



# Groundwater Impacted System Management Plan

Berkhamsted, River Bulbourne

January 2021



It's everyone's water

# Version control

Version	Date	Amendment	Author	Checked	Reviewed
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1-d2	Jan 2021	Final Draft for EA	DJ	APH	KD
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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.

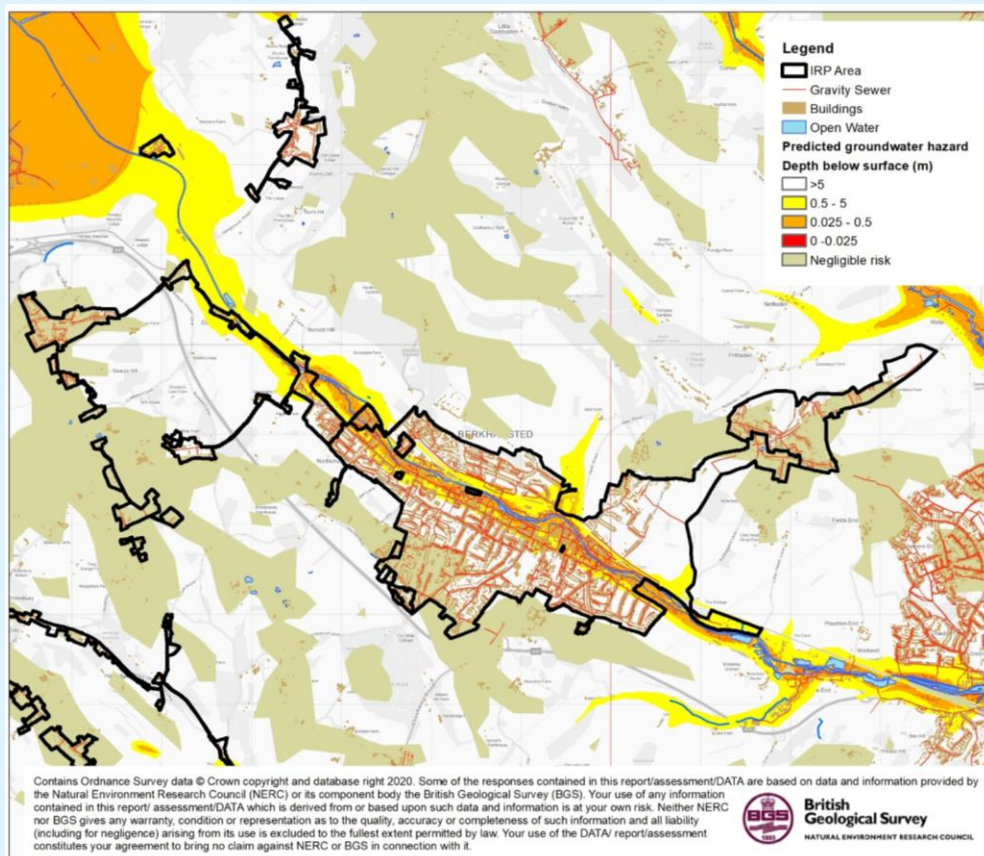
<sup>2</sup> On occasions it is possible to over-pump between manholes to isolate sections of sewer to survey, this is not always feasible when the flows involved are simply too great to over-pump or the location prohibits this approach.



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 Berkhamsted catchment



## 1.0 – Berkhamsted catchment

Berkhamsted is located in the Bulbourne Valley, Hertfordshire, England, approximately 5 miles West of Hemel Hempstead. Berkhamsted serves a population equivalent<sup>3</sup> of 25,500 with a predominantly separate sewerage network totalling some 127 km in length excluding private drains and sewers. The extent of the catchment is shown in Figure 1.0 above.

### Problem characterisation

Following prolonged wet periods, we experience increased rates of flow arriving at the Sewage Treatment Works (STWs). On occasions, when rainfall patterns are significantly above expected rates, it may impact the performance of the STW. We are currently investigating the source and impact of flows into the sewage treatment works to ascertain whether groundwater infiltration is the key or major source.

<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.

Our permit conditions for Berkhamsted STW state:

*“The discharge from a Combined Sewer Overflow (‘CSO’) or a sewage works storm tank shall consist solely of storm sewage effluent resulting from rainfall runoff or snowmelt into the sewerage system” and that “The discharge from a Combined Sewer Overflow (‘CSO’) or a sewage works storm tank shall not operate in dry weather conditions”.*

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 Bucks County Council as the lead local flood authority and as the 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).

Parts of the gravity system (both public and private) leading to the STW follow the river valley of the River Bulbourne

and Grand Union Canal. There is some correlation between flows arriving at the works and river levels within the catchment. This is not indicative or evidence of a direct connection between the river and the sewerage system, simply that similar sources of flow are likely to be influencing both systems, and hence helps to further our understanding of what some of the mechanisms might be leading to increased winter flows (at the STWs). We therefore have a perceived understanding of the possible root causes, which we are in the process of investigating, monitoring, and verifying over the forthcoming winter periods.

In the network, whilst we experience increased flow in winter, we are not aware of any escapes or flooding as a result, the impact is focused/centred solely at the STW.

In conclusion, we believe it is likely that groundwater infiltration in the Berkhamsted catchment is the most probable cause of incidences where the sewage treatment works has not been able to cope with all incoming flows, triggering spills to the storm tanks in periods of dry weather.

On occasions, where the incoming flow has exceeded treatment capacity for sustained periods, the storm tanks have become overloaded and spill to river has occurred on both wet and dry days.

# General outline plan & timescale

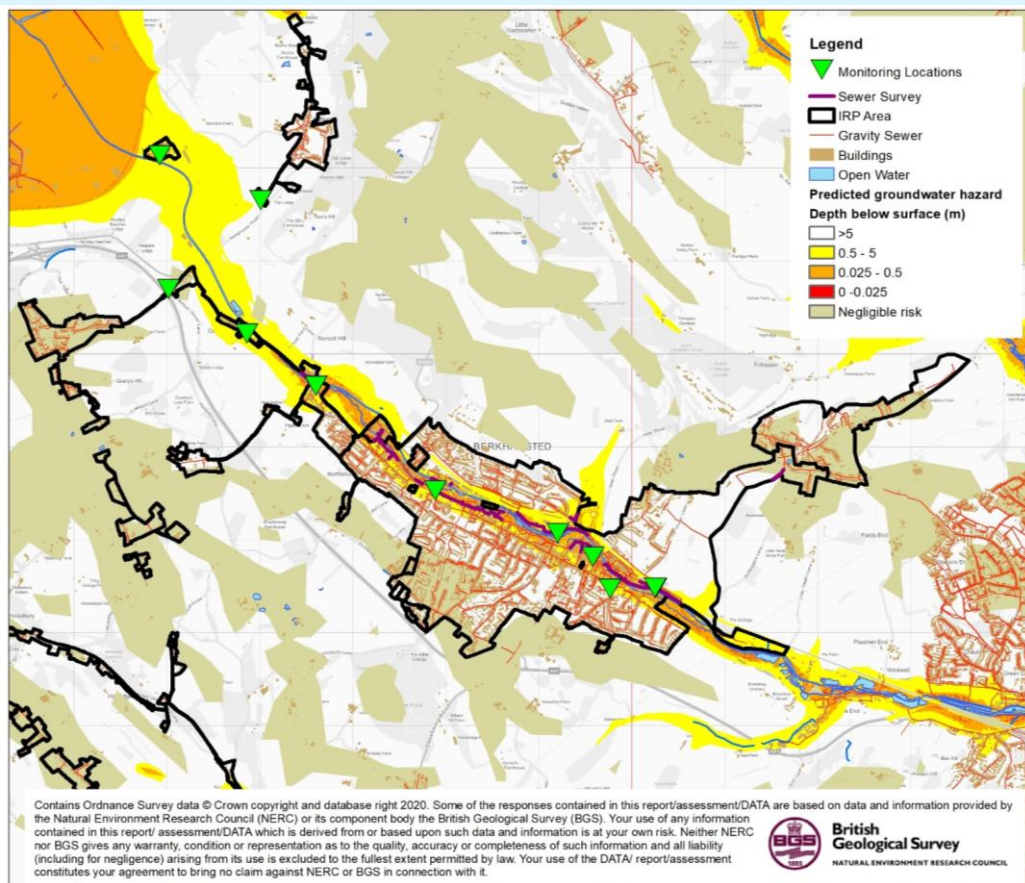


Figure 2.0 – Berkhamsted monitoring and infiltration zones

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 Berkhamsted 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 Berkhamsted 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 Berkhamsted.

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. Location and coverage to be reviewed each year.
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.

# Berkhamsted 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 at Berkhamsted 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 31/03/2023.

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 Berkhamsted our approach to tackling infiltration will be undertaken as follows:

1. Our programme for implementation of the upgrade of the STWs is completion by 2023.
2. 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 or infiltration that are cost effective<sup>7</sup> 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 sewers and 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).

3. Where interventions can be undertaken as part of normal sewer maintenance activities these will be communicated 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 and need. Significant investment needs may need to be included in our next investment planning cycle at PR24.

## Investigations

As mentioned above we have commissioned JBA Consulting to undertake an exercise involving groundwater elevation data to determine

<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.

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) 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 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.

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 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 Berkhamsted we do not envisage needing to undertake mitigation work 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	11.17	12.7
Medium	Predicted groundwater extreme 0-1m above pipe invert	4.94	5.6
Low	Predicted groundwater extreme 0-1m below pipe invert	6.34	7.2
Very Low	Predicted groundwater extreme >1m below pipe invert	65.20	74.5
Total		87.65	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	250	9.8
Medium	Inundation risk in 1% AEP fluvial or pluvial event	169	6.6
Low	Inundation risk in 0.1% AEP fluvial or pluvial event	425	16.7
Very Low	All other manholes	1703	66.9
Total		2547	100.0

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.

