



Groundwater Impacted System Management Plan

Bentley, River Wey

April 2021



It's everyone's water

Version control

| Version | Date | Amendment | Author | Checked | Reviewed |
|--------------------|--------------|--|--------|---------|----------|
| 1-d1 | March 2021 | Draft for EA | DJ | SE | APH |
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| 1-V2 | July 2021 | Update to introductory text and infiltration potential figures | DJ | APH | JO |
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| Annual Update 2022 | October 2022 | Addition of Annual Update 2022 | MB/JH | DJ | DJ |
| Annual Update 2023 | October 2023 | Addition of Annual Update 2023 | MB | DJ | DJ |
| Annual Update 2024 | October 2024 | Addition of Annual Update 2024 | CW/MW | 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 significant likely leading to the sewerage system, on occasions, to become overwhelmed.

All sewerage systems combined and separate will experience some groundwater infiltration¹ 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 possible². 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 & fix' approach to date lacks a degree of certainty of resolution and for this reason Thames Water in 2020 undertook a different approach for 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 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 the Bentley system

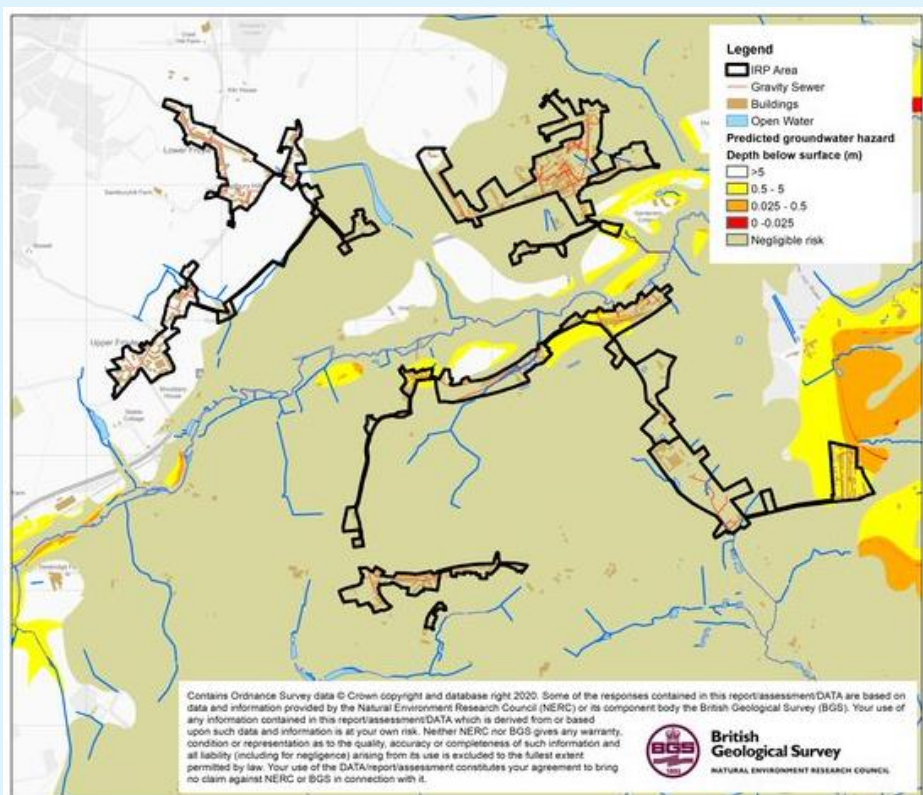


Figure 1.0 – Bentley catchment

The Bentley system lies on the River Wey, in Hampshire, England, approximately 5km south west of Farnham. The Bentley system serves a population equivalent³ of 2689 with a predominantly separate sewerage network totaling some 33km in length excluding private drains and sewers. The extent of the catchment is shown in Figure 1.0 above and includes the villages of Bentley, Bentley Station, Upper and Lower Froyle, Isington and Binsted.

Problem characterisation

The foul sewerage system in Bentley has become overwhelmed, in some locations for weeks at a time, in recent years following prolonged heavy rainfall, resulting in the Sewage Treatment Works (STW) at times struggling to manage the flows. We believe that the system has become overwhelmed because of a combination of groundwater infiltration into public sewers and private drainage, surface water runoff from saturated

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

fields and surface water misconnections into the foul sewage system (such as down pipes from roofs), and also that flood water from the River Wey and other local surface water drainage systems may also have entered sewers through manholes.

The sewerage system is identified on the public sewer records as being a separate foul system, rather than a combined system. It should therefore, in theory, only be accepting foul drainage rather than a combination of foul and surface water, however, there are almost no areas in the system with public surface water sewers. Pumping station run time data sets indicate evidence of groundwater infiltration in the network but also high storm responsiveness indicating surface water connections upstream.

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.

In recent winters the problems associated with groundwater infiltration have been predominately at the sewage treatment works, with no known escapes from manholes in the network being reported or instances of restricted toilet use as a result of surcharged sewers.

A number of our sewerage systems include for permitted 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.

Our permit conditions for Bentley 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 snow melt”

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 Hampshire County Council as Lead Local Flood Authority, County Council and East Hampshire District Council as 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).

On occasions, in sustained wet periods, the storm treatment area has become full and spills to watercourses have occurred.

Anticipated unavoidable discharges

Within recent years there have been unavoidable sewage escapes in the network as a result of surcharging manholes causing pollution incident.

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

No mitigation in the form of temporary overflows has been undertaken in this system.

General outline plan & timescale

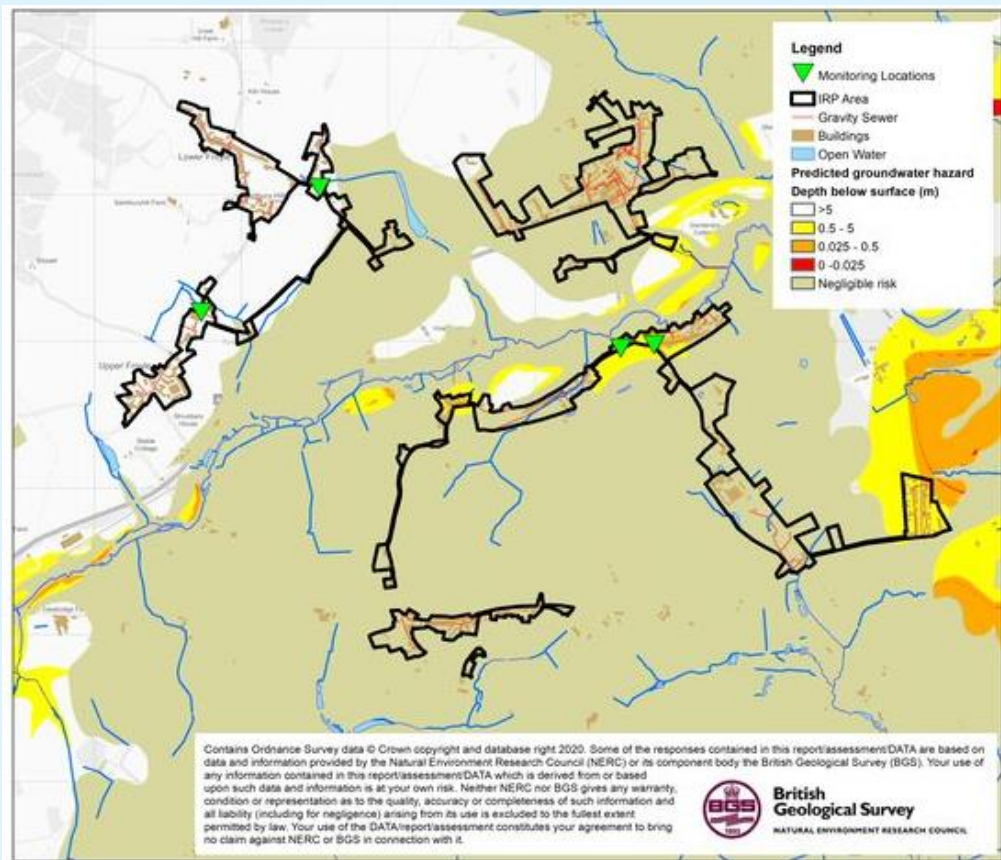


Figure 2.0 – Bentley monitoring and infiltration zones

Key to bringing the impact of groundwater infiltration under control is an enhanced monitoring regime. We have identified and have installed several telemetered depth monitor locations around the Bentley 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 Bentley 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 wholly⁴ of the high risk zones, 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.

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 Bentley.

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 | JBA have been engaged to undertake modelling activities to identify the areas to be targeted for sealing in the 56 systems in the Thames Water region identified as being impacted by infiltration. |
| Install monitors | 2020-2023 | Further 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 Decisions regarding the extent of sealing will be based on outcomes of works undertaken to date, result of monitoring and successful submission of our plans for 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 / Price review | 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. |

Bentley Infiltration Management Plan

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

As part of our current investment plan, we have projects to increase the storm capacity at Bentley STW. This work is programmed to be completed by 31/03/2025.

In the intervening period we also 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.

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

High level approach statement

For the system 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 effective⁵ 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 aid 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 further 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.

We will also review any results of Winter 2019/20 and 2020/21 with historic data to build up evidence to support interventions in the network (Summer/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. 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 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 any work undertaken is included in the appendix to this report.

Monitoring

Further Sewer Depth Monitors were 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.

These units 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 (manholes) points on the network, make use of pumps to manage flows or deploy settlement tanks to part treat sewage before release to the environment.

We do not envisage needing to undertake mitigation work as described above in the network in the Bentley system apart from tinkering where necessary.

Updates

Work on the Groundwater infiltration management plan will continue, and we will provide updates in October 2022 and annually in October thereafter.

