Chinnor Drainage Strategy

Stage 1 - Initialise/Prepare



At the heart of daily life

Introduction

Why sewer flooding

Britain's first sewerage systems were constructed 150 years ago in the Victorian era, and have served us well for generations. The sewer network Thames Water operates today has been much improved and vastly extended over the years; yet it remains under increasing pressure.

Everyday our network manages the demands of one of the world's busiest and most densely populated capital cities, and its urbanised surrounding areas; together with the equally complex

What can be done and when?

Sewer flooding is unacceptable. We have undertaken extensive customer research and initiated a programme of work to improve drainage and alleviate sewer flooding issues across our region.

We are adopting the good practice Drainage Strategy framework* developed by the Environment Agency and Ofwat, challenges arising in our predominantly rural catchments in the Thames Valley, Surrey and Kent.

A number of factors including population growth, less frequent but heavier rainfall, the urbanisation of green spaces and changes in agricultural land practices, and utilised machinery, occasionally overwhelm our sewer network. The result can be unwanted sewer flooding for customers and our neighbouring natural environments.

the water industry economic regulator, to produce a drainage strategy for our affected catchments. As outlined in Figure 1, the strategies will develop throughout the 4-stage framework to define how we intend to alleviate sewer flooding or to address growth related issues in each area sustainably, and economically, over the next few years.

This document contains:

- an Introduction to the work we are undertaking to alleviate sewer flooding in our region
- a Feedback: Q&A section addressing key questions from customers and stakeholders
- the Chinnor Drainage Strategy technical document.

Figure 1 High-level Drainage Strategy framework* and estimated delivery and intervention timeline**



* The detailed 4-stage Drainage Strategy framework can be found in the following Drainage Strategy document. ** The estimated delivery timeline is dependent on factors including weather conditions and is, therefore, open to change. The intervention timeline includes the implementation of 'quick-win' operational solutions throughout Stage 2 & 3, and long-term capital investment interventions in Stage 4.



Who will resolve the sewer flooding?

There are a number of stakeholders who, like us, have important drainage responsibilities and therefore, play an essential role in resolving sewer flooding in our region. These stakeholders include customers, private land owners and the Environment Agency; to name but a few. We are seeking to work partnership with all stakeholders to ensure that together, we implement and maintain the most effective and sustainable drainage strategies.

Just as our responsibilities to improve drainage and alleviate sewer flooding focus on removing and treating wastewater; other stakeholders' responsibilities include managing local flood risk on riverbanks, ground water, land and highways, utilising appropriate agricultural practices and maintaining private drains.

We take full responsibility for resolving all drainage and sewer flooding issues that fall within our remit. If the causes of sewer flooding sit outside of this, we will support the responsible stakeholder to resolve the issue and to reduce the impact on customers.

Figure 2 provides a high-level view of the stakeholders responsible for drainage in each catchment area, more detail regarding responsibilities can be found in Section 1 of the following Drainage Strategy document.

Figure 2 Partners with Drainage Responsibilities



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Next steps

Over the coming months we will undertake the following activities as this drainage strategy develops:

2015 - 2017



- Continue to consult with customers during this stage and every stage, through meetings, communications and surveys. We have gained important customer feedback during this first stage, which we are using to shape our activities
- Publish strategy documents for comment and contribution, throughout this framework process.
- Continue to establish partnership working with the regional drainage stakeholders, and agree ongoing consultation processes.
- Define catchment flooding uncertainties
- Prepare flooding risk data
- Undertake ongoing repair work to our sewer network, as the strategy develops and our investigations identify reparation work linked to drainage and flooding issues.

We will **regularly consult** with customers and stakeholders, update and republish this document throughout this 4-stage framework process.

At the heart of daily life

Feedback: Q&A Your guestions answered

We are committed to listening to, consulting and collaborating with customers and stakeholders on our activities and plans. We have addressed key feedback and questions raised by customers and stakeholders in the Chinnor catchment, and customers affected by flooding throughout the region, in this Feedback Q&A section. As far as possible, and as is relevant to Stage 1 in the framework process, we have incorporated feedback from customers and stakeholders into our network strategy development. More detail can be found throughout the following Drainage Strategy document.

Q1 Will undertaking this Drainage strategy framework process defer essential work in our area?

Answer

It is essential for us to complete this drainage strategy process, which has been developed and recommended by the water industry economic regulator Ofwat, and the Environment Agency. This will enable us to better understand the root cause of the sewer flooding issues affecting the catchment, before any major investment can be considered.

However, we may carry out some repair works as this strategy develops, in the event that our investigations identify faults or problems with the sewerage network that are highly likely to have caused flooding, as outlined in Section 7 of the Drainage Strategy document. Our previous investigations have identified some sources of inflow, such as the misconnection of surface water to foul sewers. However, as stated in the following strategy, we are not yet able to say how much this impacts on flooding. Therefore, this more detailed approach is required to ensure that the most effective and sustainable drainage strategies are implemented in the Chinnor catchment. We are committed to **listening to, consulting and collaborating** with customers and stakeholders on our sewerage network activities and plans.

Q2 What drainage actions are you undertaking in our area, and when will they be happening?

Answer

The following drainage actions have recently been undertaken, or are underway, in the Chinnor catchment in this framework stage:

Actions completed include: (For more information please see Table 2)

- 1 CCTV survey of our sewer network
- 2 Sewer and manhole surveys and reparation
- 3 Pumping station surveys
- 4 Flow surveys
- 5 Maintenance of flows
- 6 Flood mitigation
- 7 Sewer level monitoring

- 8 Sewer cleaning
- 9 Brookstones Flood Alleviation scheme.

Actions underway or planned include: (For more information please see Table 4)

- 1. Stakeholder engagement activities
- 2. Permanent monitoring of sewer levels
- 3. Sewer treatment works storm discharge monitoring
- 4. Customer surveys
- 5. Sewer and manhole surveys
- 6. Connectivity survey
- 7. Innovative solution analysis.

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Q3 Are you renovating the sewers in our area?

Answer

As per Question 2 above, as the Drainage Strategy work continues, we will target and repair localised sewer defects identified through our investigations as contributing to, or causing, drainage and flooding issues in the catchment.

Q4 What are the improvement plans for Chinnor sewage treatment works to manage capacity?