2019/20 Survey Statistics

Elements		Units	Value	Comment
Planned Survey		m	3,994	Survey was planned for a significant part of the valley floor. It was possible to complete 89% of the survey (see Figure 2) .
Survey Completed		m	3,538	
		%	89	
		Lengths (No.)	93	
Clear Flow Observed		m	1,226	41% of the sewer network surveyed had evidence of groundwater infiltration.
		%	41	
Sewer Infiltration Locations Identified	Infiltration Gushing	No.	1	61 groundwater infiltration locations were identified in the sewers.  Of those 13 were identified as “gushing” and therefore should be the focus of repair as soon as possible.
	Infiltration Gushing at Joint		12	
	Infiltration Running		8	
	Infiltration Running at joint		32	
	Infiltration Dripping		1	
	Infiltration Dripping at joint		5	
	Infiltration Seeping		1	
	Infiltration Seeping at joint		1	
	Grand Total		61	

Elements		Units	Value	Comment
Manhole Infiltration Locations Identified	Infiltration around pipe	No.		11 groundwater infiltration locations were identified at manhole locations.  Of those 6 were identified as “gushing” and therefore should be the focus of repair as soon as possible.
	Infiltration through benching			
	Infiltration through chamber wall			
	Gushing		6	
	Running		5	
	Dripping			
	Seeping			
	Grand Total		11	
Monitoring Locations Active		No.	11	14 Water level monitoring locations have been installed within the catchment. Their locations are shown in Figure 2.
Details of other Surveys				No other surveys have occurred in the catchment during the period

### 2019/20 Implementation Works

Activities	Value	Comment
Sewer Lining Length (m)	0	The focus of this period was investigations to identify the location of implementation works required. We are progressing the priority 1 locations below though our governance process for remediation, which is being monitored also by the EA.
Infiltration Points Targeted (no.)	0	
Manhole Sealing (no.)	0	

## Future Works

These are subject to feasibility and contractor review as the classification of gushers and runners is still a relatively subjective analysis.

	Priority 2020/2021	Known follow On Work
Survey	See main text	
Sewer Lining	13 gushing locations identified	26 weeping locations identified in 2019/20  Locations identified in Future Surveys
Manhole Sealing – Infiltration Ingress	6 gushing locations identified	5 weeping locations identified in 2019/20  Locations identified in Future Surveys
Manhole Sealing – Pluvial and Fluvial Ingress	Plan to be developed based on at risk manholes identified in JBA analysis	
Sewage Treatment Works Upgrade	See main text	



# 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

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# Introduction

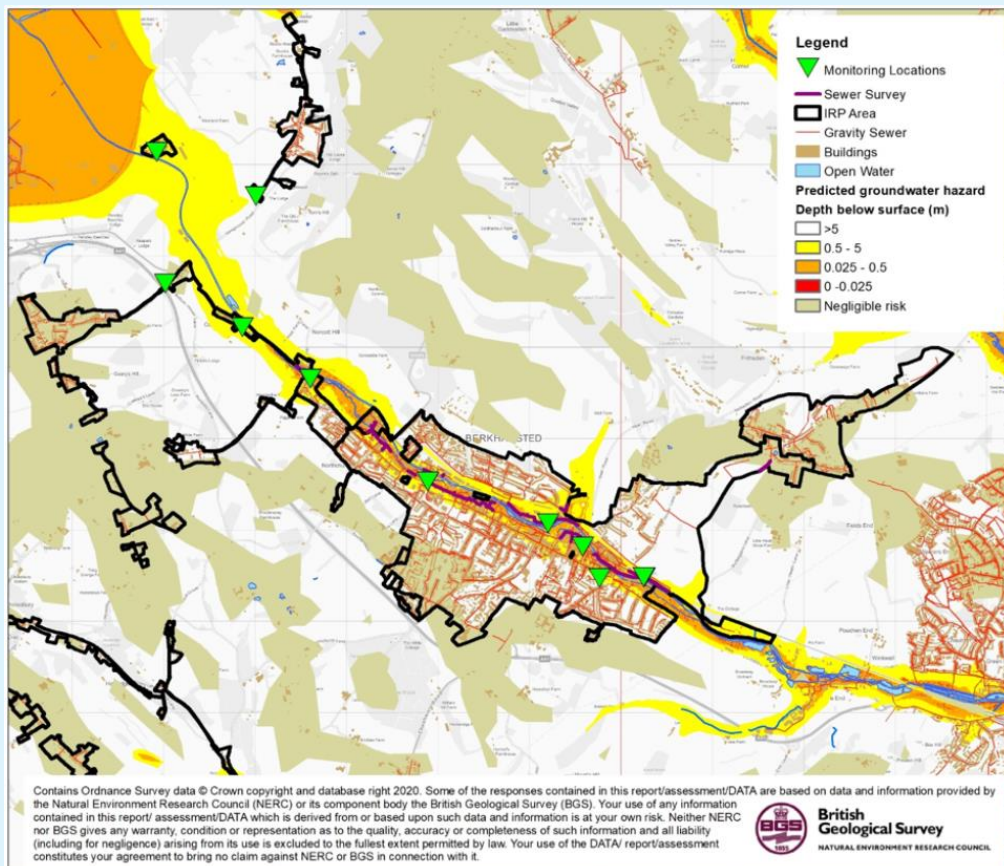


Figure 1 – Berkhamsted monitoring and infiltration zones

This addendum to the Berkhamsted Infiltration 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 <sup>1</sup>) 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

<sup>7</sup> [Happy New Water Year! | National River Flow Archive \(ceh.ac.uk\)](https://www.ceh.ac.uk/nrfa)

# 2020-21 Hydrological Review

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

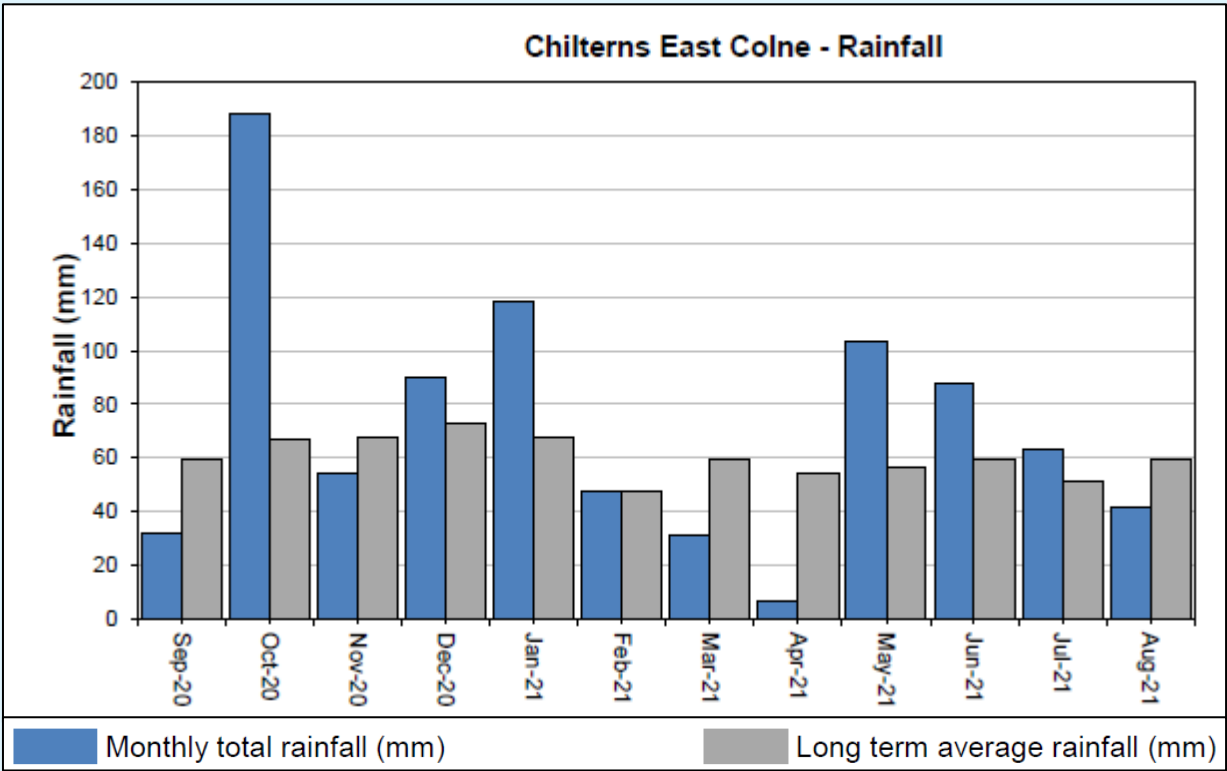


Figure 2 – Monthly rainfall depths local to the system

Berkhamsted is situated in the Chilterns East Colne water resources area. Figure 2 shows the monthly rainfall total depths against the long-term average rainfall in the location of Berkhamsted over the period taken from the *Environment Agency Water Situation Report August 2021*<sup>1</sup>

The graph indicates that monthly rainfall at times in the last year have on occasions significantly exceeded long-term averages, this was especially notable in the winter period and in October when Storm Alex occurred.

Figure 3 shows the location of the British Geological Survey (BGS) monitoring borehole at Ashley Green, which has been recording groundwater levels since 1961. Figures 4 and 5 show river levels in the River Bulbourne at Hemel Hempstead (the closest river gauging station to Berkhamsted) which provide a good indicator of the local groundwater levels over time. Figure 6 and 7 show the last two and 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 the exceptionally high range.