Appendix

Groundwater infiltration potential analysis

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 | 0.9 | 4 |
| Medium | Predicted groundwater extreme 0-1m above pipe invert | 0.6 | 3 |
| Low | Predicted groundwater extreme 0-1m below pipe invert | 1.5 | 7 |
| Very Low | Predicted groundwater extreme >1m below pipe invert | 19.6 | 86 |
| Total | | 22.7 ⁶ | 100 |

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

Manholes by Surface Water Inundation Risk Category

| Risk category | Description | Number | Percentage |
|---------------|--|--------|------------|
| High | Inundation risk in 3.3% AEP fluvial or pluvial event | 19 | 4 |
| Medium | Inundation risk in 1% AEP fluvial or pluvial event | 15 | 3 |
| Low | Inundation risk in 0.1% AEP fluvial or pluvial event | 74 | 15 |
| Very Low | All other manholes | 371 | 78 |
| Total | | 479 | 100 |

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

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

Lift and Look and CCTV surveys have not yet commenced in the Bentley System. Our next update to the plan will include information on our progress in these areas.

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 2022

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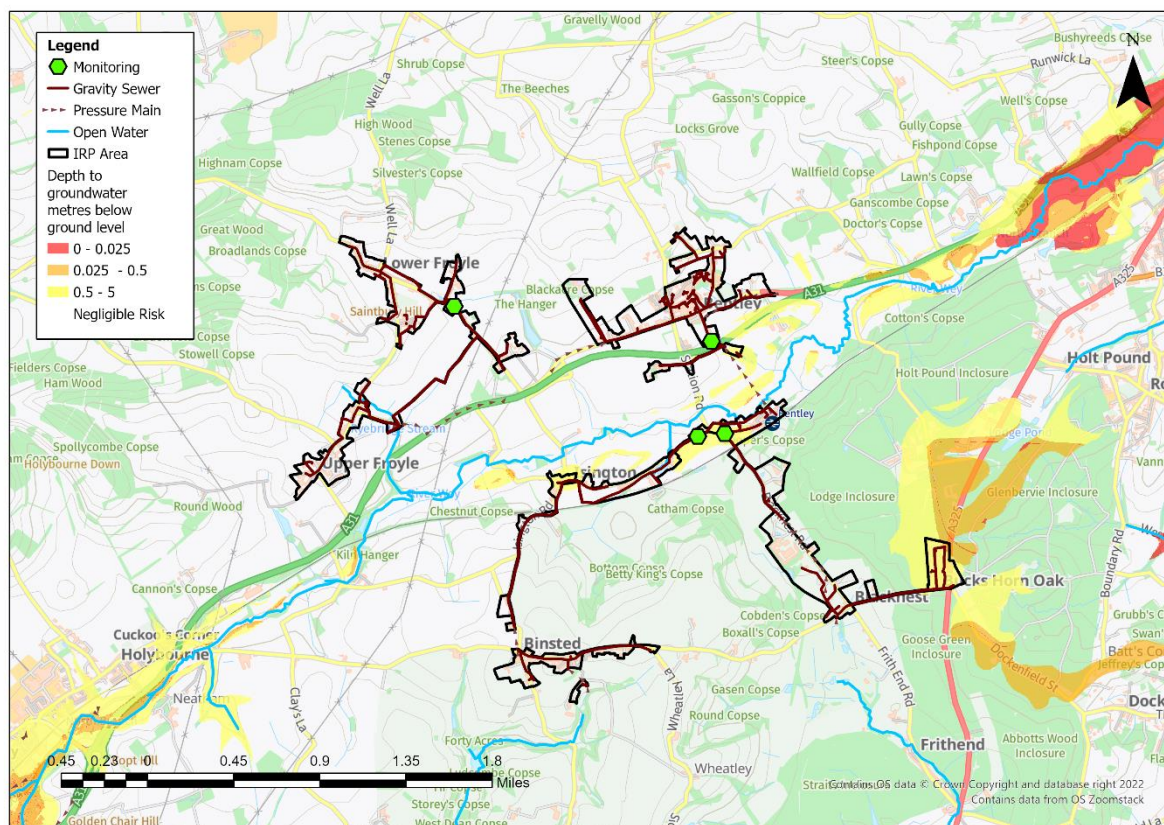
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Overview

This addendum to the Bentley 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 – Bentley Monitoring Plan



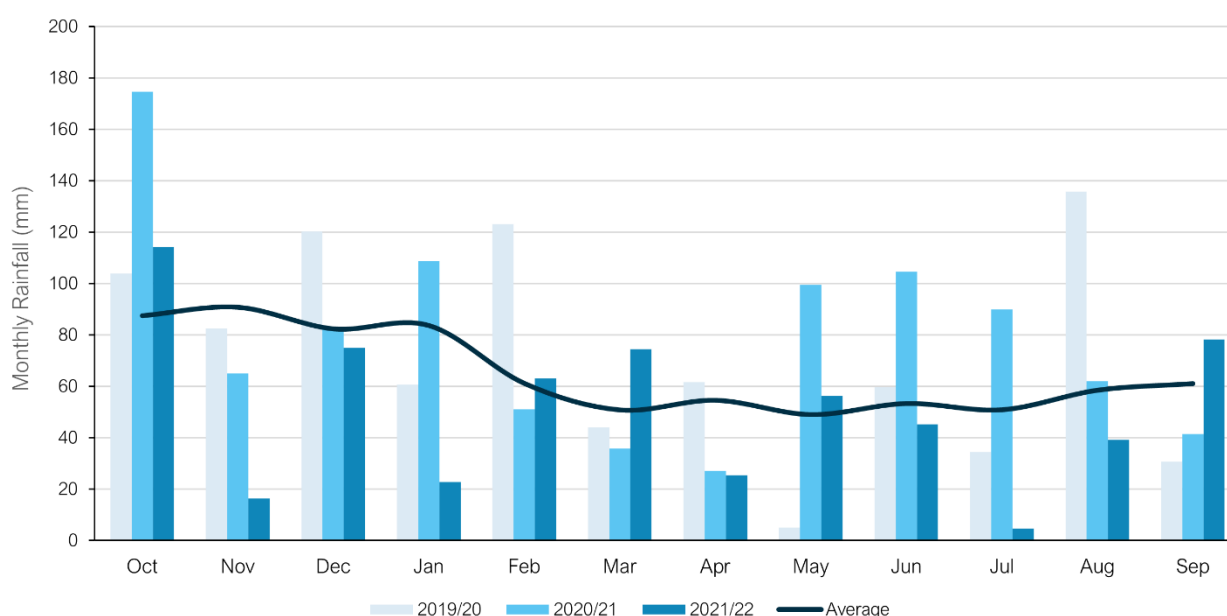
Hydrological Review – 2021-2022

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

The total rainfall for the 2021/22 hydrological year is 21% 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) |
|--------------|--------------|--------------|--------------|
| 783 | 862 | 943 | 620 |

Groundwater / Local River Level

The Bentley catchment is situated in the Wey – Greensand and North Downs – Hampshire water resources areas. It sits in the Gault Formation of mudstone and Upper Greensand Formation of calcareous sandstone and siltstone. The Upper Greensand formation 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 Wey, Farnham.
- River Wey, Kings Pond.