Answer

To meet changing performance requirements the Chinnor sewage treatment works underwent a major programme of upgrades between 2005 – 2010, to ensure its compliance with all our regulatory measures. The works operates a fully-compliant permanent storm overflow which permits us to discharge into local watercourses during storm events.

We have incorporated the prospect of new housing developments within this catchment into our strategy activities, and we are tracking key developments as outlined in Section 5.3. The capacities of the sewage treatment works and local sewers have been assessed to be adequate under normal design flow conditions, to manage current demand and the potential demand created from new developments; as outlined in the latest Council development plans. Therefore, we do not plan to enhance the treatment capability of the sewage treatment works at this time.

If this current position changes as our investigations through this 4-stage framework progress, we will consult with customers and stakeholders on our proposals, and republish them within the later stages of this Drainage Strategy document.

Q5 How are you ensuring that our local pumping stations are operating effectively?

Answer

The stations are supported by 24 hour diagnostic monitoring so that we can tightly control its operation through a flow of real-time information. Based on this performance data we can respond quickly through site visits by our engineers, and both project and rectify potential issues before they occur. As we move through this 4-stage framework process and further develop our drainage strategy for this catchment, we will review the operational control options to maximise storage of this works during wet weather, carefully avoiding increasing the risk of sewer flooding in doing so.



Q6 Are you working with the Highway Authority to resolve blocked gulleys, sewers and ditches, and with landowners to reduce field run-off, as both affect drainage and our sewers?

Answer

In Section 1of the following Drainage Strategy document, we outline the other stakeholders who, like us, have important drainage responsibilities and therefore, play an essential role in resolving sewer flooding issues in this catchment area. As Highways maintenance activities and agricultural land maintenance practices sit outside of our remit, we will work with the responsible stakeholders, to highlight these issues where this is found to have a major influence and impact on our sewerage network.

We will continue to work closely with the Council and Highways England to understand the extent to which flood waters may be escaping from highway or land drainage systems; and impacting the foul sewer network. An update on this issue will be shared with customers and featured in the later stages of this Drainage Strategy document.

Q7 How are you planning for future development in the catchment?

Answer

As per Section 5.3 in the following Drainage Strategy document, we will continue to closely monitor development applications in the catchment and assess the impact that they may have on the capacity of our operations in the future. The South Oxfordshire District Council Local Plan states that 160 new homes are required in Chinnor up to 2031. We will review the capacity of the sewage system and treatment works when we have more information and confidence regarding the location of the development. We will continue to work with all involved stakeholders through our stakeholder engagement activities, to monitor local plans and planning applications and to incorporate current and projected developments into our business planning cycle, to ensure that our service is maintained for customers throughout the catchment's development.



Q8 Is an Infiltration Reduction Plan (IRP), required for this catchment?

Answer

Ensuring that our drainage strategies fully meet the requirements of an Infiltration Reduction Plan, as set out in the Environment Agency's Regulatory Position Statement, is a fundamental consideration in their development. Therefore, to maintain our service to customers during future wet weather events, if we need to discharge to watercourses through temporary overflows a dedicated section will be included in each affected strategy, providing details of their location and intended use. This section will be included and /or revised when each strategy is updated.

In the event that temporary overflows are required, as stated above, we will describe their location and the circumstances under which we would use them. Together with plans to reduce infiltration, this drainage strategy would then fully meet the requirements of an Infiltration Reduction Plan.

Q9 Why are costs a consideration within your Wastewater outcomes?

Answer

The service we provide is the most fundamental of all – at the heart of daily life for the 15 million customers we serve. Getting it right is our focus every day, and we never forget it is paid for by customers. As a regulated company we have to carefully balance service and cost in order to keep customer bills affordable, whilst delivering our outcomes and customer service commitments.

Q10 Are growth and urban creep minor factors in these rural catchments?

Answer

Whilst the growth and urban creep rate for Chinnor is fairly average across the Thames area, relatively small population increases in these smaller rural catchments can be influential on sewer flows, hence the need for us to closely monitor planning applications. Similarly urban creep, and in particular misconnection of surface water and change of land use, can have a significant impact on sewer flooding; particularly when permeable areas such as grass are replaced with hard-standings and driveways. More growth and urban creep information can be found in Section 5.1 and 5.3 of the following Drainage Strategy document.

Q11 Are best practice techniques already used by other water companies being considered?

Answer

We are constantly reviewing and improving our business to meet and exceed industry standards, to implement best practice and to drive innovation. We lead and participate in a large number of industry forums both in the UK and worldwide, to share and expand our learning; with the ultimate aim of improving services for customers. We are deploying industry best practice techniques throughout our drainage strategy work, and also trialling new technology that is innovative within our industry, to achieve the best possible drainage outcomes for customers and their local environment.

Q12 Why are you collecting climate change data rather than 'climate proofing' assets? Answer

We are committed to responding to climate change and to reducing our contribution to it by reducing emissions in accordance with government policy. Our voluntary target is to achieve a challenging 20 per cent reduction in emissions (compared to 1990 levels), for our Scope 1 and 2 emissions^{*}. We continue to assess and collect climate change data and its impact on assets across our region, to ensure that we are fully informed and can prioritise our plans, targeted actions and investments. For more information please see the Climate Change section on the Homepage of our website.

*Scope 1 emissions refer to greenhouse gas emissions associated with the operation of our assets. Scope 2 emissions are emissions associated with the use of grid electricity.

Q13 What is the impact on local rivers of overflow points? Answer

During extreme weather conditions foul sewers may become overwhelmed through a combination of surface water or ground water, resulting in a much diluted sewage. The impact on local rivers is dependent on the nature and size of the river, and on the overflow.

To reduce the environmental impact on local watercourses we will only use overflow points when groundwater and river levels are high and therefore sewage dilution rates are also high. Additionally, as per Table 4, we are also investigating deploying mobile biological filters to prevent litter and other matter from entering local rivers. If during the development of our drainage strategy we consider that temporary overflow points are necessary in the local network, we will update the Drainage Strategy document to reflect this position.