<sup>1</sup>(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](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1016481/Thames_Water_Situation_Report_August_2021.pdf)



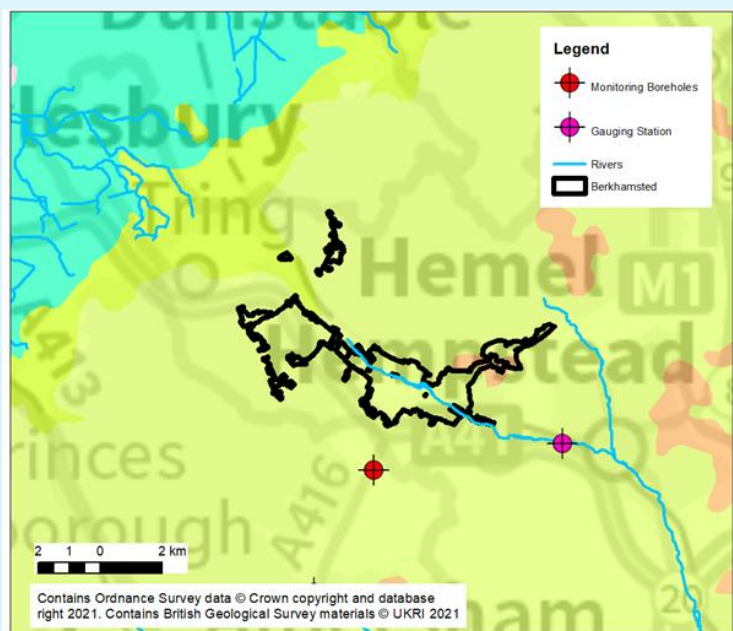


Figure 3 – Location of Ashley Green Monitoring Borehole Relative to Berkhamsted

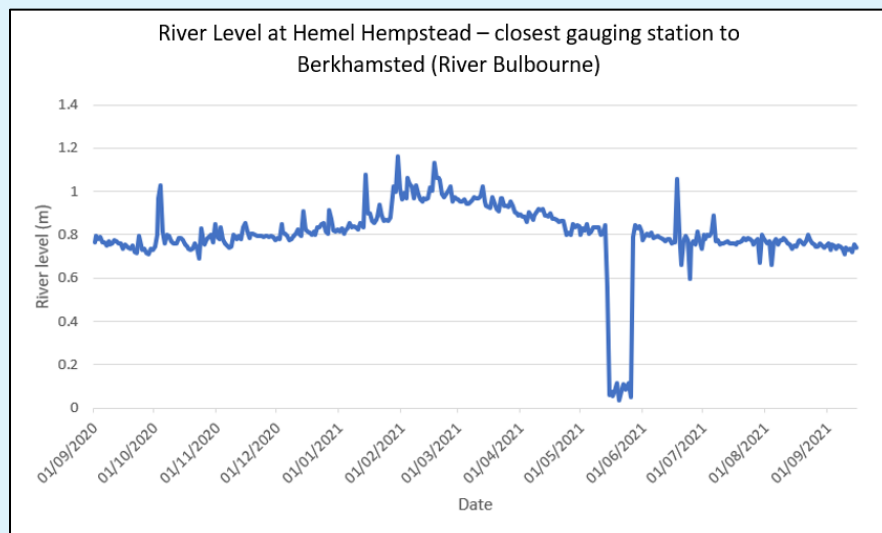


Figure 4 – 2020-2021 River levels at Hemel Hempstead (closest gauging station to Berkhamsted) - River Levels UK (riverlevels.uk)

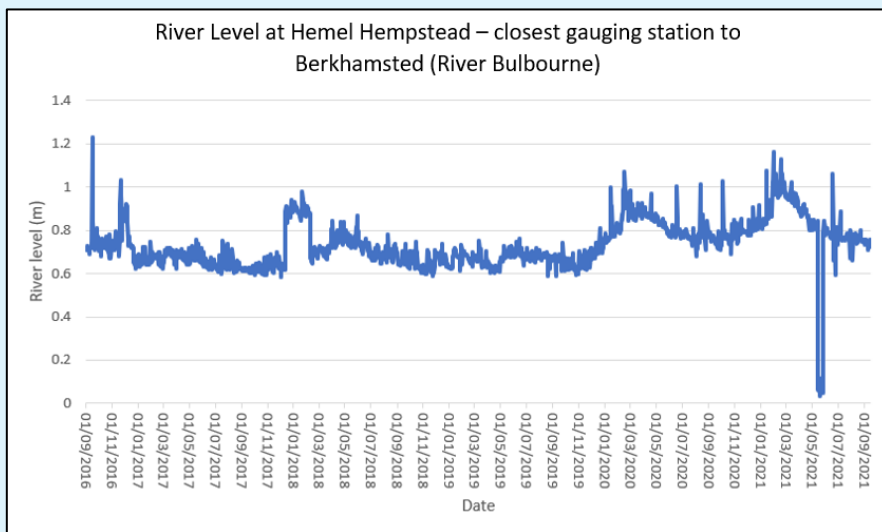


Figure 5 – 2016-2021 River levels at Hemel Hempstead (closest gauging station to Berkhamsted) - River Levels UK (riverlevels.uk)

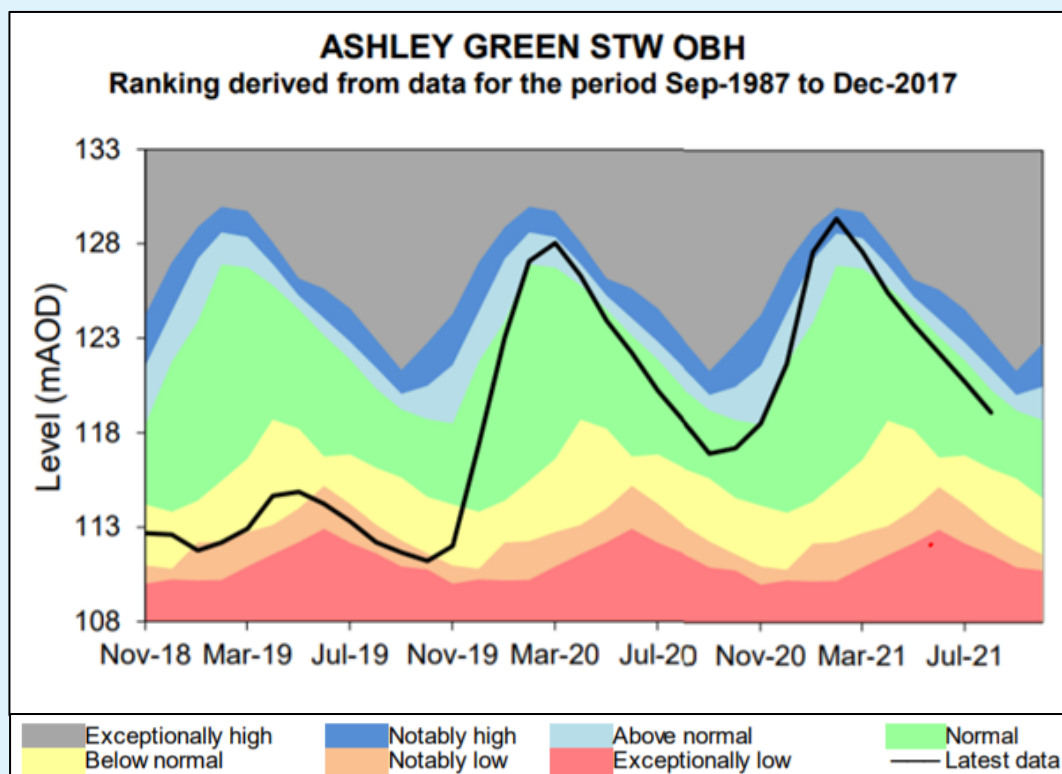


Figure 6 – 2018-2021 Groundwater levels at Ashley Green. (*Environment Agency Water Situation Report August 2021*)

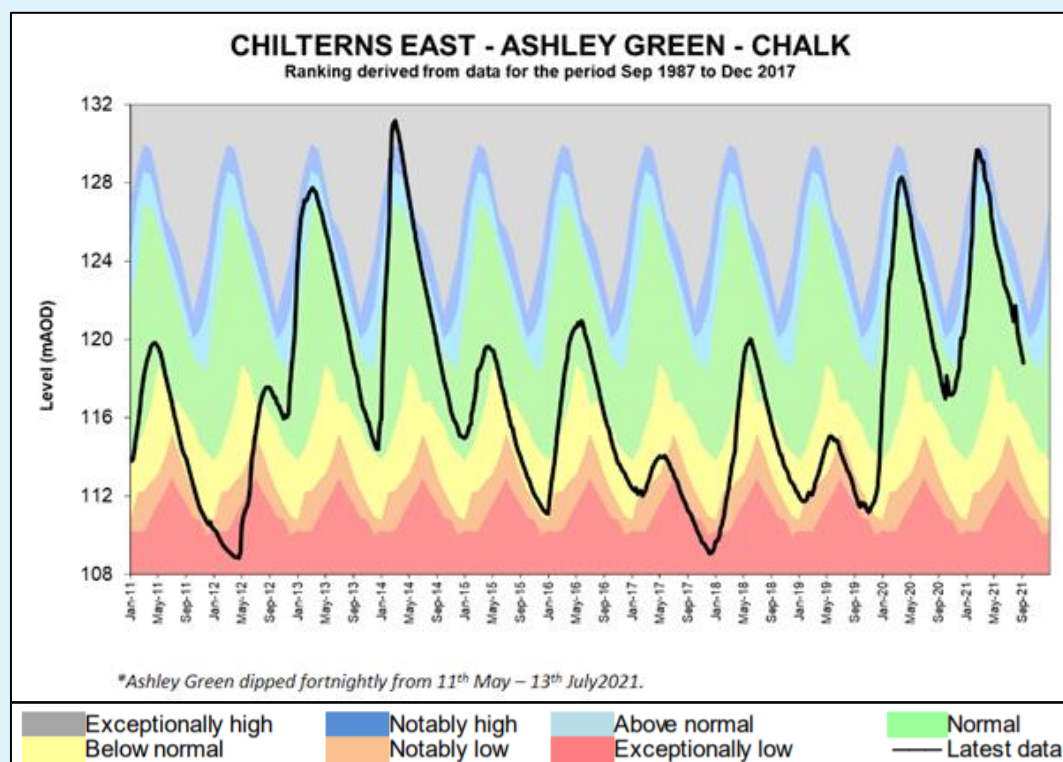


Figure 7 – 2011-2021 Groundwater levels at Ashley Green. (*Environment Agency Water Situation Report August 2021*)

# 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 work in period

Activities	Value	Comment
Sewer Lining Length (m)	100m	Surveys in 2020 identified a number of manholes and sewer locations that required priority remediation. Funding to remediate these is approved and works are due to be started in early October 2021.
Infiltration Points Targeted (no.)	19	
Manhole Sealing (no.)	8	

## Future Works

Activity	Planned work in 2021/22	Known follow On Work
Survey	Further surveys are to be carried out over the 2021/22 winter period as groundwater levels allow.	To be confirmed
Sewer Lining	To be confirmed based upon 2021/22 surveys.	To be confirmed
Manhole Sealing – Infiltration Ingress	To be confirmed based upon 2021/22 surveys.	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 AMP7 current investment plan, we have projects to increase the flow to full treatment at Berkhamsted 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 31/03/2023.	