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

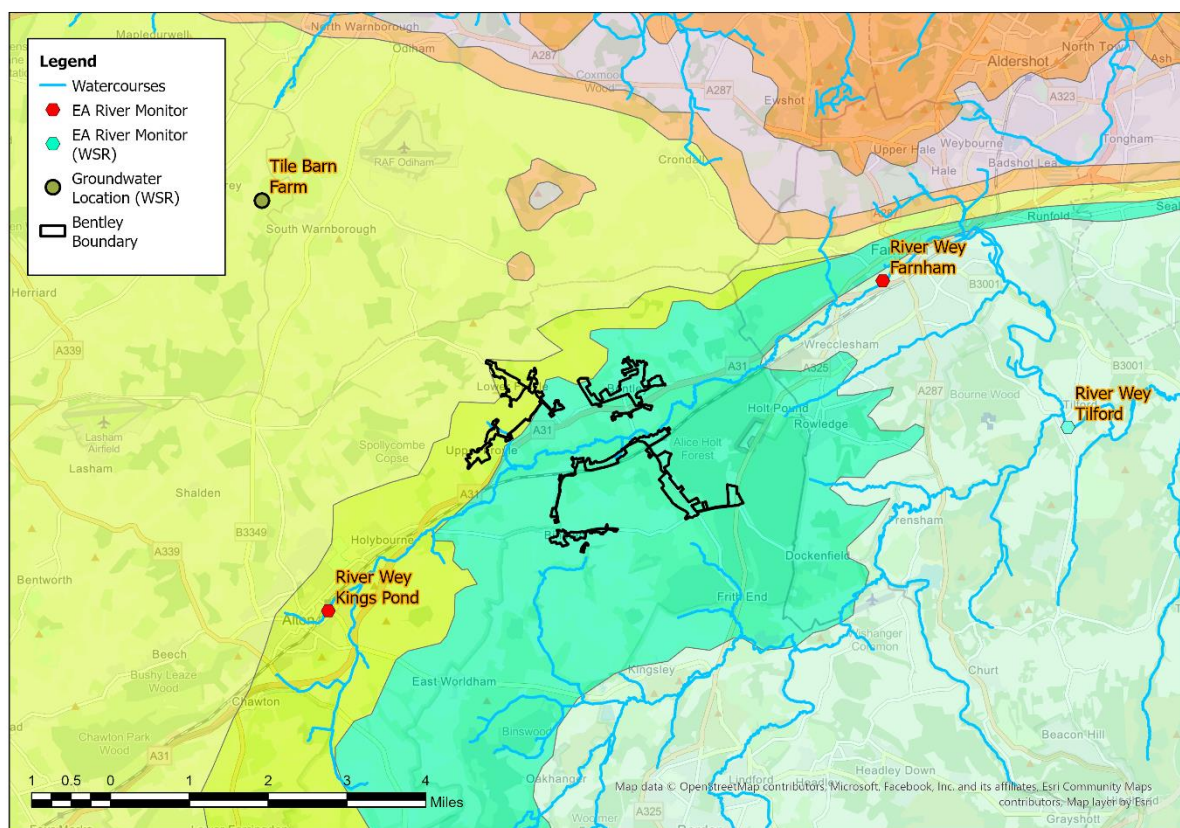


Figure 5A – River Wey, Franham

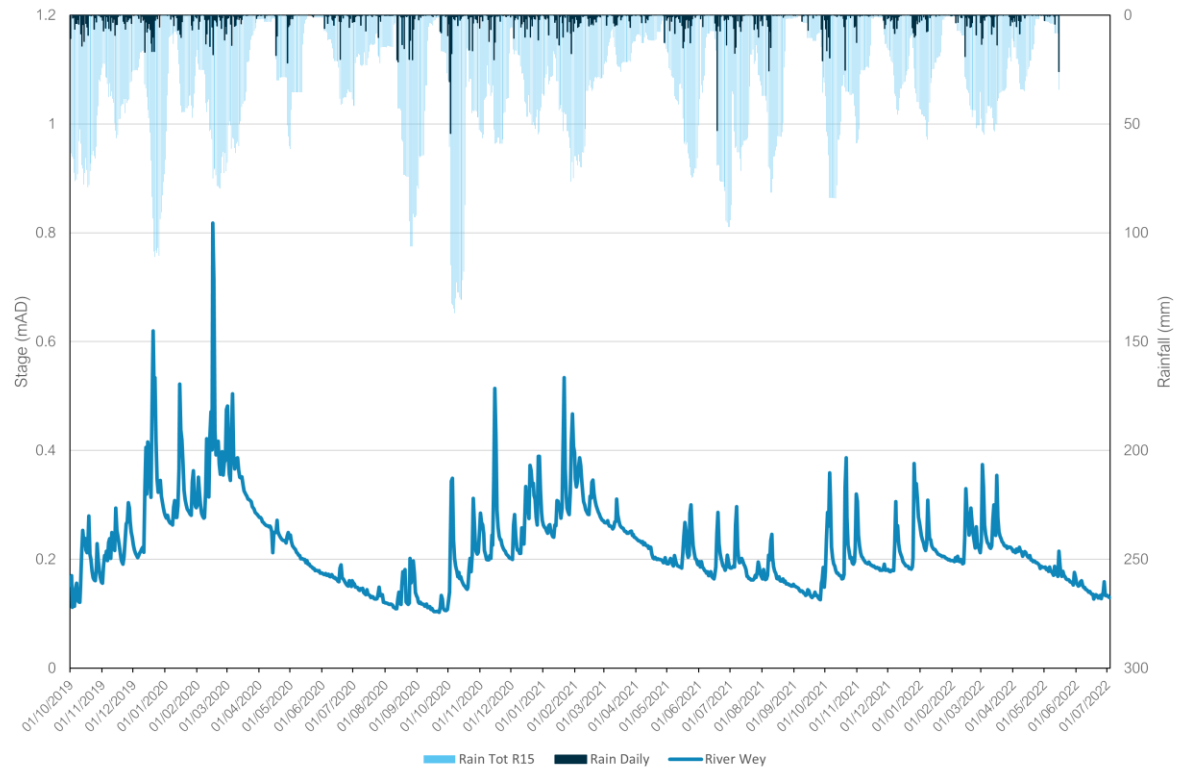
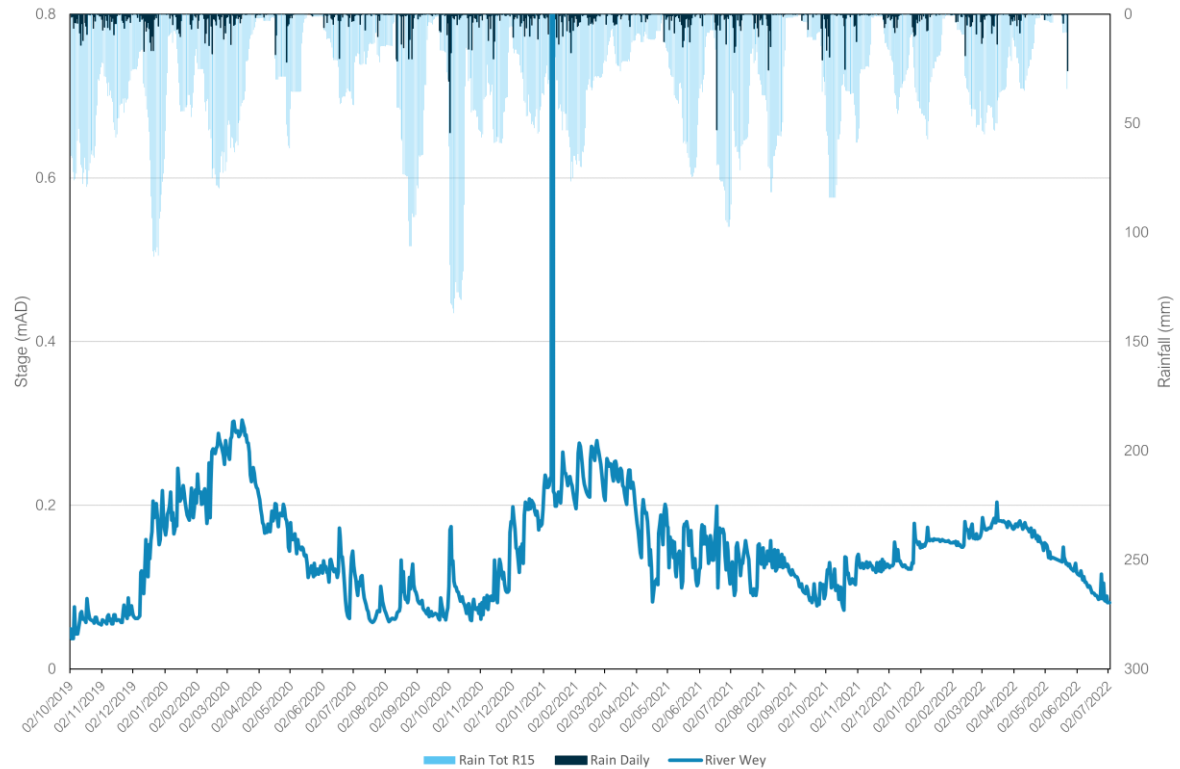
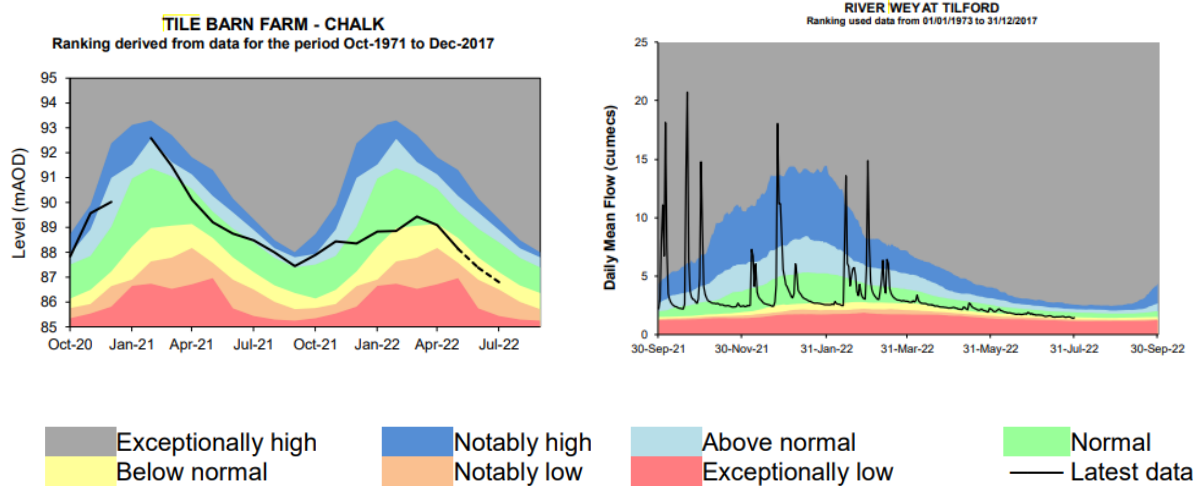


Figure 5B – River Wey, Kings Pond



In addition to this specific station, the wider groundwater context is illustrated in the Water Situation Report for Wey - Greensand. The nearest groundwater reference station is Tile Barn Farm. 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 Tilford on the River Wey. Note recent groundwater levels at Tile Barn farm have been estimated based on nearby boreholes due to site issues.

Figure 6 – Water Situation Report



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

Network Performance

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

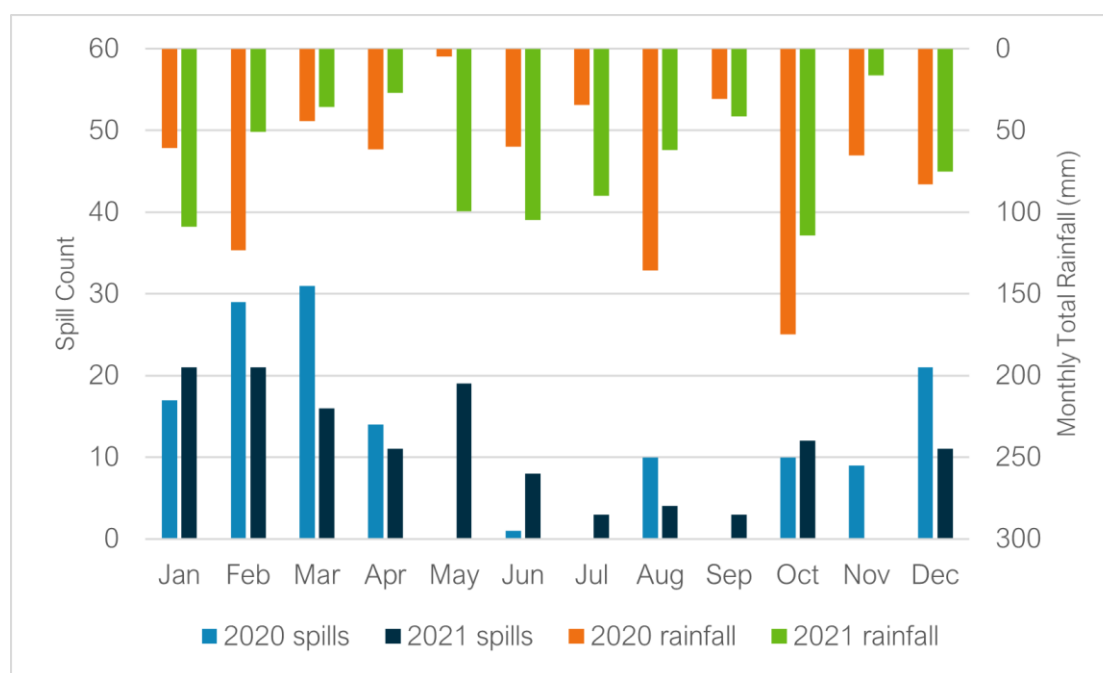
Table 7 below details the last 2 years performance of overflows within the catchment.

