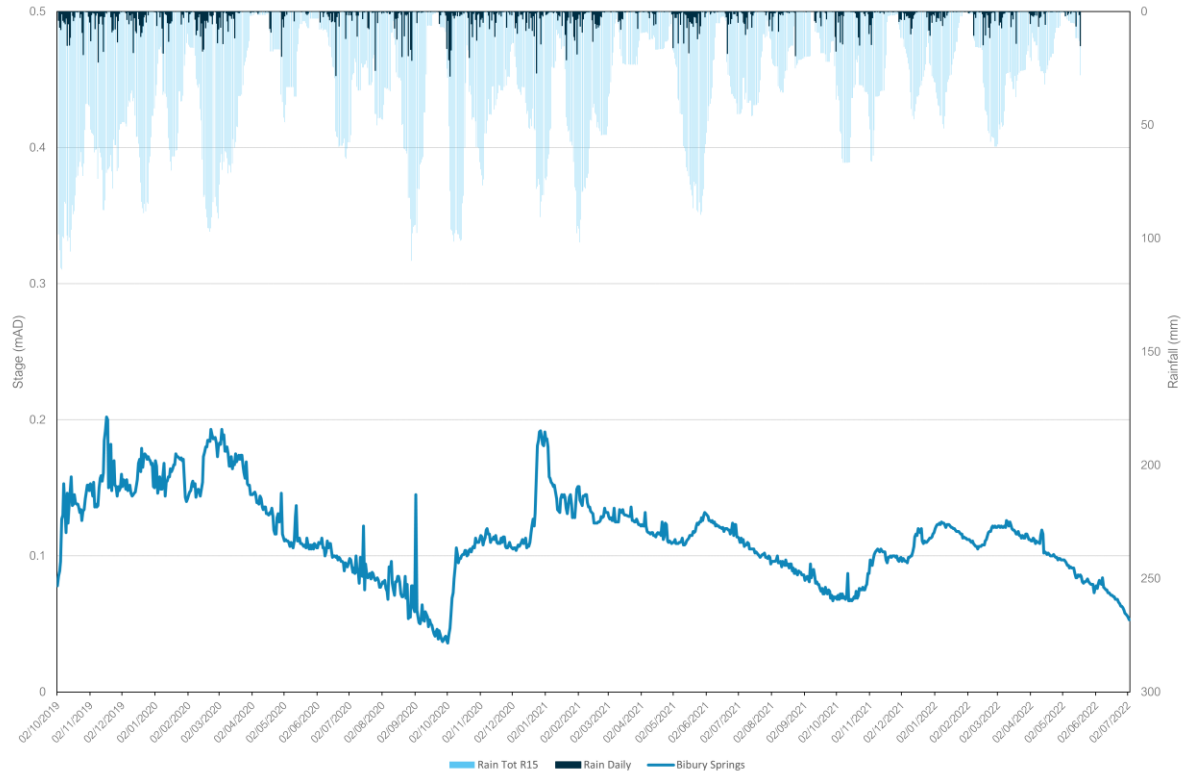
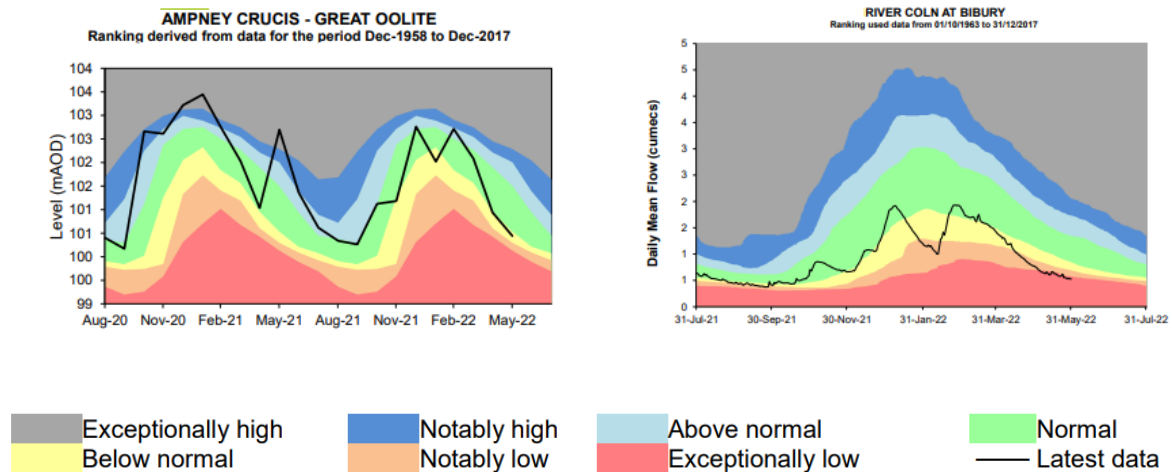


Figure 5B – Bibury Springs, Bibury Trout Farm



In addition to these specific stations, the wider groundwater context is illustrated in the Water Situation Report for the Cotswold West. The nearest groundwater reference station is Ampney Crucis. This site shows lower overall groundwater levels than the previous year, particularly evident during the winter months. 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 \(publishing.service.gov.uk\)](https://publishing.service.gov.uk)

## Network Performance

Within the Bibury catchment there are no sites detailed within the Environment Agency Consents Database which have an Event Duration Monitor (EDM) fitted. Therefore, the last 2 years of overflow performance for the Bibury catchment have not been detailed.