# 2020-21 Infiltration Review

This section looks at the impact of infiltration in Berkhamsted over the period

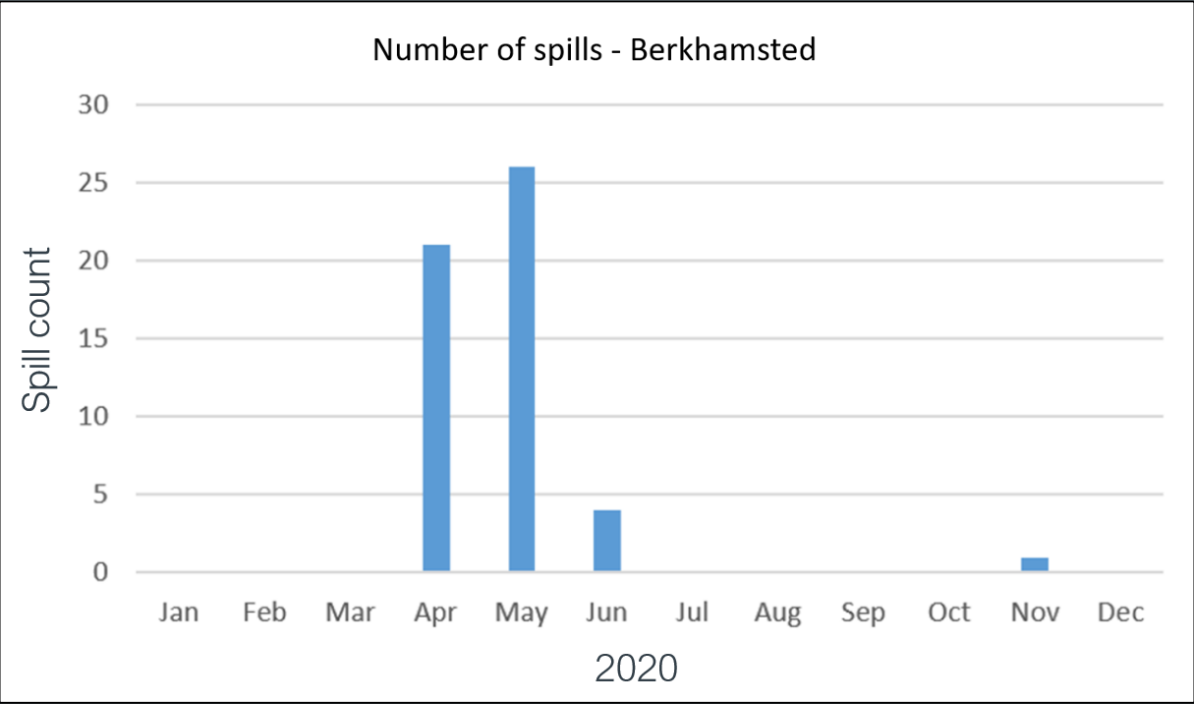


Figure 8 – Number of spills (discharge count) at Berkhamsted STW (taken from Event Duration Monitor (EDM) Data\*).

Figure 8 shows the number spills per month from Berkhamsted Sewage Treatment Works (STW). April and May experienced the greatest number of spills. There is a lag between high rainfall and high flows in the Berkhamsted system that arrive at the STW. We are still investigating this lag between groundwater level and spills, it may be indicative of a combination of surface water and groundwater combining to trigger problems as opposed to one of the other mechanism being more dominant.

Impacts of groundwater infiltration in the Berkhamsted system in this period were seen at the STW, there were no performance impacts in the network. Annual spill count exceeds the Sewer Overflow Assessment Framework (SOAF) trigger of 40 hence this system is being picked up for additional analysis in relation to spills. We would look to combine the work of the GISMP with the SOAF investigations.

\*2020 verified and audited EDM data. 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 chalk aquifer beneath Berkhamsted notably high for long periods. The impact of groundwater on the discharges at the Sewerage Treatment works as shown by the Event Duration Monitoring data is evident indicates a lag that requires further investigation.

Spill frequency at Berkhamsted have exceeded the Sewer Overflow Assessment Framework (SOAF) trigger of 40 spills per annum, although this is normally applied on a 3 year rolling basis. However, investigations into what is triggering the spills is underway and the investigations as part of the SOAF work and the GISMPs will be looked at collectively to gain the greatest insight into the performance of the system.

A review of the runtimes of the pumping stations in the catchment, which are located around the periphery of the catchment, identified that they did not experience infiltration issues this winter, indicating that infiltration most likely arises from Berkhamsted town and not the surrounding villages. This correlates well with the infiltration potential mapping carried out by JBA in the original GISMP report.

Surveys carried out to date have identified a number of manholes and sewers that require priority remediation. On-site works are due to start in October 2021 at these locations.

Lift and look and CCTV surveys will continue throughout the remaining wet periods within this AM7 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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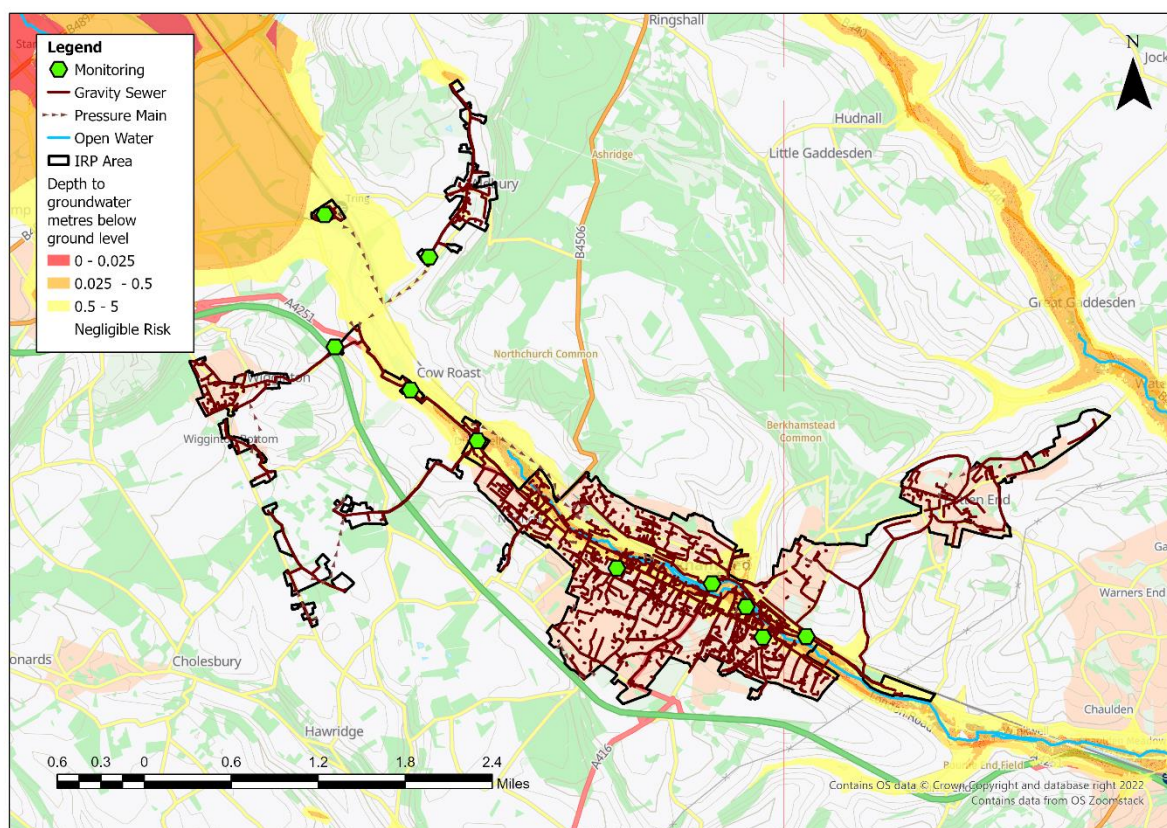


## Overview

This addendum to the Berkhamsted 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 – Berkhamsted Monitoring Plan