Table 7 – Event Duration Monitoring

| Overflow | 2020 | | 2021 | |
|-------------|--------|------------------|--------|------------------|
| | Spills | Duration (hours) | Spills | Duration (hours) |
| Bentley STW | 142 | 1665.80 | 129 | 804.39 |

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

Figure 8 – EDM Monthly Performance



The trend in spill performance across the two recorded years does show variation in spills, with a focus on spills during the autumn and winter months. The data suggests a wider relationship between rainfall, elevated groundwater levels and spill frequency, particularly evident at the start of the hydrological years (October – December). Despite broadly similar rainfall, significantly more spills were recorded at Bentley STW in December 2020 compared to December 2021. The indicator sites suggest groundwater levels in the catchment were higher in December 2020. A slower tail off in spills is also evident within the first three months of 2020 when the indicator sites shown in Figure 5 suggest groundwater levels in the catchment were higher.

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 4 monitors installed within the Bentley 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 Bentley 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 | N/A |
| Patch lining | N/A |
| Manhole sealing | N/A |
| Manhole sealing plates | N/A |
| Manhole covers and frames replaced | 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 2021/2022 hydrological year.

Summary

Rainfall in the Bentley catchment over the 2021/22 hydrological year has been below average, with groundwater levels in the aquifer beneath Bentley 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 lower number of EDM spills recorded at Bentley STW in December 2021, compared to December 2020, when the indicator sites suggest groundwater levels in the catchment were higher.

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.

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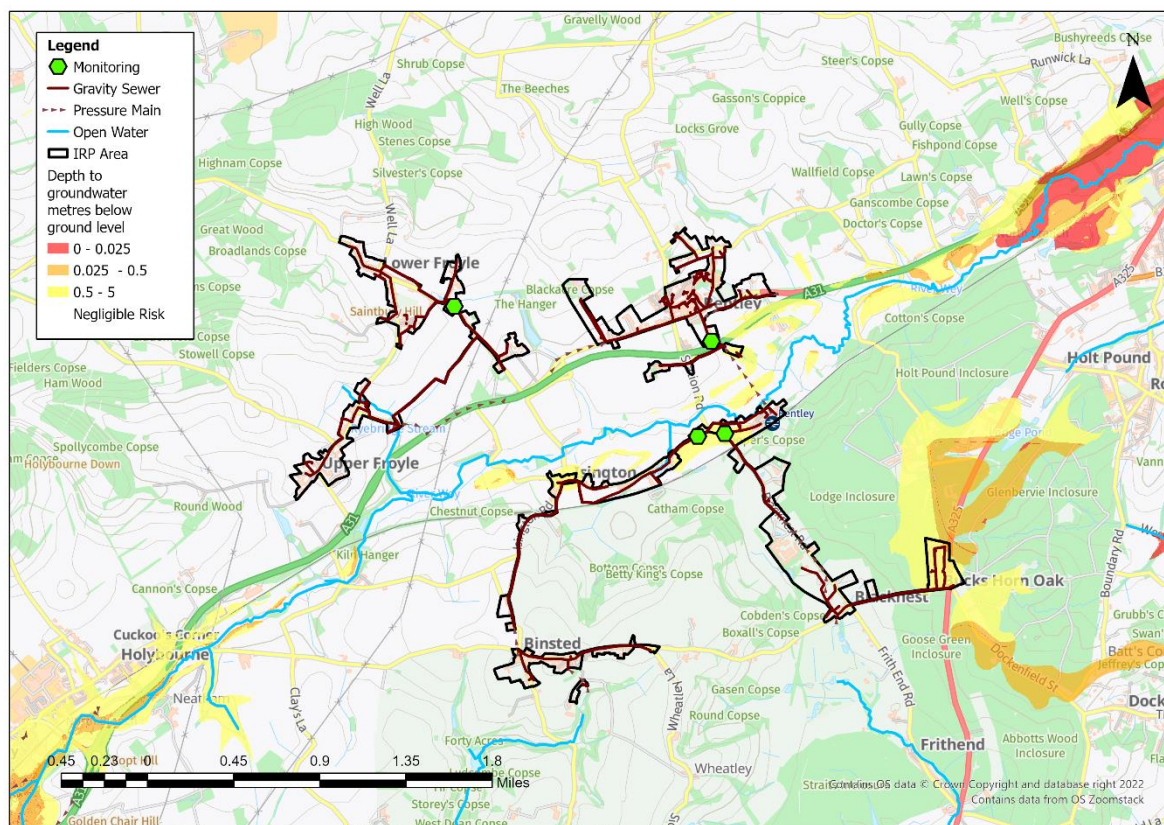
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- Performance of the sewerage system
- Mitigation / remedial measures progressed over the last year and being planned
- Summary and plan for 2023/24

Figure 1 – Bentley Monitoring Plan



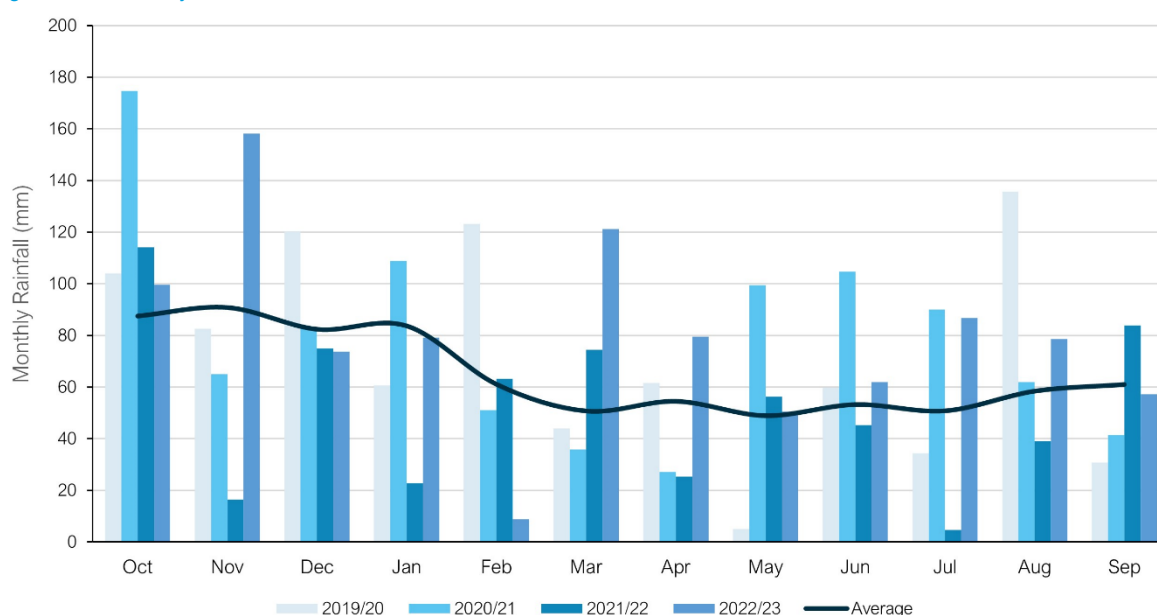
Hydrological Review – 2022-2023

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

The total rainfall for the 2022/23 hydrological year is 22% 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) |
|--------------|--------------|--------------|--------------|--------------|
| 783 | 862 | 943 | 620 | 955 |

Groundwater / Local River Level

The Bentley catchment is situated in the Wey – Greensand and North Downs – Hampshire water resources areas. It sits in the Gault Formation of mudstone and Upper Greensand Formation of calcareous sandstone and siltstone. The Upper Greensand formation is a designated principal aquifer within the UK.