Chinnor Drainage Strategy

Technical Document



At the heart of daily life

Stage 1: Initialise / Prepare

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About this document

Based on customer research

Undertaking extensive customer research has been a fundamental step in our business plan preparation for 2015-20. Our research findings have informed our business planning activities, and contributed to the development of a set of long-term customer 'outcomes'. The water industry economic regulator,

Approved approach

We have adopted the Drainage Strategy Framework1 outlined in Figure 1 below, developed by the Environment Agency and Ofwat. It identifies 4 key stages to producing a good-practice drainage strategy. Drainage strategies



and sustainable drainage. This document describes the strategy that we will follow in delivering our long-term customer outcomes for drainage, specifically in the Chinnor catchment, in a sustainable and economic manner.

our region, through effective, economic

typically focus on the sewerage network, and not the performance of sewage treatment works. The Chinnor drainage strategy is currently at the first stage of this framework - the Initialise/Prepare stage. In this document, we describe the activities that we plan to undertake to address current issues and future challenges facing the catchment, and the data that we need to gather to complete the risk assessment and options appraisal stages.



¹ http://www.ofwat.gov.uk/future/sustainable/drainage/rpt_com201305drainagestrategy.pdf.



Consultation and publication

We will update and republish this document to provide the results of our risk assessment, options appraisal and our selected strategy for intervention, once data from instrumentation and other fieldwork has been collected and analysed.

Throughout this process we will attend local flood forums for ongoing communication and consultation with

Meeting the Infiltration Reduction Plan (IRP)

To ensure that this Drainage Strategy meets the requirements of an Infiltration Reduction Plan, as set out in the Environment Agency's Regulatory Position Statement on discharges made from groundwater surcharged sewers, we have included a section in this document which defines if, how and when we propose to operate temporary overflows. This is in addition to our plans to reduce infiltration customers and stakeholders. We will also make the Drainage Strategy documents available on the Drainage Strategy webpage of our website.

over time, where it has been identified as a root cause of sewer flooding. Please see Section 8 in the Drainage Strategy document below.

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Executive summary

In recent years the foul sewerage system in the Chinnor catchment has become overwhelmed in some locations, following prolonged and heavy rainfall. This has resulted in properties suffering from sewer flooding, restricted toilet use at customers' homes and sewage spills from manholes.

We believe that significant volumes of surface water run-off from the surrounding saturated fields entered the foul sewerage network during the wet winters of 2012/13 and 2013/14, causing the network to surcharge. The surveys we have carried out also suggest that there is some evidence of groundwater infiltration into the foul sewerage network when groundwater levels are high, and inundation from highways, public spaces and properties. Surface water misconnections (i.e. downpipes from roofs), into the foul sewerage network may also be a contributing factor, however further analysis is required to determine the extent to which this has contributed to sewer flooding. The root causes of sewer surcharges are therefore numerous and the resolution of the issues complex. requiring all stakeholders responsible

for drainage in the catchment to work together to resolve them.

In response, this Drainage Strategy follows the Environment Agency and Ofwat's 4-stage framework. The Chinnor strategy is currently at Stage 1 (Initialise/Prepare). We describe in this document the actions that we plan to carry out to complete the following risk assessment and options appraisal stages. We will update and republish this document once this work has been completed.

In preparing our company business plan for the 5 year period 2015 to 2020 we have listened very carefully to the views of customers. Beyond being able to maintain the current service that we provide, customers have told us that they would like to see a reduction in instances of sewer flooding and odour nuisance and an improvement in river water quality. Our research indicates that customers are willing to pay for these improvements to service²; a summary of our related customer research can be found on our website via the hyperlink below. We have therefore developed a set of company outcomes that we are committed to working towards over the next 5 years, and beyond. The outcomes relevant to the Chinnor drainage strategy are:

- Asset health a composite range of measures against which we will manage the health of our sewerage network
- Properties and public areas protected from sewer flooding
- River water quality meets customer's expectations and regulatory requirements.

This Drainage Strategy must also address future challenges to the Chinnor catchment. We assess these to be:

 Climate change – analysis of the latest data suggests that rainfall could become 15% more intensive by 2080 increasing the likelihood of flooding. Longer wetter winters may also mean groundwater levels are high more often; this could also exacerbate fluvial flooding from local watercourses

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² http://www.thameswater.co.uk/cr/Howwedobusiness/Engagingwithourstakeholders/Publicconsultationresearch/index.html.

- Urban creep paving over of front gardens and loss of green space results in more strain on the sewerage network when it rains heavily. Modelling we have undertaken suggests urban creep rates in Chinnor are about average for the Thames Operational Area
- Population growth the population in the South East is set to grow rapidly. A number of possible development sites are identified around Chinnor which we are tracking, as outlined in Section 5.3. We will continue to monitor any other emerging applications for this catchment arising in the future.

Our strategy is to understand the relative impact on this catchment of overland flow from saturated fields, groundwater infiltration and surface water misconnections; and then to identify cost beneficial solutions to reduce the risk of sewer flooding using willingness to pay research. We may carry out sewer rehabilitation works as the strategy develops, in the event that our investigations identify faults or problems with the sewerage network that are highly likely to have contributed to flooding. Our next steps focus on permanent monitoring using the flow monitoring devices installed in Ickfield Way and upstream of the sewage treatment works in the winter of 2014, collecting sewer flooding information and details of loss of service from customers. The depth monitors will remain in place as we continue through this 4-stage framework process and develop our plans for the catchment.



Figure 2 Chinnor priority catchment

The extent of the catchment is outlined in red.



1 Thames Water and drainage

1.1 Our statutory responsibilities

Thames Water is a regulated Water and Sewerage Company. We supply water to 9 million customers in London and the Thames Valley and provide wastewater services to 15 million customers across an area that stretches from Gloucestershire to Essex. We operate 108,000km of sewer through which an average of more than 4.4bn litres of wastewater is collected and treated every day at our 350 sewage treatment works.

The primary legislation that sets out our role and responsibilities is the Water Industry Act (1991), which describes the duties and services that we are responsible for and the powers that we have to connect, operate, maintain and extend the sewerage network. We are regulated by the Water Services Regulation Authority (Ofwat). The original 1991 Act has been amended by further legislation in recent years, transferring some drains and sewers that were hitherto in private ownership to Thames Water's responsibility³.

Other recent pieces of legislation relevant to this Drainage Strategy are the Flood & Water Management Act (2010), and the Water Act (2014). These set out new responsibilities for Thames Water to manage flood risk in partnership with local councils and the Environment Agency, with more emphasis on Sustainable Drainage Systems (SuDS), such as swales and permeable paving to mimic natural drainage.