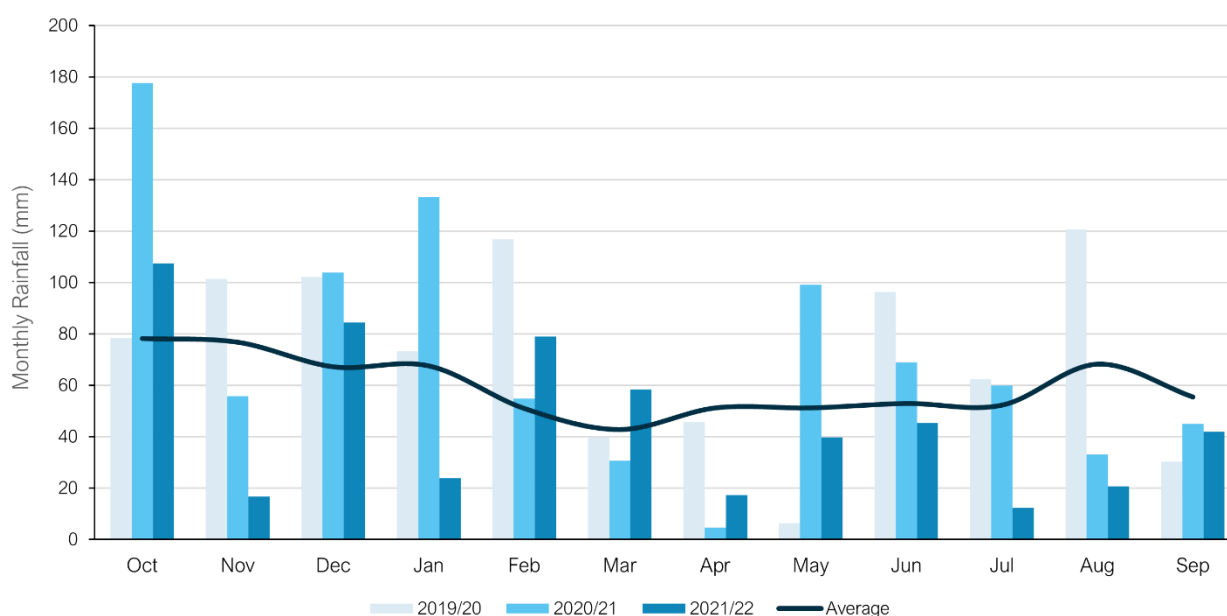
## Hydrological Review – 2021-2022

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

The total rainfall for the 2021/22 hydrological year is 22% 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)
715	874	867	555

## Groundwater / Local River Level

The Berkhamsted catchment is situated in the Chilterns – East – Colne water resources areas. It principally sits in the Holywell Nodular Chalk Formation of sedimentary bedrock and is designated principal aquifers within the UK.

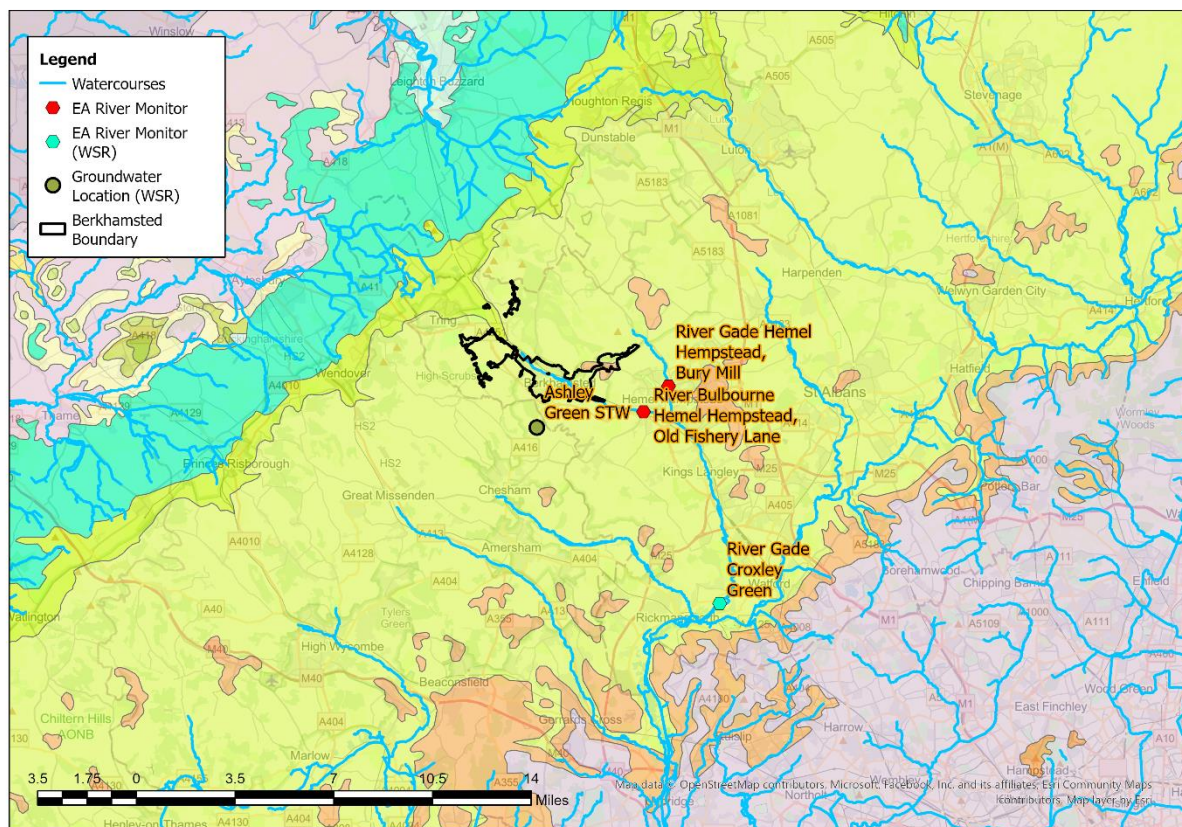
The Environment Agency has gauging stations on local watercourses measuring stage and observation boreholes measuring groundwater levels locally to the catchment which can be used to provide indicative local groundwater performance.

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

- River Bulbourne, Hemel Hempstead, Old Fishery Lane
- River Gade, Hemel Hempstead, Bury Mill

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 Bulbourne, Hemel Hempstead, Old Fishery Lane

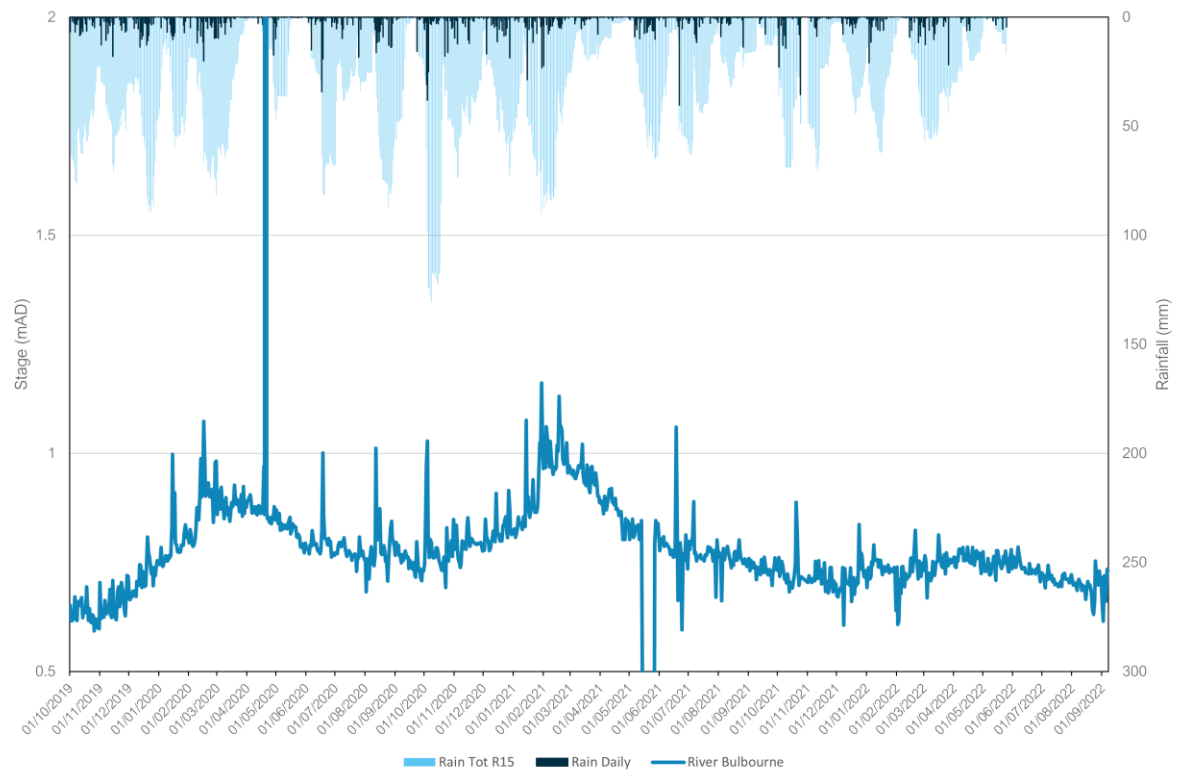
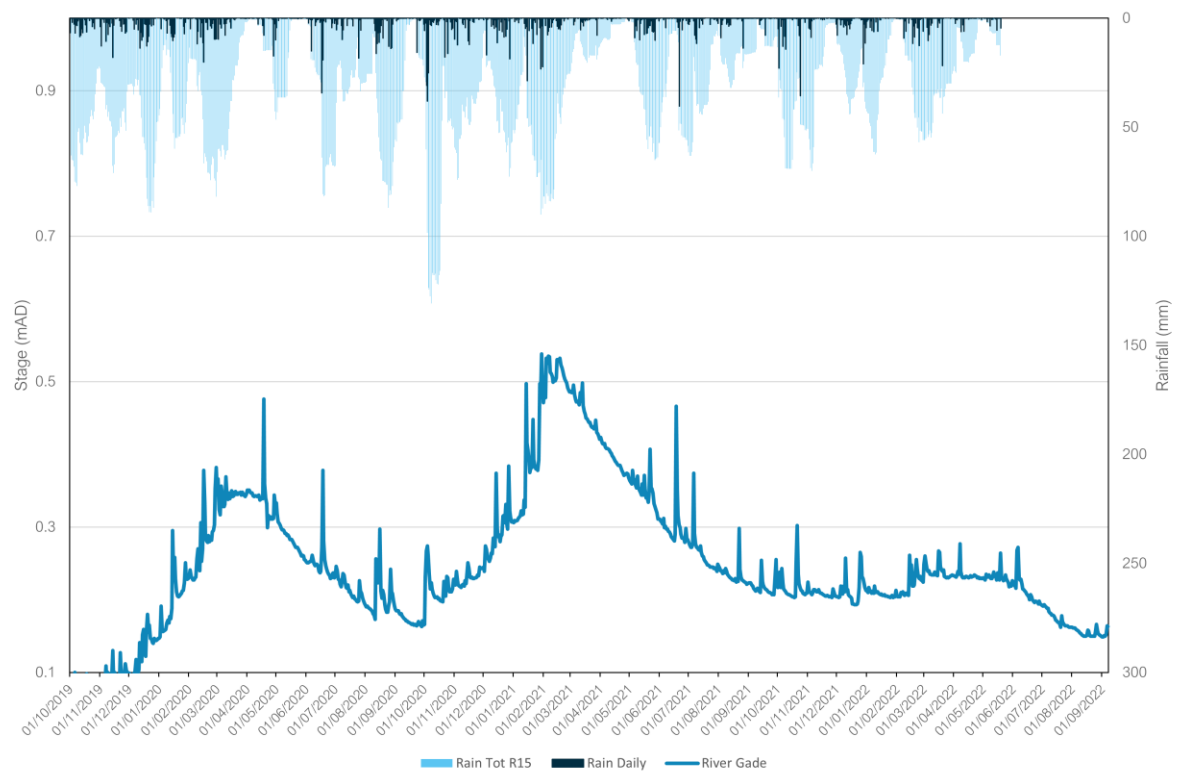
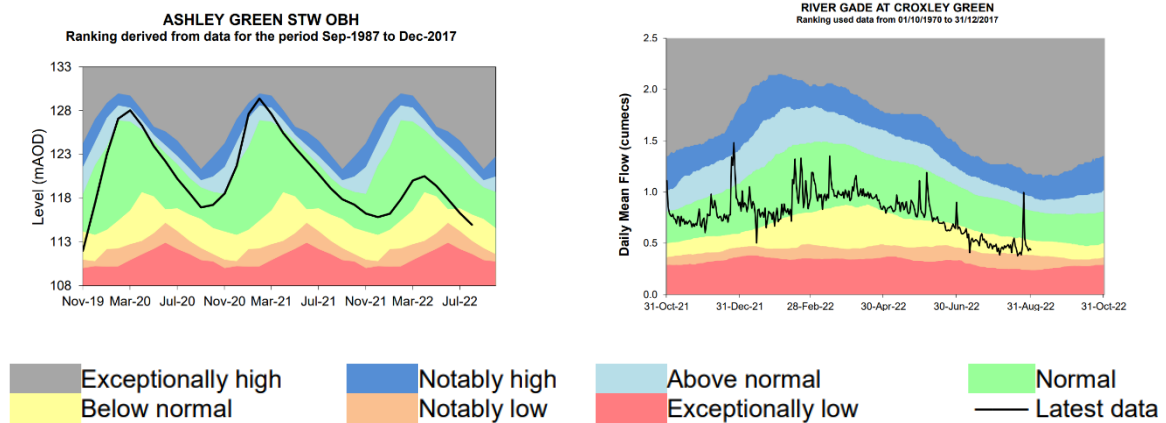