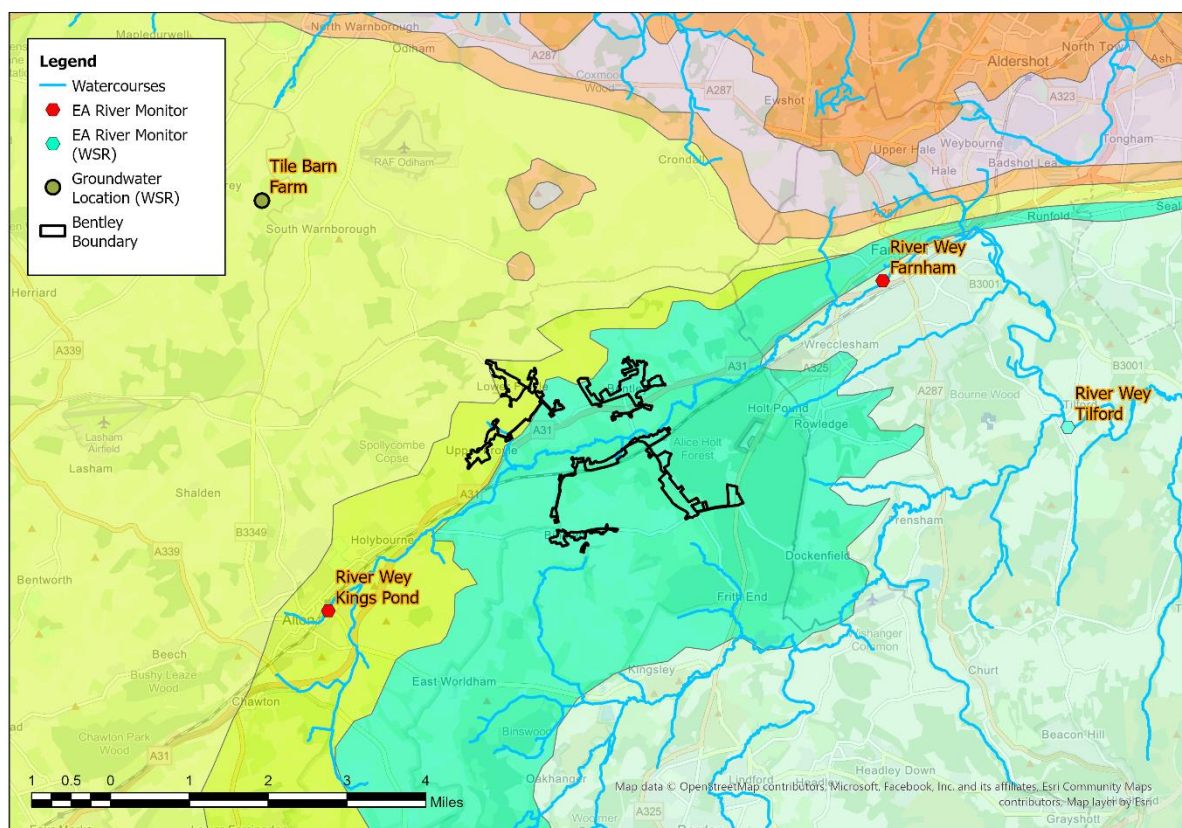
The Environment Agency has gauging stations on local watercourses measuring stage and observation boreholes (OBH) measuring groundwater levels locally to the catchment which can be used to provide indicative local groundwater performance.

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

- River Wey, Farnham.
- River Wey, Kings Pond.

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 Wey, Farnham

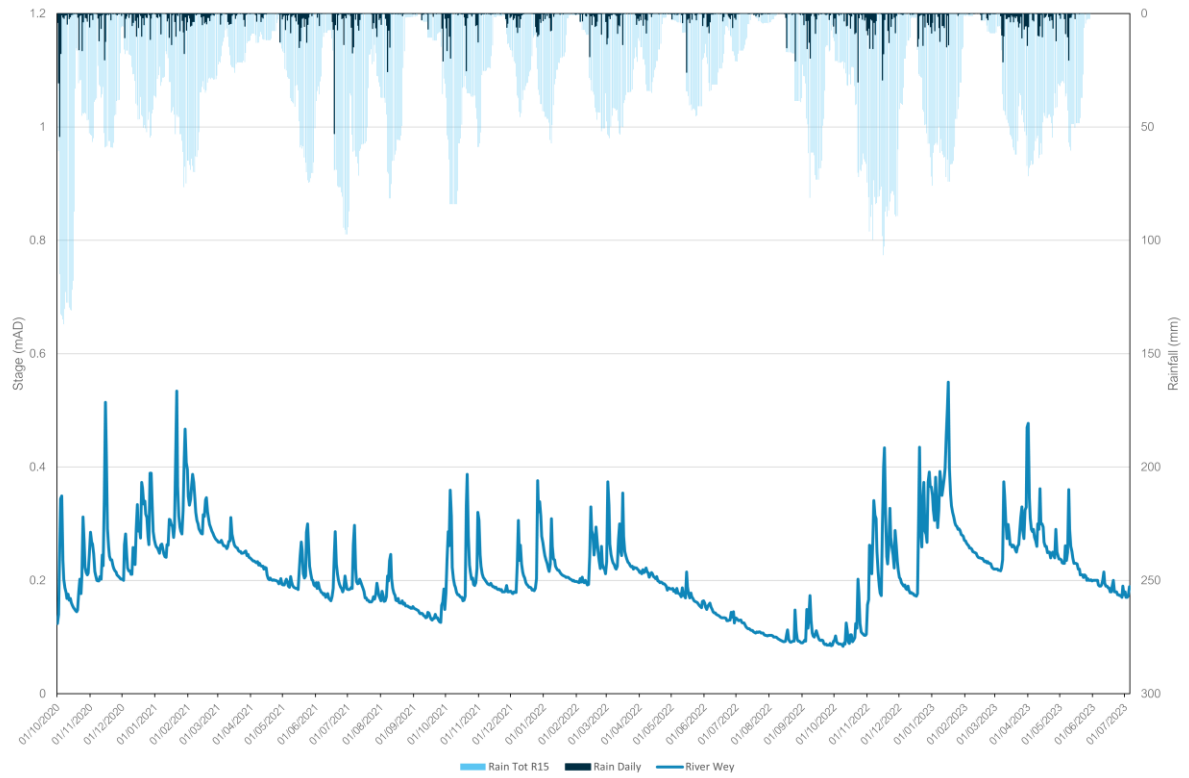
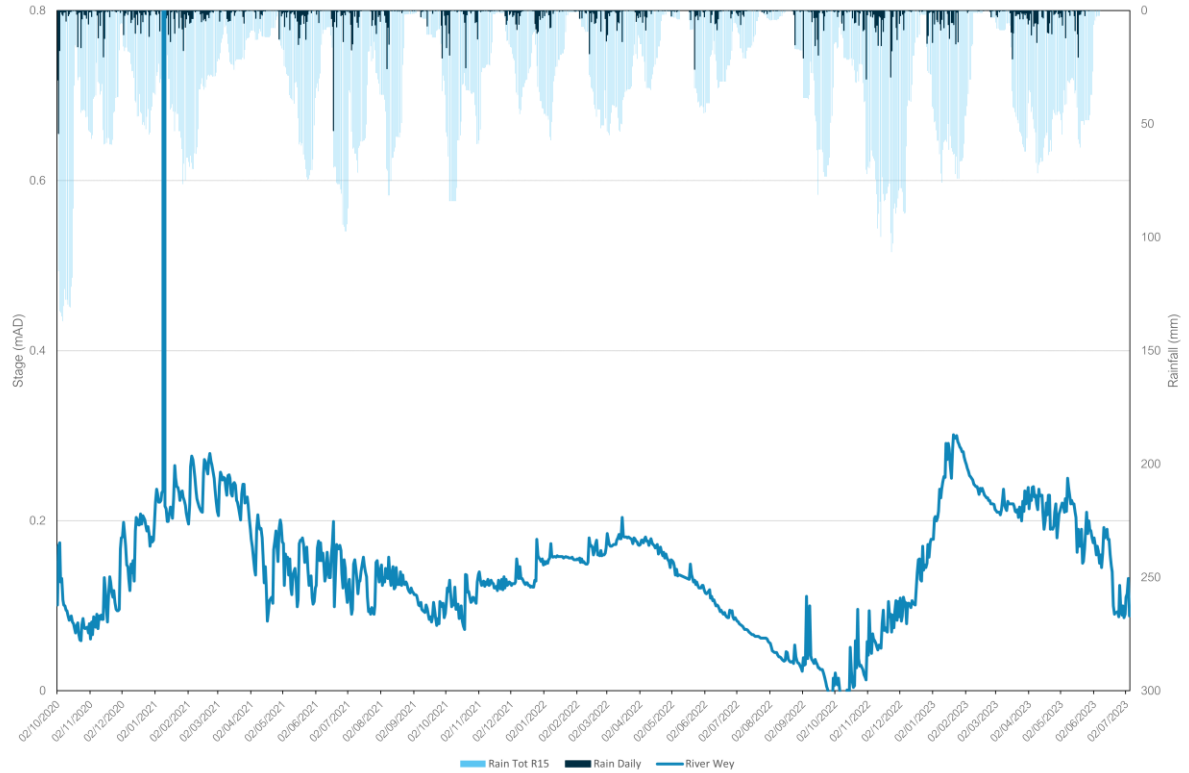
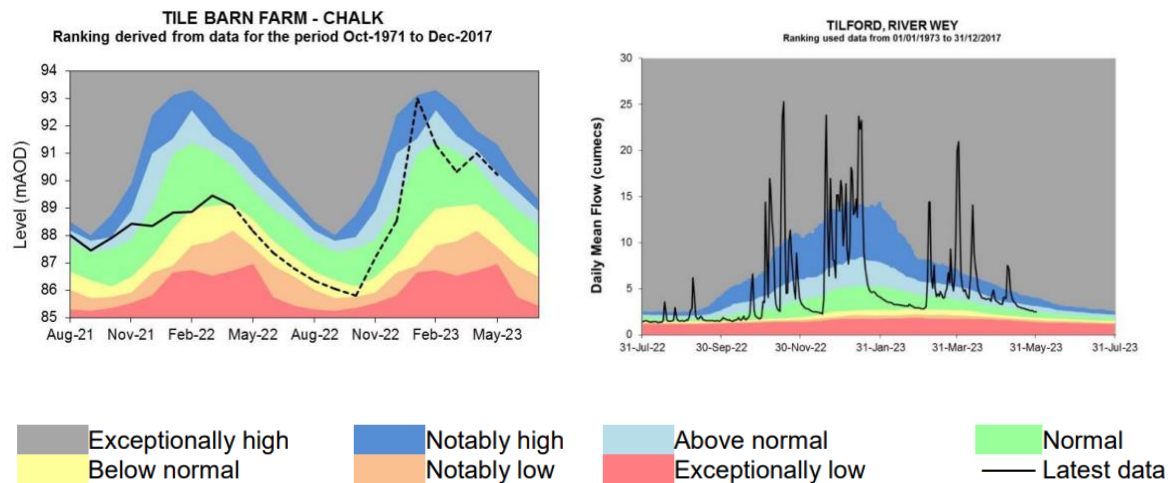


Figure 5B – River Wey, Kings Pond



In addition to these specific stations, the wider groundwater context is illustrated in the Water Situation Report for Wey - Greensand. The nearest groundwater reference station is Tile Barn Farm. This site shows groundwater levels to be at normal levels at the start of 2022, dropping to below normal levels for a significant period. Groundwater levels are observed to increase towards the end of 2022 and are at normal, above normal, and notably high levels in 2023. This can be seen in the figure below alongside the river indicator location at Tilford on the River Wey. Note recent groundwater levels at Tile Barn farm have been estimated based on nearby boreholes due to site issues.