Thames Water also has a statutory obligation to comply with environmental

legislation, including European Directives. 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).

A comprehensive and detailed list of all legislation relevant to Thames Water can be found in the 'statement of obligations' published by Defra⁴.

³ See http://www.thameswater.co.uk/help-and-advice/8654.htm for more information.

⁴ See https://www.gov.uk/government/publications/statement-of-obligations.



1.2 Working in partnership with other stakeholders

Other stakeholders responsible for managing various forms of drainage need to work together with us to reduce the risk of flooding. Each has specific responsibilities as summarised in Figure 3 below.



Figure 3 Stakeholder responsibilities for drainage

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Thames Water

We are responsible for removing and treating wastewater, which includes the foul sewers and surface water sewers in some areas⁵. In some cases, the cause of sewer flooding may not fall under our responsibility. In these circumstances, we will explain what we can do to help and continue supporting the relevant authorities or third parties to reduce the impact for customers.

Environment Agency

The Environment Agency is responsible for main rivers and part of its remit includes monitoring and informing the levels of ground and river water. The Environment Agency also investigates pollution incidents and monitors the quality of the water in rivers.

Local Council - Lead Local Flood Authority & District Council

Lead local flood authorities have the responsibility under the Flood & Water Management Act for managing the local flood risk from groundwater and surface water runoff e.g. local watercourses and culverts⁶. They work with landowners

to maintain privately owned ditches, drainage and watercourses, keeping them clear of blockages. They are also responsible for managing the risk of groundwater flooding, both inside and outside of properties. Water from these local authority gullies and drains and privately owned ditches can also impact Thames Water's sewers, therefore, we work with all responsible stakeholders to resolve the excess flow. The County Council or Unitary Authority tends to be both the lead local flood authority and the highways authority and hence is responsible for both land drainage and highway drainage. The District Council tends to be the local Planning Authority, but equally may have responsibility for ensuring maintenance of watercourses; particularly on council-owned land.

Customers

Customers own, and are responsible for, the maintenance of private drains within the curtilage of their property, which did not transfer to Thames Water ownership in October 2011⁷.

Highway Authority

The Highway Authority is generally the County Council (or Unitary Authority), and is responsible for highway maintenance and highway drainage. Highways England is responsible for the drainage of motorways and certain trunk roads.

Riparian Owners

Riparian Owners are landowners who own land with watercourses or land adjacent to watercourse (ie road side ditches). The responsibility for the operation and maintenance of ditches, local watercourses and general land drainage lies mostly with riparian owners.

Land Owners

Land owners include farmers and both residential and commercial customers, but includes trusts etc. They are responsible for ensuring the adequate drainage of their land, such that it is not a nuisance to others.

- ⁵ Thames Water is responsible for the collection and treatment of commercial and domestic sewage. Typically this will be the foul sewerage. Domestic or commercial roof and paved drainage will often go to a soakaway or directly to a water course/river, which if so is not the responsibility of Thames Water.
- ⁶ Some local watercourses and/or culverts are termed as 'Riparian' meaning that a land owner, possibly adjoining or owning the land containing the watercourse/culvert is responsible for the maintenance and free-flowing of the watercourse/culvert
- ⁷ See http://www.thameswater.co.uk/help-and-advice/8654.htm for more information.



2 Catchment description

2.1 Geology and topography

The Chinnor sewerage catchment is located approximately 20km east of Oxford and includes the villages of Crowell, Kingston Blount, Kingston Stert, Sydenham, Emmington, Henton and Ashton Rowant.

The catchment is generally made up of a chalk bedrock in the higher areas (Chinnor, Crowell), and Gault in the lower areas

(Kingston Stert, Emmington). The chalk also extends locally to Sydenham. This catchment is situated in an area that is prone to significant seasonal fluctuations in groundwater levels, with the added likelihood of rainfall induced infiltration8 owing to its permeable soils.

Appendix B includes maps showing the geology and fluvial, pluvial and

groundwater flood risk areas in the catchment.

A number of watercourses run through the Chinnor catchment including the Upper Cuttle Brook and tributaries, and Kingsey Cuttle Brook and tributaries at Thame. According to the Environment Agency the current ecological status of these watercourses is 'Moderate'⁹.

2.2 Sewage treatment works

The Chinnor sewage treatment works serves the town of Chinnor and surrounding villages supporting a combined population of circa 7,350. The works is believed to date from the 1950's and is likely to have been implemented by Bullingdon Rural District Council, together with the sewerage system, as a first-time sewerage scheme. During the intervening period, the sewage treatment works has undergone a number of upgrades to meet changing performance criteria this includes work in 2005 on the inlet screens, and 2007 to improve capacity for the proposed growth within the catchment, increasing the daily flow to full treatment to 4320m³/ day. The flows vary throughout the day but typical daily average flows are shown in figure 6. The capacities of the works have been assessed to be adequate under normal design flow conditions and it is fully compliant with its effluent quality consent, there are no plans to enhance the treatment capability of the works during AMP6. Flows arrive at the works via two gravity sewers and are screened before being passed to treatment, which includes primary settlement, secondary biological treatment and tertiary treatment, with the treated flow discharging to the Henton Stream. Flows beyond the full treatment flow capacity are screened and pass to storm tanks which store the flow and return to the inlet for treatment. Excess flows above the storm tank capacity, pass through further screens and discharge to the watercourse.

⁸ Rainfall Induced Infiltration is the term given to sewer infiltration that occurs as a result of rainfall percolating into the ground impacting the sewer on route to recharging the groundwater table.

⁹ Environment Agency website, interactive map, Basin Management Plans.



2.3 Foul sewers

The catchment is served by a separate foul water gravity sewerage system which drains to Chinnor sewage treatment works. The bulk of the foul flows within the catchment drain via gravity sewers, although low lying areas of the network are pumped up to gravity systems – a schematic diagram of the catchment is shown in Figure 4 below.