Figure 5B – River Gade, Hemel Hempstead, Bury Mill



In addition to these specific stations, the wider groundwater context is illustrated in the Water Situation Report for Chilterns – East – Colne. The nearest groundwater reference station is Ashley Green STW. This site shows lower overall groundwater than the previous year. This can be seen in the figure below alongside the river indicator Croxley Green on the River Gade.

Figure 6 – Water Situation Report



Extract from - [Water Situation Report \(publishing.service.gov.uk\)](https://publishing.service.gov.uk)

## Network Performance

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

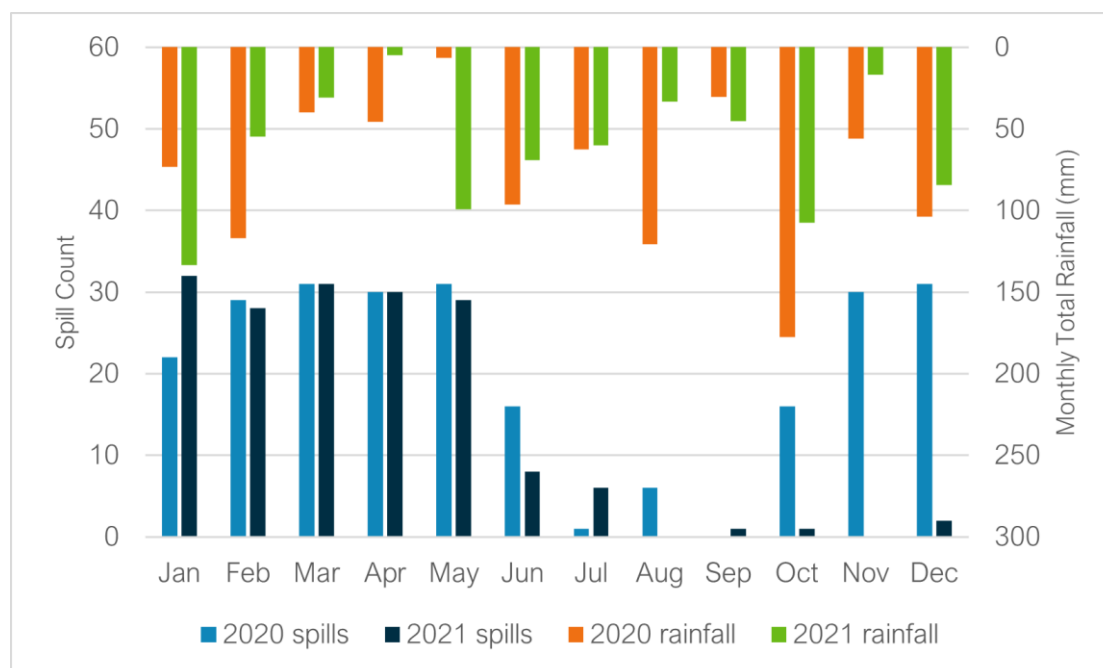
Table 7 below details the last 2 years performance of overflows within the catchment.

Table 7 – Event Duration Monitoring

Overflow	2020		2021	
	Spills	Duration (hours)	Spills	Duration (hours)
Berkhamsted STW	243	861.46	168	3770.12

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. Note a spill frequency of 243 is stated for 2020, which is higher than the published spill count of 52. The data has been revalidated/ corrected and the revised spill count of 243 will be included in re-submission to the EA. Figure 8 below presents the EDM performance trend and rainfall for recent years.

Figure 8 – EDM Monthly Performance



The data suggests a wider relationship between groundwater/river level, rainfall, and network performance. Despite broadly similar rainfall, significantly more spills were recorded at Berkhamsted STW in December 2020, compared to December 2021. The indicator sites suggest groundwater levels in the catchment were higher in December 2020.



## Investigations & Interventions

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

### Monitor Installations

The sewer depth monitor (SDM) programme supports long term groundwater understanding within GISMP catchments. Currently, there are a total of 11 monitors installed within the Berkhamsted 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 Berkhamsted 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	N/A
Look and lift survey	N/A
Sewer lining	104 meters
Patch lining	N/A
Manhole sealing	3 manholes
Manhole sealing plates	N/A
Manhole covers and frames replaced	N/A

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 Berkhamsted catchment over the 2021/22 hydrological year has been below average, with groundwater levels in the aquifer beneath Berkhamsted not reaching the levels seen in previous years which triggered groundwater ingress into the sewerage network and elevated flow/depth readings at monitoring sites. This is indicated by the fact only 2 EDM spills were recorded at Berkhamsted STW in December 2021, compared to over 30 in December 2020, when the indicator sites suggest groundwater levels in the catchments were higher.

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

# Addendum - Annual Update 2023

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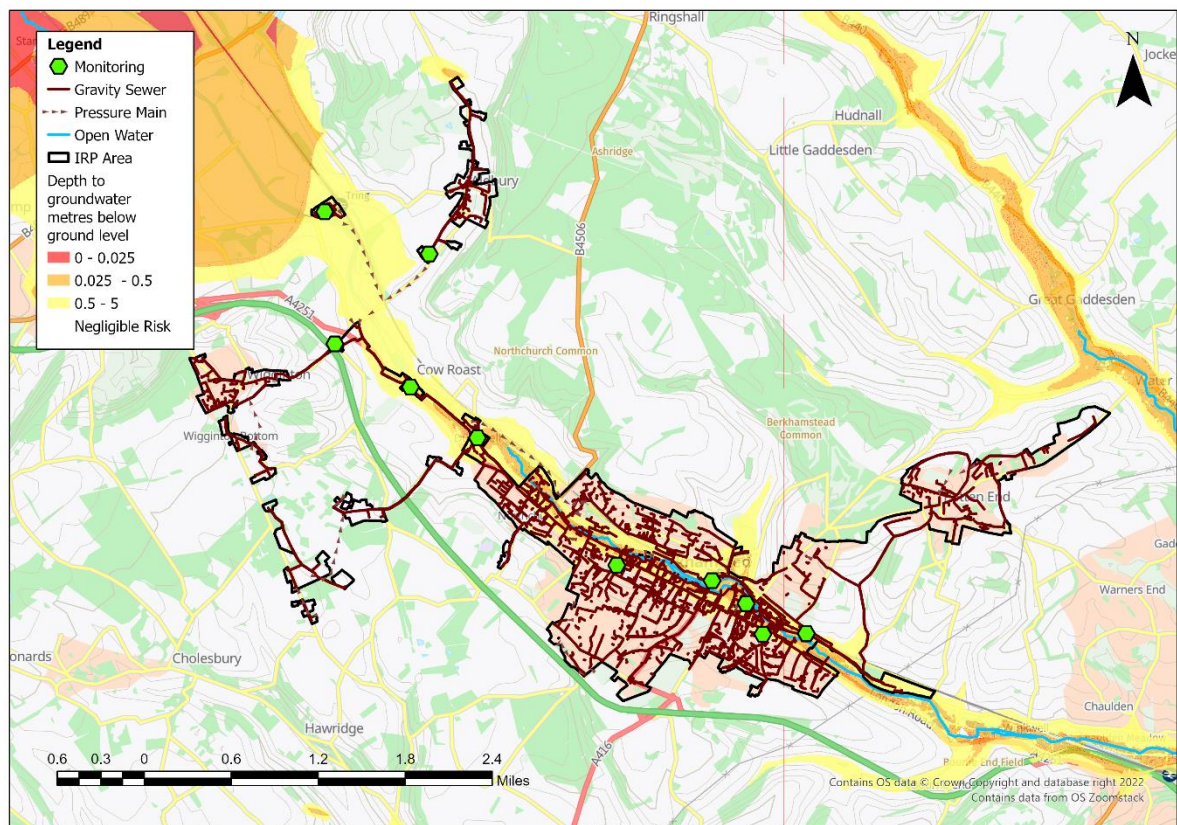
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## Overview