Figure 6 – Water Situation Report



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

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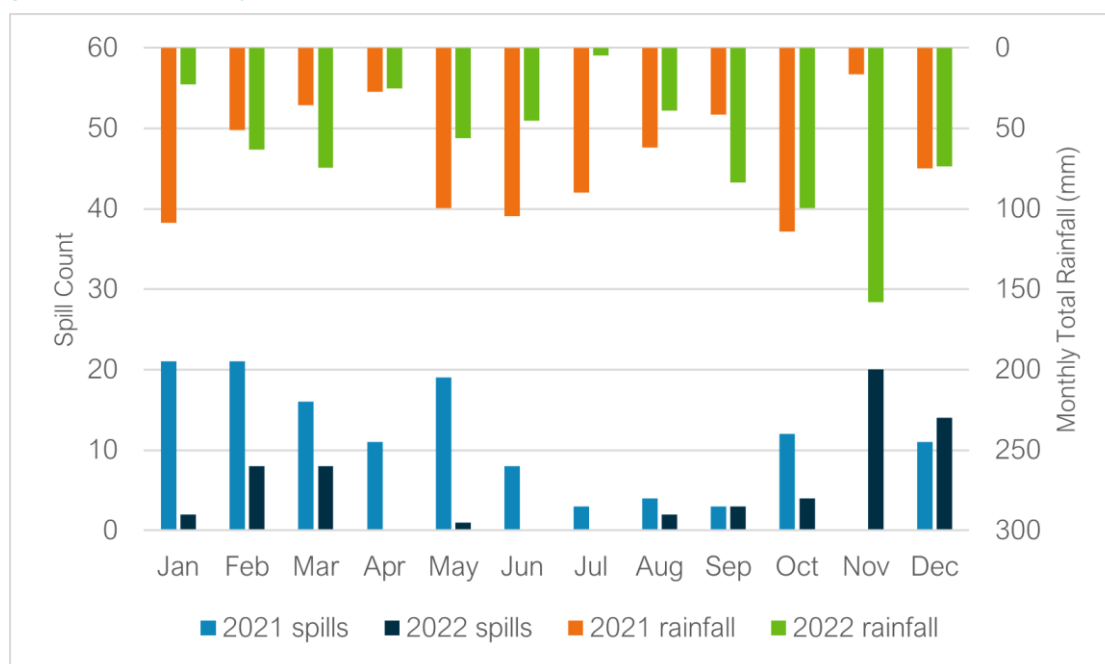
Table 7 below details the last 2 years performance of overflows within the catchment.

Table 7 – Event Duration Monitoring

| Overflow | 2021 | | 2022 | |
|-------------|--------|------------------|--------|------------------|
| | Spills | Duration (hours) | Spills | Duration (hours) |
| Bentley STW | 129 | 804.39 | 62 | 595.90 |

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. Despite broadly similar rainfall totals, significantly more spills were recorded at Bentley STW in February 2021 compared to February 2022. The indicator site graphs shown in Figure 5, suggest groundwater levels in the catchment were higher in February 2021. Similarly, in March 2022, a higher rainfall total was recorded for the catchment compared to March 2021, however significantly more spills were recorded in March 2021, with the indicator site data suggesting higher groundwater levels in March 2021. The significant number of spills recorded during the spring and summer months, is also indicative of spills occurring as a direct response to rainfall in the catchment, 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 2022-23.

Monitor Installations

The sewer depth monitor (SDM) programme supports long term groundwater understanding within GISMP catchments. Currently, there are a total of 4 monitors installed within the Bentley 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 Bentley 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 2021/22 | Number/ length undertaken 2022/23 |
|------------------------------------|-----------------------------------|-----------------------------------|
| CCTV survey | N/A | N/A |
| Look and lift survey | N/A | N/A |
| Sewer lining | N/A | N/A |
| Patch lining | N/A | N/A |
| Manhole sealing | N/A | N/A |
| Manhole sealing plates | N/A | N/A |
| Manhole covers and frames replaced | N/A | N/A |

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

Bentley STW is being upgraded at a cost of more than £6 million. This upgrade will increase the capacity of the storm tanks at the STW, therefore reducing the need for untreated sewage discharges to the environment. The scheme is due for completion in 2023.

Summary

Indicator site data suggests groundwater levels in the Bentley catchment were at or below normal levels during 2022, and generally lower than in 2021, with trends in the EDM data indicative of the role of groundwater infiltration on spills in the catchment. This hydrological year (October 2022 – September 2023), 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.

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.

Addendum - Annual Update 2024

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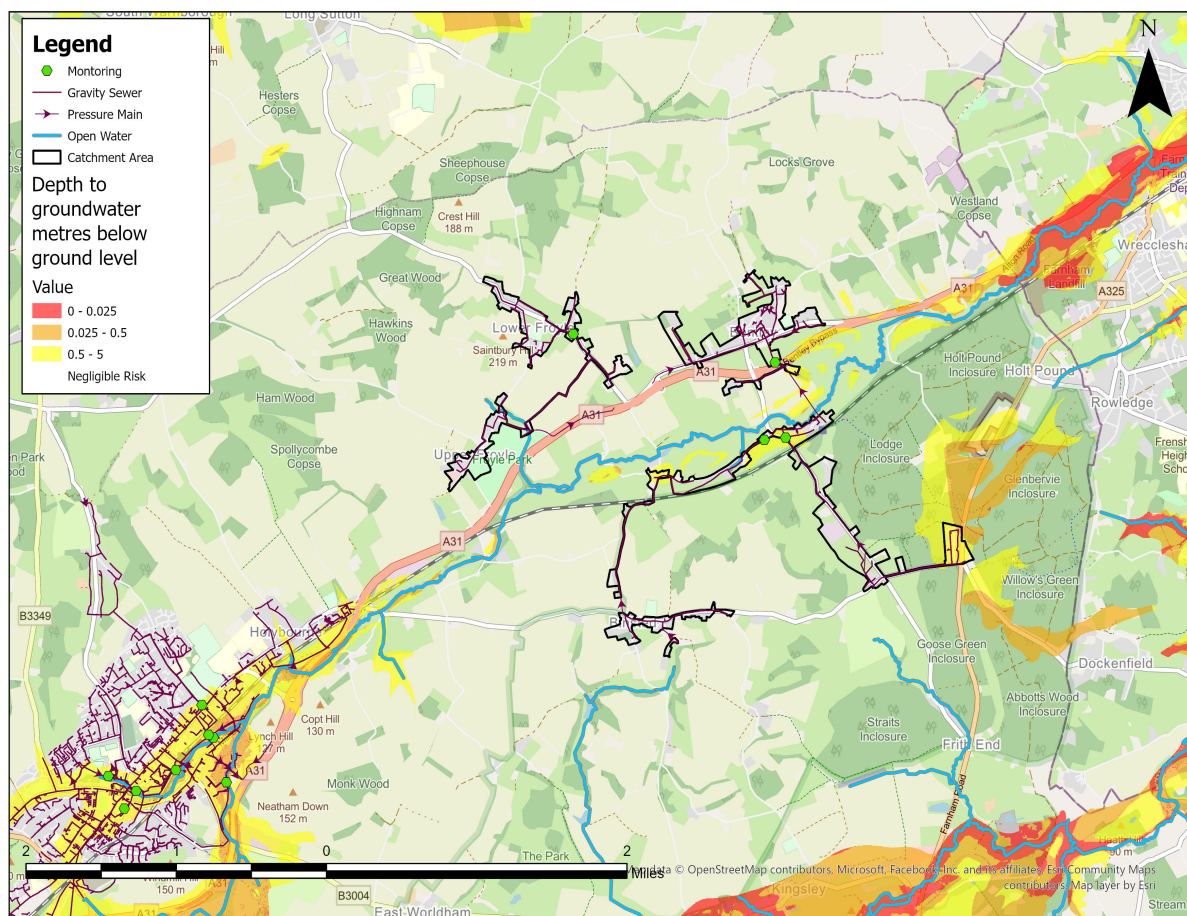
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Overview

This addendum to the Bentley Groundwater Impacted System Management Plan 2021 (GISMP) provides an update on performance/work undertaken 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 being planned
- Summary and plan for 2024/25