Wastewater from Chinnor drains via the local aravity network to a 375mm sewer direct to Chinnor sewage treatment works, wastewater in the village of Henton similarly gravitates direct to the sewage treatment works via a 300mm diameter sewer. Wastewater from Sydenham in the west of the catchment drains to the Plough Corner (Sydenham) pumping station which pumps to the gravity network in Emmington, before draining to Chinnor Sewage treatment works. To the south west of the catchment wastewater in the village of Crowell drains to the Chinnor Road (Crowell) pumping station which pumps flows onto the foul sewer network at Kingston Blount. Wastewater from Ashton Rowant also gravitates to this sewer. In the past these flows have drained to the foul network in Sydenham. A recent project was completed in April 2015 to reduce the flood risk to properties in Sydenham and Emmington by constructing a new pumping station in Strert Road and transferring the flows from Kingston Blount and Ashton Rowant, via a new pumping main, direct to the network downstream of Chinnor, therefore bypassing Sydenham.

Sewer design criteria ensures the appropriate sizing and laying of pipes at an appropriate gradient to maintain a satisfactory self-cleansing characteristic. Capacity of the sewer is typically set to cater for six times Dry Weather Flow (DWF) and a 10% allowance is included for infiltration¹⁰. In terms of design capacity, a 225mm sewer laid at a gradient of 1 in 150 has sufficient capacity to cater for the foul sewage for around 1,500 houses, which based on average occupancy rates, equates to 4,500 people. Problems in sewers smaller than 300mm tend to be as a result of blockages in the pipes. However, occasionally surface water can be misconnected into the foul sewerage network, problems then arise when it rains heavily. The run-off from a single misconnected roof into a foul water sewer can easily match the total foul water flow along an entire street.

As stated in 2.2 above, the sewerage system is believed to date from the 1950s. Materials used in the construction of the sewerage system are typical of the time, with clay pipework and brick and concrete manholes. The clay pipework can have a very long service life, but sometimes the joint seals can deteriorate over time. The 1950s pipes were typically laid on bedding material such as pea shingle, with the trenches likely to have been backfilled with 'as dua' excavated material. More recent drains and sewers, i.e. since the 1980s, are typically surrounded with pea shingle. This protects the pipe but can also act as a good conduit for groundwater.

Structural condition, based on CCTV surveys undertaken indicates the system to be in good condition. The layout of the village suggests that most properties are likely to have their own foul drains that connect directly into the public sewer. The private foul water drains within the property boundaries in the Chinnor catchment are the responsibility of the property owners.

¹⁰ Dry Weather Flow is the term given to the average flow rate observed over a 24 hour period and based on Sewers for Adoption, the industry standard, includes an allowance for infiltration of 10% of the calculated flow rate.





Figure 4 Chinnor sewerage catchment, indicating principal assets

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2.4 Surface water sewers

There are no surface water sewers in the catchment. Surface water is likely to be disposed of via private soakaways, drainage ditches and other sustainable drainage techniques. Soakaways can only function satisfactorily when ground conditions allow soakage and may be completely ineffective at times of high groundwater levels. In other locations, we have seen examples of customers using their foul sewers to drain excess surface water when their soakaways stop working. This exacerbates capacity problems for other customers connected further downstream in the sewerage network, although we have not yet identified

whether this practice is occurring in Chinnor.

With the exception of Chinnor itself, the catchment is mostly rural and incorporates a network of roadside ditches and minor watercourses that are intended to take the non-property related surface water in the area. The responsibility for the operation and maintenance of these ditches, local watercourses and general land drainage is mostly with riparian owners. Oxfordshire County Council as lead local flood authority has overall responsibility for managing groundwater. The Environment Agency has the duty and the authority to ensure that the Chinnor Brook and Upper Cuttle Brook and tributaries are maintained appropriately. Responsibility for maintenance lies with the riparian owners.

The extent of highway drainage is uncertain, but it is likely that highway run-off discharges direct to the roadside ditches, some of which will act as soakaways. Oxfordshire County Council is responsible for the highway drainage and culverts crossing the highway.

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3 Long-term outcomes

We have listened very carefully to the views of customers before developing our plan for the Asset Management Period 6 (AMP6), regulatory period. Between 2009 and 2013 we carried out over 50 separate customer research and engagement activities.

Beyond being able to maintain the current service that we provide, customers have told us that they would like to see a reduction in instances of sewer flooding and odour nuisance and an improvement in river water quality. These are areas where some customers are prepared to see, and pay for, an improvement in the

current level of service.

In response to this, we have developed 4 company outcomes and 11 service outcomes for our wastewater service that we are committed to working towards over the next 5 years and beyond, further details can be found on our website¹¹:

Table 1 Wastewater outcomes

Company outcome	Wastewater service outcome	Why is this service outcome chosen
We will provide a safe and reliable wastewater service that complies with all necessary standards and is available when our customers	Asset health: maintaining our assets to ensure we can provide a safe and reliable service in the long-term.	We must ensure an appropriate balance between reducing costs today and not compromising our future service.
require it.	Properties and public areas protected from flooding.	Flooding is one of the worst service failures for customers.
	Resilient sewage treatment service that minimises the impact of extreme events on river water quality.	We need to be able to provide service against a variety of pressures such as climate change and population growth.
Our customers and stakeholders can trust us, we are easy to do business with and we care.	Do the basics excellently by getting things right first time.	This service outcome ensures our wholesale activity is completely aligned to our objective to improve our Service Incentive Mechanism (SIM) scoring.
We will provide the level of customer service our customers require, in the most economic and efficient manner, to ensure that bills are no more than necessary.	Reduced dependence on energy from the grid.	Reducing dependence on energy from the grid is one of a range of measures across our entire plan to keep costs down to an affordable level for customers.
We will limit our impact on the environment and achieve a socially responsible, sustainable business for future generations, including reducing levels of leakage.	Minimising our carbon footprint.	There is an expectation from society that we will play our part in reducing carbon emissions.

¹¹ See http://www.thameswater.co.uk/tw/common/downloads/about % 20us % 20- % 20corporate % 20responsibility/ AMP6_-_Outcomes_Reporting_Policy.pdf for more information.

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Company outcome	Wastewater service outcome	Why is this service outcome chosen
	River water quality meets customers' expectations and regulatory requirements.	We must meet environmental regulations, and river quality is a visible indicator to citizens of our environmental stewardship.
	Satisfactory sludge disposal.	Sludge is a resource that we should manage effectively to keep bills down.
	Corporate responsibility.	We will act as a responsible company, meeting expectations from wider society.
	Reduced odour from wastewater operations.	Odour is a problem for some of our customers.
	Compliance with new environmental regulations.	We must meet environmental regulations, and river quality is a visible indicator to citizens of our environmental stewardship.