## 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 2 monitors installed within the Bibury catchment. There are no further monitor installs currently 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 7 below provides a summary of the investigations and remediation works undertaken or planned within the Bibury catchment in the 2021-22 Hydrological Year.

Table 7 – 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
Manhole sealing plates	N/A

With the seasonal trends in groundwater being low in comparison with previous years, the larger scale survey, identification and remediation of the sewerage network has not been possible within the 2021/22 hydrological year.

## Summary

Rainfall in the Bibury catchment over the 2021/22 hydrological year has been below average, with groundwater levels in the aquifer beneath Bibury 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 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.

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Closing Statement

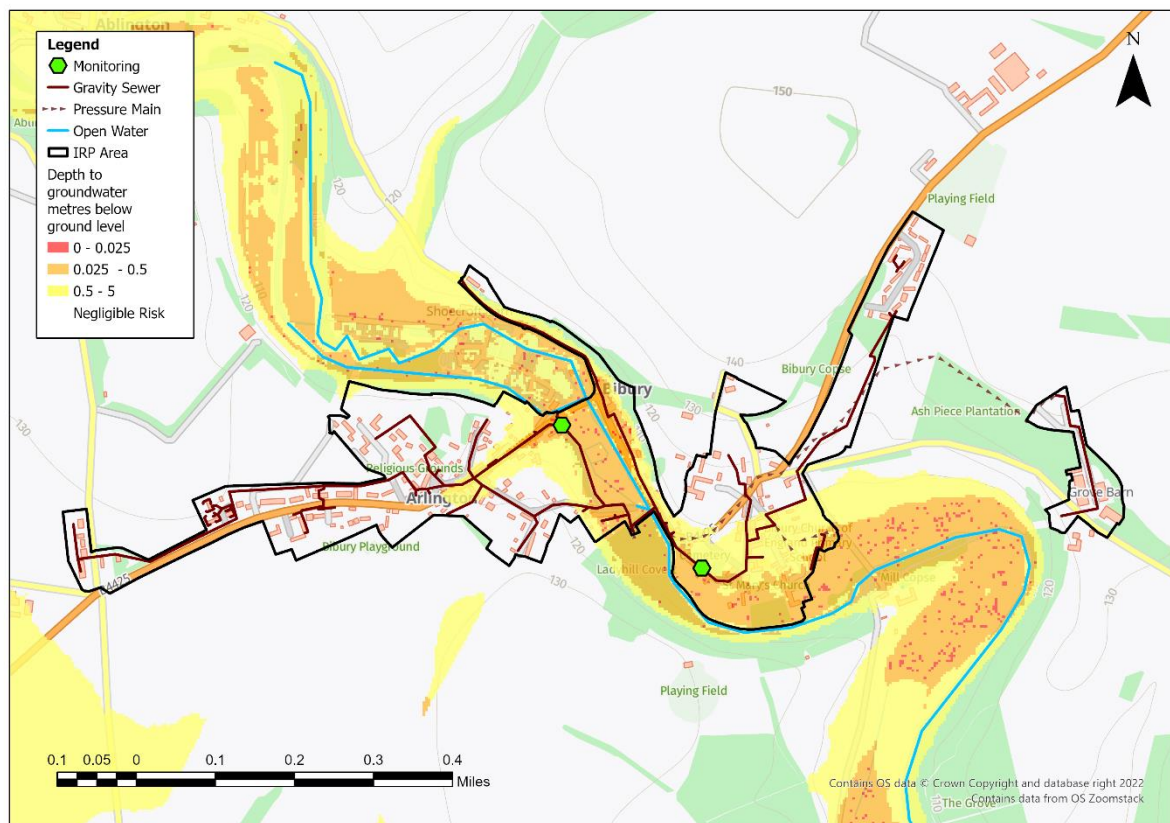
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## Closing Statement

It has been agreed with the EA that the Bibury catchment will be removed as a GISMP system. The catchment is a 'treat all' site and does not contain any overflows. Groundwater flooding and associated pollutions within the catchment have not occurred since a customer in the catchment ceased discharging significant groundwater flows into the foul sewer system.

There are 2 GISMP depth monitors installed in the Bibury catchment. These will remain installed to allow the system and any changes within it to continue to be monitored.

Figure 1 – Bibury Monitoring Plan





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