Figure 1 – Bentley Monitoring Plan



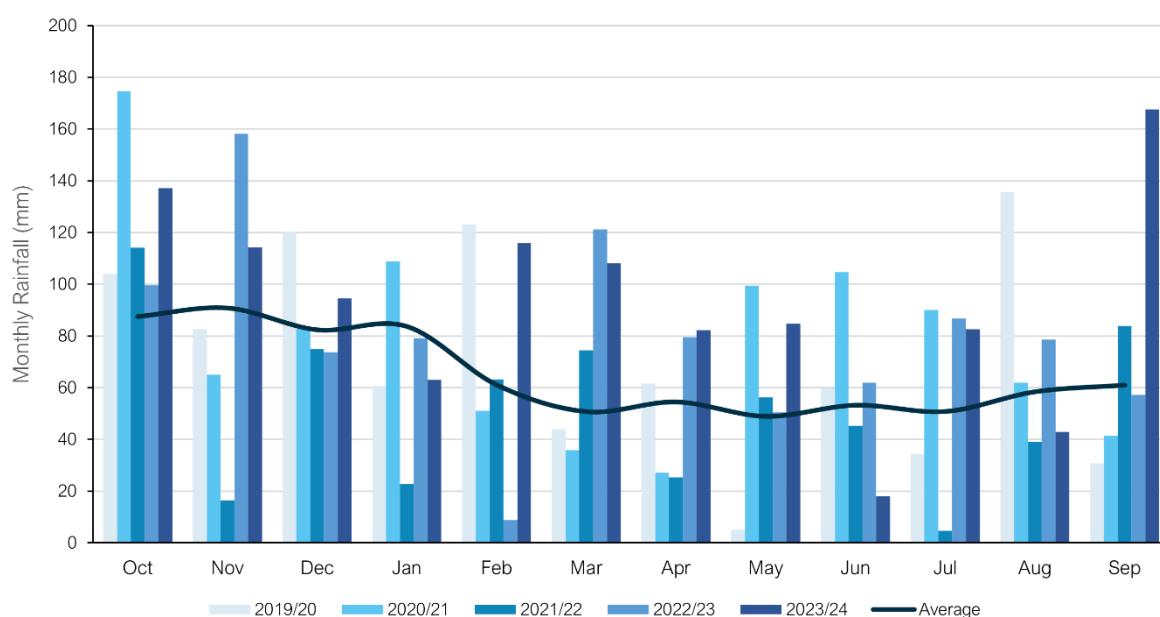
Hydrological Review – 2023/24

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

The total rainfall for the 2023/24 hydrological year is 42% 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) |
|--------------|--------------|--------------|--------------|--------------|--------------|
| 783 | 862 | 943 | 620 | 955 | 1111 |

Groundwater / Local River Level

The Bentley catchment is situated in the Wey – Greensand and North Downs – Hampshire water resources areas. It sits in the Gault Formation of mudstone and Upper Greensand Formation of calcareous sandstone and siltstone. The Upper Greensand formation 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 are good indicators of groundwater levels within the catchment.

- River Wey, Farnham.
- River Wey, Kings Pond.

These sites are illustrated in the Figure 4, alongside the closest groundwater reference station and closest gauging station from the Water Situation Report.

Figure 4 – Local Monitoring Stations

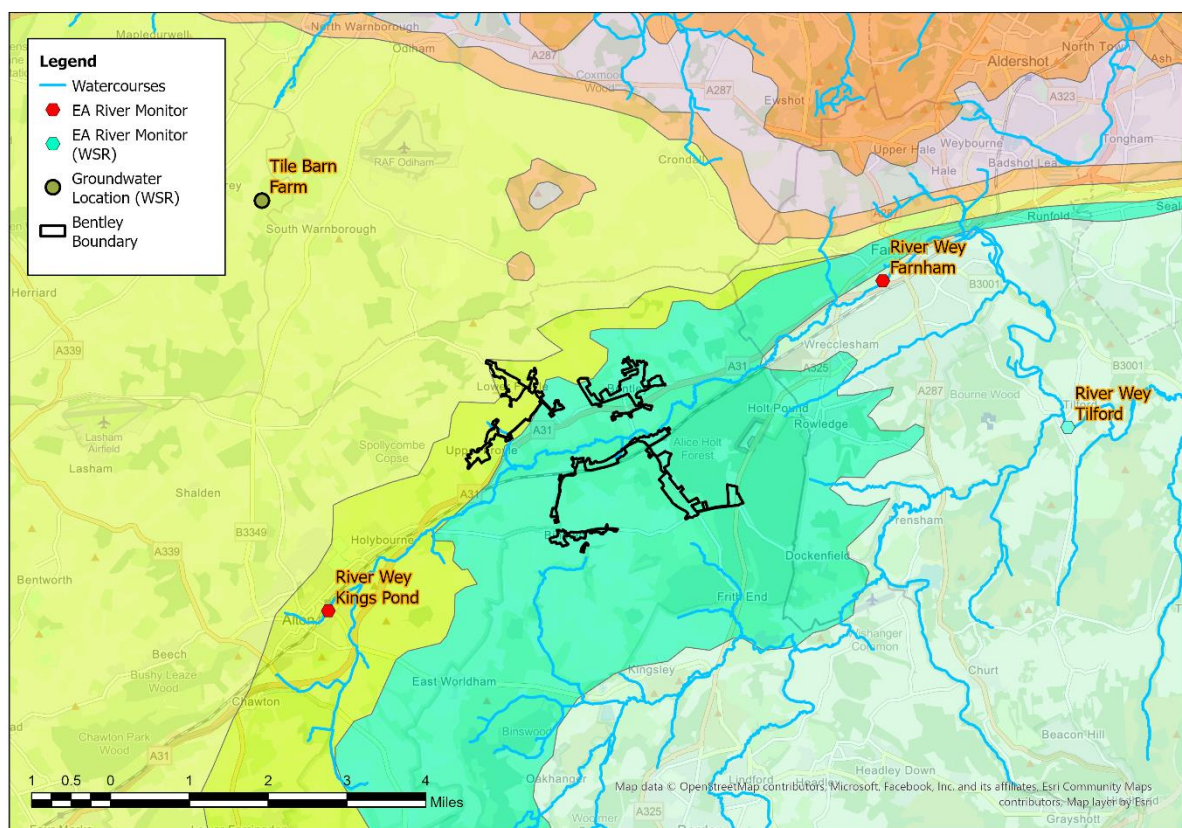


Figure 5A – River Wey, Farnham

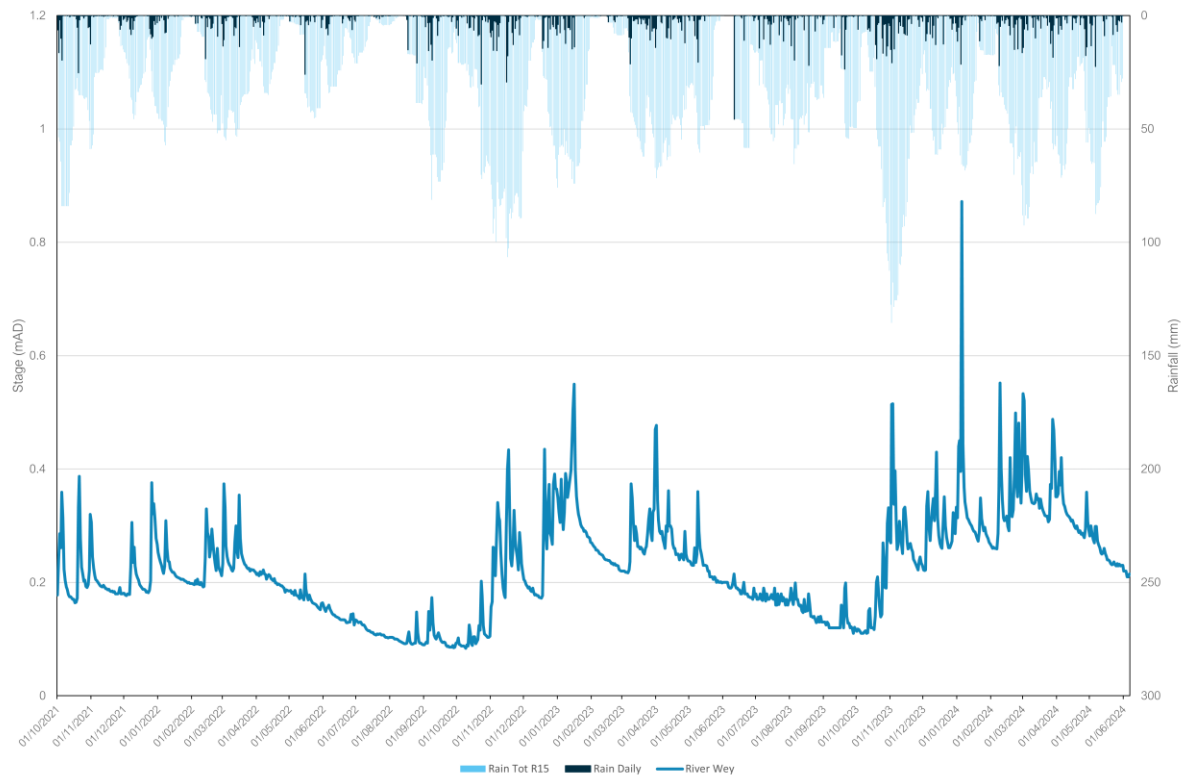
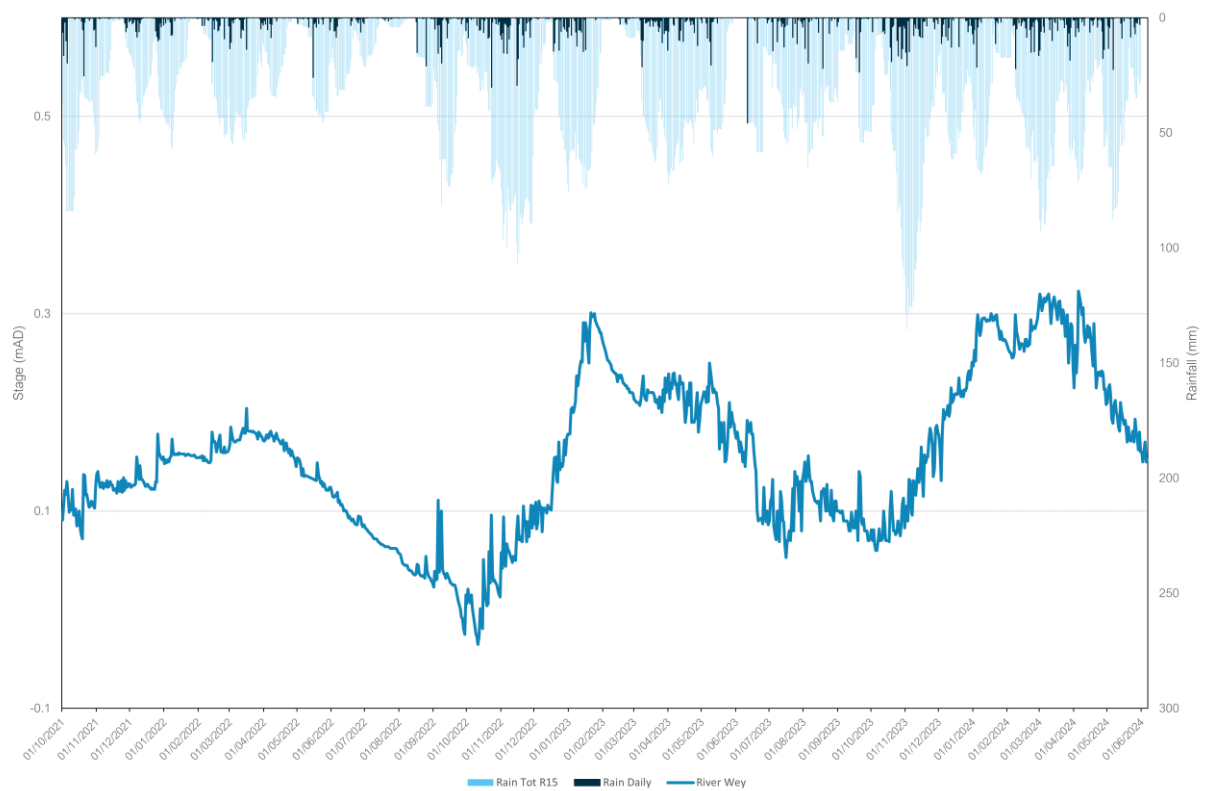
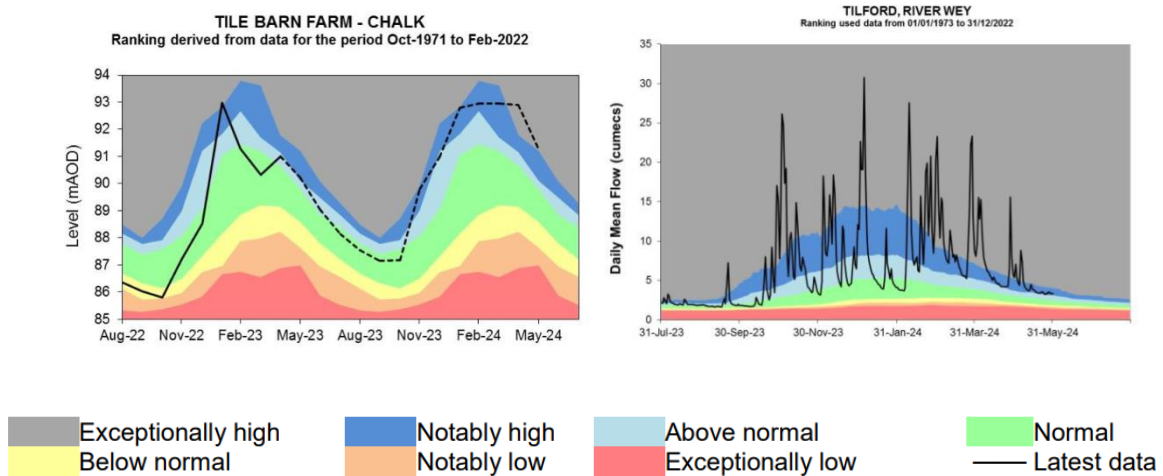