Below, we provide more information about our asset health, properties and public areas protected from flooding and river water quality service outcomes, as these are relevant to the Chinnor drainage strategy.

3.1 Asset health

Our Asset Health performance commitment encompasses a composite range of measures against which we will manage the health of our sewerage network. This commitment underpins our outcome of a safe and reliable wastewater service. It includes sewer collapses, blockages, unconsented category 1 to 3 pollution incidents and properties internally flooded due to operational problems (such as blockages, collapses or equipment failures).



3.2 Properties and public areas protected from flooding

There are two performance commitments that underpin the delivery of this service outcome:

1. We commit to protecting properties from flooding due to rainfall. We estimate that our plan for 2015-20 will result in over 2,100 properties being alleviated from internal flooding, external flooding and also from restricted toilet use (for example when groundwater levels are high following prolonged periods of wet weather). Our customer research indicates that our sewer flooding programme will deliver £20m of benefit to customers every year by 2020.

2. We commit to reducing the risk of sewer flooding and pollution from combined sewers (i.e. those that convey both foul and surface water) by slowing down surface water run-off and rerouting the flow through sustainable drainage measures such as water butts, permeable paving, rain gardens and green roofs. We aim to retrofit over 20 hectares of sustainable drainage measures by 2020. We may also apply this commitment to areas where the network was designed to take foul flow only, but investigation shows that a substantial amount of surface water is in the foul sewer.

3.3 River water quality meets customers' expectations and regulatory requirements

We have a performance commitment to reduce the number of pollution incidents as a result of discharges from our sewerage network and treatment works. Pollution can occur as a result of blockages, collapses or failure of our equipment and also following heavy rainfall when our sewers have insufficient capacity to cope with the flow. All pollution incidents are reported to the Environment Agency's National Incident Recording System (NIRS).



4 Current issues

4.1 Recent wet weather events

The foul sewerage system in Chinnor has become overwhelmed for weeks at a time in recent years, following prolonged heavy rainfall. This has been associated with significant sewer flooding. Based on site reconnaissance that we have carried out we believe that the system has surcharged due to a combination of groundwater infiltration, surface water run-off from saturated fields, surface water inundation from highways, public spaces and properties, and surface water misconnections.

We are confident that this is a comprehensive list of factors that have caused flooding.

The following incidents have been observed with respect to the sewerage system:

- surcharging sewers causing spills out of many public manholes
- Manor Road and Plough Corner

pumping stations running constantly increasing the risk of pump failure

- two 'category 3' pollution incidents were recorded in the sewerage network over the winter of 2012/2013
- flooding to properties in Brookstones, Sydenham, Henton and Emmington
- properties experiencing restricted toilet use and loss of services.

During these events, other sources of flooding have also been observed:

- highway drainage overwhelmed causing highway flooding
- land drainage issues in Henton with water running off fields onto the highways.

Locations of identified issues are indicated in Figure 5 below. High flows are evident in the villages of Kingston Blount and Aston Rowant during periods of prolonged wet weather, and the downstream pumping stations at Manor Farm Road and Plough Corner run constantly during these periods. Flooding occurs in these catchments and a project was completed in April 2015 to intercept the flows and pump them via a new pumping main to the sewer network approximately 1km upstream of Chinnor sewage treatment works, removing the pressure on the network in Sydenham and Emmington.

Two pollution incidents have been recorded for Chinnor sewage treatment works in the last 5 years, one in 2013 and one in 2014. Neither incident was associated with hydraulic overload of the site, both were attributed to mechanical faults which were rectified. Furthermore, neither incident occurred during periods of high flows or during times when we have experienced exceptionally high groundwater in the catchment

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Figure 5 Chinnor sewerage catchment, identified catchment issues

The pink lines indicate the extent of the foul water catchment and the red circle indicates identified areas of flooding.

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4.2 Our operational response

To maintain service and to prevent foul water flooding outside customer properties, tankers were used in the winter of 2012/13 at Manor Farm Road pumping station. Tankers have limited capacity and can only draw off water at a relatively low rate. They can also cause considerable noise and disruption to local communities. Due to the significant impacts of fluvial and groundwater flooding across our region during the winter event of 2013/14, we decided to mobilise our tanker fleet of nearly 100 vehicles to protect customers at the greatest risk of internal property flooding. For this reason, and recognising the limited effectiveness of tankering following more extreme weather conditions, tankers were deployed in other areas.

Figure 6 compares the average daily treated flows at Chinnor sewage

treatment works (STW), with groundwater levels recorded at Environment Agency borehole RBHL.0191. It can be seen that there is a good correlation between groundwater levels and flows discharged from the sewage treatment works, though it should be noted that this borehole is some distance away in a more elevated location and doesn't indicate the actual groundwater level throughout the catchment.



Figure 6 Chinnor Sewage treatment works treated flows and groundwater levels

4.3 Investigations and activities completed to date

Table 2 below, details the investigations and actions that we have completed in recent years within the Chinnor catchment. These form the extent of our current understanding of issues within the catchment.

Activity	Purpose	Date complete	Outcome
Camera surveys	Assess structural and service grade of the sewerage network and if possible detect sources of unplanned or unaccounted inflow.	1995 to 2012	The system is generally in sound condition and no major structural defects are apparent. Where minor or local defects have been detected they are resolved through localised patch lining.
Sewer and manhole surveys	Ascertain sewer and manhole condition and identify areas of the network that may be exhibiting high inflow rates.	2000 to 2010	High flow experienced in Kingston Blount and Ashton Rowant, but past attempts to locate specific sources have proved unsuccessful.
Pumping station surveys	Draw down tests to ascertain the perfor- mance of the pumping stations within the network to ensure the stations are delivering the design flow rates.	2010 - 2104	The results of the tests have confirmed that the stations are operating within their expected range.
Flow surveys	Short-term monitors to assess how the catchment responds to rainfall / groundwa-ter and verify the hydraulic model.	2010	The Chinnor catchment hydraulic model was developed to investigate options for Manor Rd flooding problems. The model was verified in 2010 using two short-term flow monitors.
Flood mitigation	Installation of non-return valves to protect properties, 16 maintenance activities between May 2012 and April 2014.	From 2012	Mitigate consequences of flooding.
Maintenance of flows	Regular tankering over winter 2012 / 2013.	March 2013	Short term discharges to reduce the impact of surcharged sewers.
Permanent monitoring of sewer levels	Permanent monitors installed in 8 locations in Chinnor. Plan is for monitors to remain in situ for at least 5 years and to capture the next wet weather event as a minimum. Analyse the recorded depths and compare with other catchment variables, such as rainfall events and changes in groundwater levels.	May 2013	Use information to identify additional actions for inclusion in the drainage strategy for Chinnor. Share information with other agencies.