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

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

Figure 1 – Berkhamsted Monitoring Plan



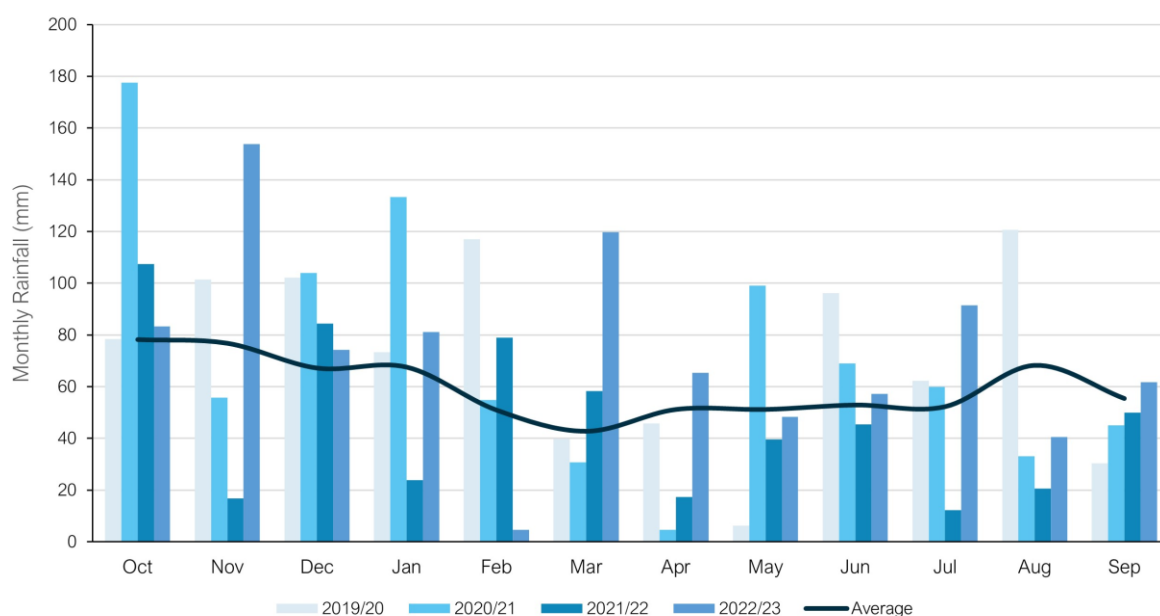
## Hydrological Review – 2022-2023

This section summarises the hydrological conditions across the Berkhamsted catchment within the period under investigation and provides comparison against the 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 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 Rothamsted 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)
715	874	867	555	882



## Groundwater / Local River Level

The Berkhamsted catchment is situated in the Chilterns – East – Colne water resources area. It principally sits in the Holywell Nodular Chalk Formation of sedimentary bedrock and 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 Bulbourne, Hemel Hempstead, Old Fishery Lane
- River Gade, Hemel Hempstead, Bury Mill