Figure 5B – River Wey, Kings Pond



In addition to these specific stations, the wider groundwater context is illustrated in the Water Situation Report for Wey - Greensand. The nearest groundwater reference station is Tile Barn Farm. This site shows groundwater levels in 2024 at notably high levels for a more prolonged period than in 2023, reaching exceptionally high levels in late spring. This can be seen in Figure 6 alongside the river indicator location at Tilford on the River Wey. Note recent groundwater levels at Tile Barn farm have been estimated based on nearby boreholes due to site issues.

Figure 6 – Water Situation Report



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

Network Performance

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

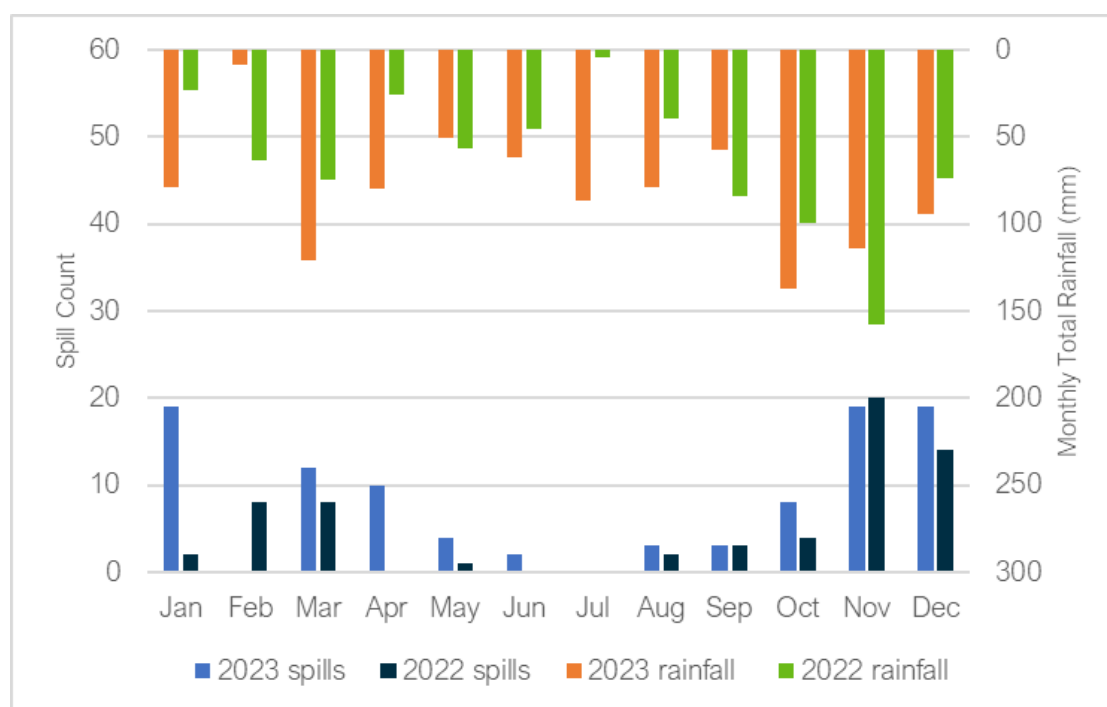
Table 7 below details the last 2 years performance of overflows within the catchment.

Table 7 – Event Duration Monitoring

| Overflow | 2022 | | 2023 | |
|-------------|--------|------------------|--------|------------------|
| | Spills | Duration (hours) | Spills | Duration (hours) |
| Bentley STW | 62 | 595.90 | 99 | 1127.25 |

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. The data suggests a wider relationship between rainfall, elevated groundwater levels and spill frequency. For example, despite significantly more rainfall in November 2022, similar spills were recorded in both years. Indicator sites suggest groundwater levels to be higher at this time in 2023 (see Figures 5 and 6). Similarly, a high number of spills were recorded in January and April 2023, when the indicator site data shown in Figures 5 and 6 suggests that peaks in groundwater levels occurred in the catchment. The EDM data for 2024, once available, will be analysed to further understand the relationship between groundwater levels and overflow spills at Bentley STW.

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 4 monitors installed within the Bentley 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 Bentley catchment in the 2023-24 Hydrological Year, as well as works undertaken in the previous two hydrological years.

Table 9 – Works Undertaken in the 2023/24 Hydrological Year, 2022/23 Hydrological Year & in the 2021/22 Hydrological Year

| Investigation/ remediation type | Number/ length undertaken 2021/22 | Number/ length undertaken 2022/23 | Number/ length undertaken 2023/24 |
|------------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| CCTV survey | N/A | 330 metres | 2.35 Kilometres* |
| Look and lift survey | N/A | N/A | N/A |
| Sewer lining | N/A | N/A | N/A |
| Patch lining | N/A | N/A | N/A |
| Manhole sealing | N/A | N/A | N/A |
| Manhole sealing plates | N/A | N/A | N/A |
| Manhole covers and frames replaced | N/A | N/A | N/A |

*Total length of network scoped for survey across sewers predicted to be at high/ medium and low risk of groundwater infiltration. The purpose of the surveys to identify priority locations for remediation and to help verify the sewer risk zones.

Tables 10 and 11 below summarise the CCTV work undertaken for Bentley in the 2023-24 Hydrological Year and gives details on the infiltration identified.

Table 10 – Total length of sewerage network surveyed by CCTV in the 2023-24 Hydrological Year

| Investigation/ remediation type | Length (m) |
|---------------------------------|------------|
| Planned CCTV Survey | 2350 |
| Survey Completed | 1814 |
| Total surveyed with clear flow | 1692 |

Table 11 - Number of points of infiltration found and assessed severity from CCTV surveys

| Infiltration severity | No. of sections of pipework |
|-----------------------|-----------------------------|
| Gushing | 0 |
| Running | 3 |
| Dripping | 2 |
| Seeping | 5 |
| Total | 10 |

330 metres of CCTV was undertaken in the catchment over the summer/ 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. All surveyed network, accounting for 35% of the high-risk network in the catchment, was identified as being in a good structural condition.

Bentley STW is being upgraded at a cost of more than £6 million. This upgrade will include a new storm tank at the STW, therefore reducing the need for untreated sewage discharges to the environment. The quality of treated effluent going to the river will also be improved. The storm tank scheme is due for completion in 2025 and the phosphorus scheme to improve the quality of treated effluent in AMP8 (2025-2030). 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 this catchment will meet all government targets for storm overflows by 2030.

Summary

Indicator site data suggests groundwater levels in the Bentley catchment were mostly at normal or above normal levels in 2023 with trends in the EDM data indicative of the role of groundwater infiltration on spills in the catchment. This hydrological year (October 2023 – September 2024), groundwater levels in the catchment have generally been higher than those observed in the previous hydrological year, and EDM data for 2024 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 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.



It's everyone's water