Table 2 Investigations and activities completed

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Activity	Purpose	Date complete	Outcome
Manhole cover replacement	Replacement of 5 manhole covers with leak tight covers.	March 2014	Stop ingress of surface water through manholes located in flood plain.
Sewer cleaning	Sewer cleaned (removal of fat and silt).	2012 to 2014	Maintain 'asset health'.
Brookstones Flood Alleviation scheme	Project to construct a new pumping station at Stert Road to intercept flows and pump via a new rising main to discharge to the sewer network approximately 1km upstream of Chinnor sewage treatment works. Local upsizing of the sewer network in Sydenham Road and Emmington.	March 2015	To reduce risk to properties in Syndenham.

In summary, it is believed that various locations within the Chinnor sewage treatment works' catchment suffer excessive inflow which contributes in part to restricted toilet use and flooding. The Brookstones Flood Alleviation scheme, completed in March 2015, will help to reducing these issues in Sydenham and Emmington. Survey works have been carried out over the previous years to inform this scheme. These works will not however, resolve all the issues in the catchment and further survey and investigation is required to identify sources of inflow and their resolution. Permanent depth monitors were installed in the catchment in May 2013, and further monitoring is planned to better understand this impact.



Figure 7 Chinnor depth monitor locations



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4.4 Activities carried out by drainage partners

Table 3 below, details the activities carried out by other stakeholders with drainage responsibilities within the Chinnor catchment, alongside our work, to reduce the risk of flooding in the area. For more detail on the other organisations responsible for managing various forms of drainage within the catchment, please see Section 1 of this Drainage Strategy document.

Activity	Purpose	Impact on sewerage
Maintenance of	Improve surface water drainage.	Prevents inundation as a major source of surface
surface water drainage		ingress. In major events likely to reduce need for tankering and / or over-pumping.
Routine maintenance	Ensure adequate surface water drainage from	Less risk of surface water inundation into the foul
of private surface	properties.	sewers and hence less risk of sewer flooding,
soakaways		sewage treatment works.
Routine maintenance	Ensure adequate highway drainage.	Less risk of surface water inundation into the foul
of highway drainage		sewers and hence less risk of sewer flooding,
		sewage treatment works.
Land drainage	Performance issues in Henton linked to poor land	Less risk of surface water inundation into the foul
improvements in	drainage.	sewers and hence less risk of sewer flooding,
Henton		pollution incidents and storm tank overflows at the
		sewage treatment works.
Strategy for infiltration	Consider a strategy for reducing infiltration into	Less risk of groundwater infiltration into private
through private drains"	the sewer network via private drains if the	drains and hence less risk of sewer flooding, pollution
	cignificant cause for concern	Incidents and storm tank overnows at the sewage
Monitoring and control	Significant cause for concern.	Loss rick of aroundwater infiltration into private
of construction	drainage is fit for purpose	drains and hence less risk of sewer flooding, pollution
standards for private	didilidge is ne for purpose.	incidents and storm tank overflows at the sewage
drains		treatment works
Sharing of information	Agencies to share information to ensure	Identification of most cost beneficial solutions and
<u> </u>	collaborative approach to groundwater	quicker resolution of issues.
	infiltration, surface water inundation, pluvial and	
	fluvial flooding. Use forums as appropriate.	

Table 3 Actions by other stakeholders to prevent flooding

*Thames Water does not have powers to compel customers to repair defective private drains at their cost. At this stage, we do not know how significant infiltration from private drains is within the Chinnor catchment, but we will develop an appropriate strategy as part our of stage 2 risk assessment, when information becomes available and this document is updated. We note that local authorities are only able to instigate action under Section 59 of the Building Act where evidence is provided of a defective private drain.



5 Future challenges

In 2011, Ofwat commissioned Mott MacDonald to look at factors likely to affect sewerage networks in the future. The report 'Future impacts on sewer systems in England and Wales' (June 2011)¹² looked at the likely relative impact of climate change, population growth and impermeable areas up to around 2040. In preparing our plan for 2015-2020, we have also carried out research into these factors across the Thames Water region. We summarise our findings for the Chinnor catchment in this section.

5.1 Urban creep

Urban creep is defined as the transformation of a catchment by the paving over of previously permeable areas, and includes extensions to existing properties and other land use changes. Rather than surface water soaking into the ground when it rains heavily, more water runs off into the sewerage network and can cause the sewers to surcharge and flood. It is therefore important to understand the rate at which urban creep is occurring.

We have studied aerial photography and satellite imagery across 11 catchments across the Thames Water region using data from two periods in the late 1990s and mid 2000s to determine the rate at which urban creep is occurring. We then carried out a statistical analysis and built a model to predict the rate of urban creep for the entire Thames Water region, taking account of factors such as property age, land use, demographics such as family sizes and financial income, need and available space. We found that affluent suburban areas with detached and semidetached properties, where families have young children, are most likely to have high urban creep rates.

The results for the Thames Region are presented in Figure 8 below. The urban creep rate for Chinnor is 0.0953%. In other words, this is the increase in impermeable area per year as a percentage of the total area connected to the sewerage network. When compared

against the rest of the Thames Water region, Chinnor is about average; not as high as suburban areas around central London and major towns. Whilst the immediate issues in Chinnor appear to be strongly related to groundwater, we will continue to monitor change in impermeable area as the strategy continues to develop. If we observe an increase in urban creep, we will raise the issue with South Oxfordshire District Council who is responsible for managing surface water. We may then also look to retrofit sustainable drainage measures (such as permeable paving and water butts), in the area to counter the increased run-off following rainfall, to reduce the risk of flooding.



¹² Mott MacDonald, Future impacts on sewer systems in England and Wales, June 2011 [T0306].