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

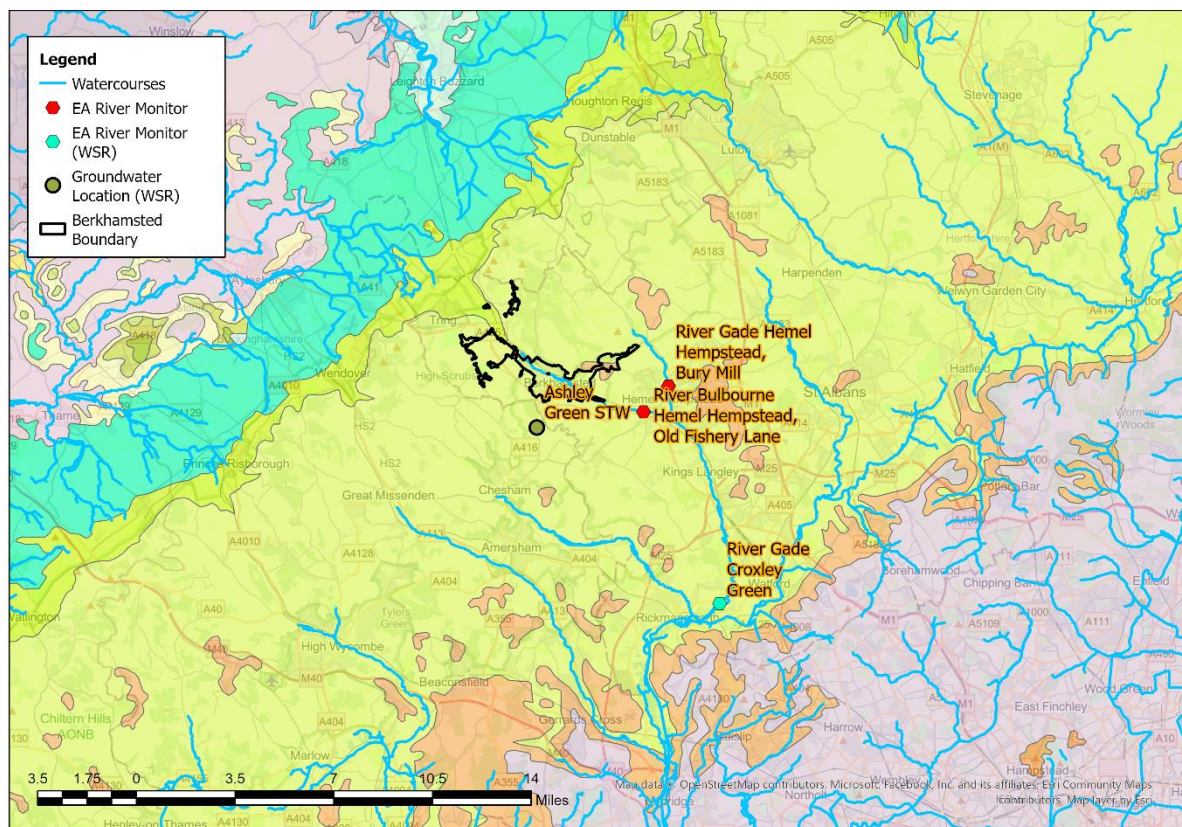




Figure 5A – River Bulbourne, Hemel Hempstead, Old Fishery Lane

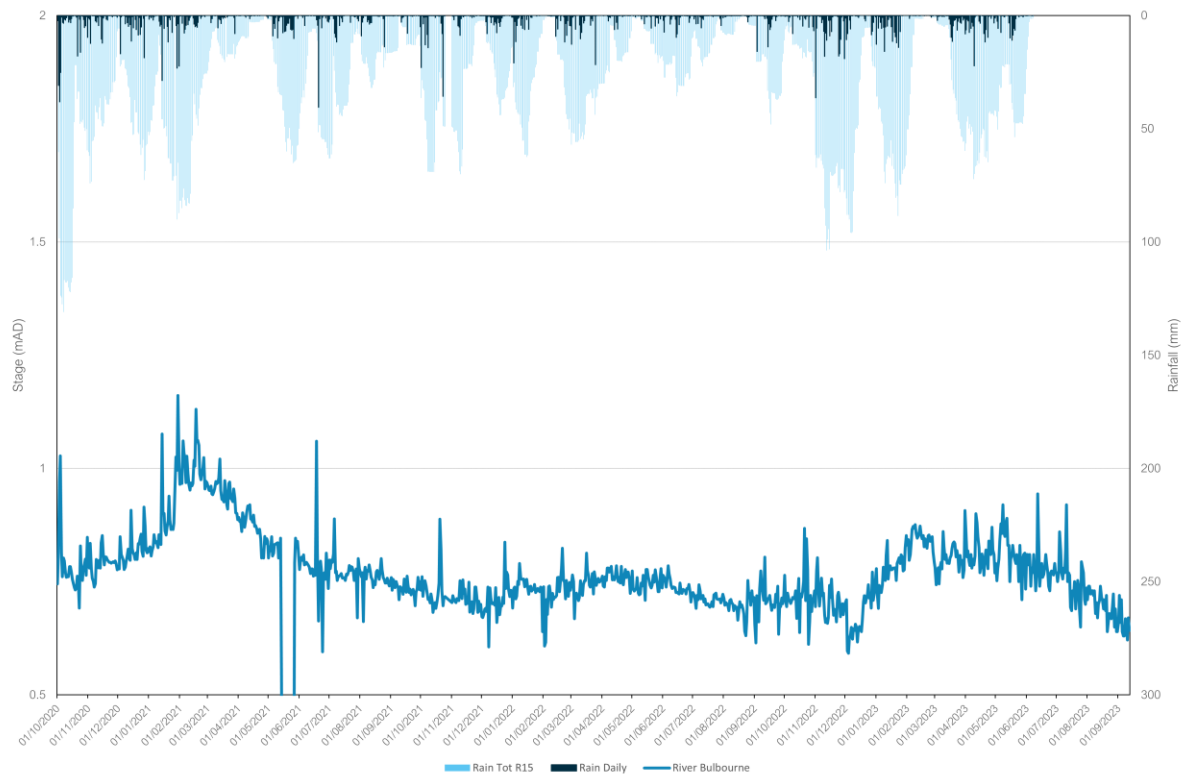
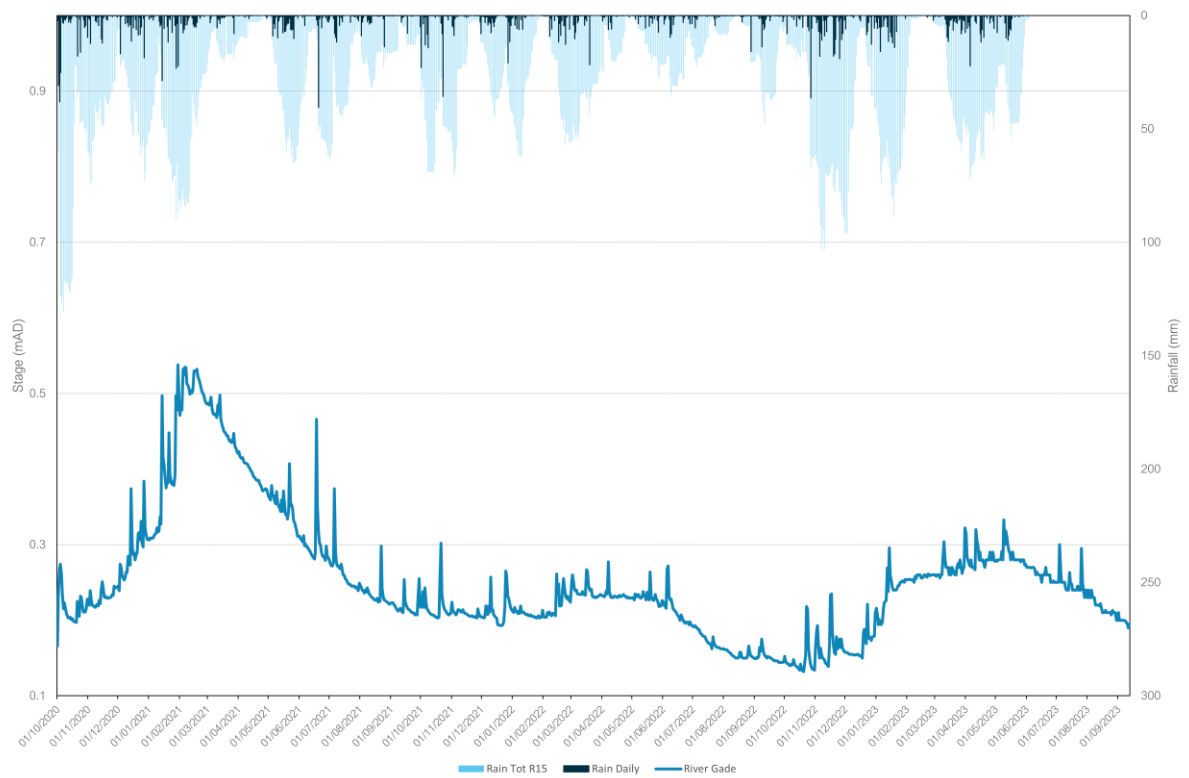
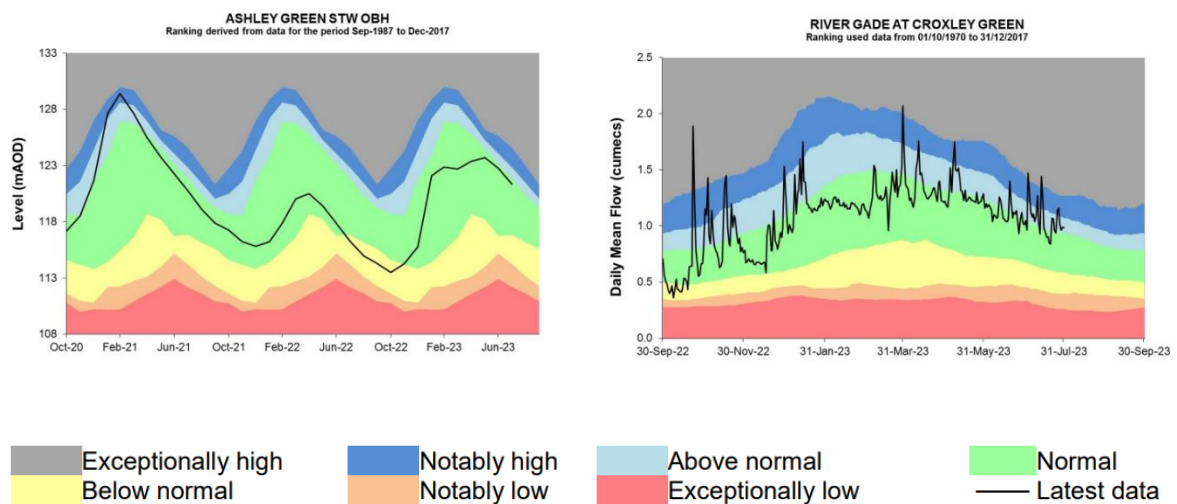


Figure 5B – River Gade, Hemel Hempstead, Bury Mill



In addition to these specific stations, the wider groundwater context is illustrated in the Water Situation Report for Chilterns – East – Colne. The nearest groundwater reference station is Ashley Green STW. This site shows groundwater levels at normal or below normal levels throughout 2022. The groundwater levels for the months from February to June 2023 are higher compared to the same period in 2022. This can be seen in the figure below alongside the river indicator located at Croxley Green on the River Gade.

Figure 6 – Water Situation Report



Extract from - [Water Situation Report \(publishing.service.gov.uk\)](https://publishing.service.gov.uk)

## Network Performance

Within the Berkhamsted catchment there are two sites detailed within the Environment Agency Consents Database which have an Event Duration Monitor (EDM) fitted. As part of the process of matching GISMP catchments to EDM sites, an additional EDM site has been identified in the Berkhamsted catchment, which was not included in last year's addendum report. No spills were recorded at the additional overflow site – Trumps Green – in 2022 or in 2021.

Table 7 below details the last 2 years performance of overflow 'Berkhamsted STW'.

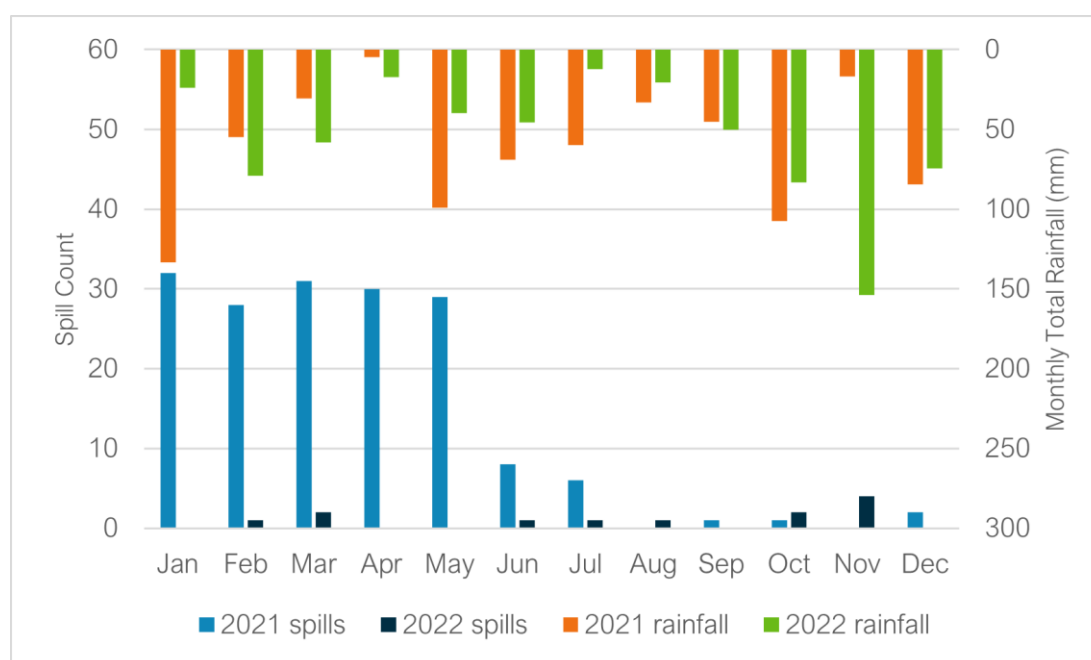
Table 7 – Event Duration Monitoring

Overflow	2021		2022	
	Spills	Duration (hours)	Spills	Duration (hours)
Berkhamsted STW	168	3770.12	12	63.72

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 data suggests a wider relationship between rainfall, elevated groundwater levels, and spill frequency. Significantly more spills were recorded at Berkhamsted STW between the months of January to June 2021, compared to the same period in 2022. The indicator site data shown in Figure 5, suggests groundwater levels in the catchment were higher January – June 2021, compared to the same period in 2022. Only 12 spills were recorded in the year 2022, compared to 168 in 2021, with Figure 6 suggesting groundwater levels in the catchment were at normal or below normal levels throughout 2022.

## Investigations & Interventions

This section details the activities that have been undertaken across 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 Berkhamsted 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 Berkhamsted catchment in the 2022-23 Hydrological Year, as well as works undertaken in the 2021-22 Hydrological Year.

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

Investigation/ remediation type	Number/ length undertaken 21/22	Number/ length undertaken 22/23
CCTV survey	N/A	N/A
Look and lift survey	N/A	N/A
Sewer lining	104 metres	N/A
Patch lining	N/A	N/A
Manhole sealing	3 manholes	N/A
Manhole sealing plates	N/A	N/A
Manhole covers and frames replaced	N/A	N/A

No interventions/ investigations were carried out in the catchment in the 2022/23 Hydrological Year. A level of 0.85 mAD has been assigned to the Hemel Hempstead – Old Fishery Lane indicator site, to indicate when high levels of groundwater infiltration into the network are likely to be occurring. This level was only exceeded for brief periods during the winter 2022/23 period, providing limited opportunity for investigations to be carried out. The system will continue to be monitored and investigations/ interventions carried out as appropriate and when conditions allow.

Berkhamsted STW is being upgraded at a cost of more than £25 million. This work will provide a major increase in treatment capacity, reducing the need for untreated discharges to the environment, and ensure a higher quality of treated effluent going to the river. The projects are expected to complete in 2023 and in 2024.

## Summary

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

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



It's everyone's water