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5.2 Climate change

We have analysed the 2009 UK Climate Projections (UKCP09), to determine the likely increase in rainfall intensity due to climate change in 15 catchments across our region¹³. More intensive rainfall in the future will increase the peak flow in sewerage networks and with it the likelihood of sewer flooding. selected to give a representative sample of inner London, outer London and more rural areas in the Thames Valley. A number of these catchments are also areas which experience sewerage related issues like pollution, flooding and urban creep.

We assessed different combinations of emission scenarios and climate change percentiles for each of the 15 catchments. Chinnor lies in the centre of 5 separate catchments that were analysed for climate change (Abingdon, Bicester, Berkhamstead, Slough and Wokingham). The results show a central estimate of an increase of 13-16% in rainfall by 2080, but in some scenarios this could be as high as 31% or as low as 4%. We will ensure that our strategy takes account of these potential increased peak flows as it develops.

Fifteen catchments across our region were



Figure 9 Locations assessed for increased rainfall intensity by 2080

Increased rainfall intensity may not be the only consequence of climate change. UKCP09 data also suggests that the UK is likely experience longer wetter winters in future. Further research is needed to understand whether high groundwater levels, such as those observed in the winters of 2012/13 and 2013/14 are likely to become more frequent in future. As the recent experience of prolonged rainfall and high groundwater levels have been shown to be the principal factors, this research will be very significant in informing any risk assessment and appraisal of costs and benefits of solutions.

¹³ Atkins, Thames UKCP09 Rainfall Intensity Assessment Revised Report, October 2012.

5.3 Population growth and new development

We use a combination of top-down and bottom-up information to ensure that our forecast of population and new development is as robust as possible to keep costs down, in order to minimise the bill impact of any investment that may be necessary.

Our forecast of the number of new households is taken directly from Experian data. We have used the 'Plan-Based' projection which uses information provided by local authorities about planned numbers of new dwellings in their respective areas. During the period 2015 to 2020 we expect to see an increase in new development across the Thames Water region and are forecasting a total of 263,000 new connections to the sewerage network during this time.

Our Development Tracker System (DTS), is used to track developer enquiries through

the planning process to construction. When we are contacted by a developer, we typically carry out preliminary modelling to determine whether our network or treatment works has the capacity to accommodate the increase in flow. Where it does not, we propose planning conditions for consideration by the Planning Authority, although we encourage developers to contact us as early as possible in the planning process to avoid this.

The independent review into the causes of the 2007 floods (The Pitt Review), concluded sustainable drainage systems (commonly known as SuDS), are an effective way to reduce the risk of 'flashflooding' which occurs when rainwater rapidly flows into the public sewerage and drainage system, causing overloading and back-up of water to the surface. Typically, SuDS slow the rate of surface water run-off and improve infiltration, thus mimicking natural drainage in both rural and urban areas. It now seems likely that the Government will make changes to the current planning regime in order to approve, adopt and maintain SuDS for all new development. This will be a change to the original proposals envisaged in the 2010 Flood and Water Management Act.

In the case of Chinnor, whilst SuDS might help to reduce the risk of flooding following heavy rainfall when groundwater levels are low (i.e. typically during summer months), they will not be effective in reducing flood risk when groundwater levels are high. We will take account of this when we come to assess options as part of this drainage strategy.

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The South Oxfordshire District Council Local Plan states that 160 new homes are required in Chinnor up to 2031 and the South Oxfordshire Strategic Land Availability Assessment identifies a number of possible sites that could deliver homes in the area. The capacity of the sewage system and treatment works will be assessed when we have more information and confidence about location of development. Using sources that include the South Oxfordshire District Council Development Plan, South Oxfordshire Strategic Land Availability Assessment and third party planning enquiries, we are currently tracking:

- 234 dwellings in a mixed use development at Chinnor Cement Works, Chinnor Hill
- 14 dwellings on land at Siareys Yard, Seymor Business Park
- 14 dwellings on land at St Andrews CE School, Station Road
- 39 dwellings at Chinnor Garden Centre, Thame Road
- Commercial site equivalent to net property increase of 18 on land At Former Chinnor Cement Works, Hill Road
- Extension of hotel with a net property increase of 54 at The Lambert Arms Hotel, London Road, Aston Rowant.

Other applications exist but relate to developments where detailed numbers have not been confirmed or are fewer than 10 properties. We will continue to monitor future plans for the catchment through our stakeholder engagement work. A key element of our assessments will be to establish the extent to which these developments may be significant in the context of the sewer flooding challenges currently experienced in the catchment. This assessment work will be undertaken and findings shared in an update to this Strategy document.



6 Strategy development

The drainage strategy for the Chinnor catchment is currently at Stage 1 (Initialise/prepare), of the 4-stage framework process. The following activities in Table 4, are planned and ongoing, in order to carry out the risk assessment and development of our strategy options.

Table 4	Activities	planned and	ongoing to	enable strategy	development
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Activity	Purpose	Date planned	Outcome
Stakeholder engagement	This document will be circulated to the Environment Agency, Lead Local Flood Authority and South Oxfordshire District Council before being published on our website for formal consultation. The Local Flood Forum will continue to be used as the primary route for stakeholder engagement.	Ongoing	Stakeholders informed about progress and timing of works to reduce the risk of flooding. Work carried out by Thames Water is coordinated with activities of other partners involved with drainage.
Permanent monitoring of sewer levels	Eight monitors are currently installed in Chinnor. The plan is for monitors to remain in situ for at least 5 years and to capture the next wet weather event as a minimum. Depths will be recorded, analysed and compared with other catchment variables, such as rainfall events and changes in groundwater levels.	Ongoing	Use information to identify additional actions for inclusion in the drainage strategy for Chinnor. Share information with other agencies.
Sewage treatment works storm discharge monitoring	Monitor the discharges from the storm tanks.	From Autumn 2015	Use information to identify additional actions for inclusion in the drainage strategy for Chinnor. Share information with other agencies.
Customer surveys	Validate the historical records of flooding and restricted toilet use in the catchment to enable a detailed benefits assessment of potential further intervention options that could be implemented by Thames Water.	From Autumn 2015	Use information to help test the cost benefit of options to improve drainage and reduce the risk of sewer flooding in Chinnor.
Sewer and manhole surveys	Ascertain sewer and manhole condition and evidence of infiltration via CCTV survey and manhole "lift and look" surveys, when appropriate.	From Autumn 2015	Use information to identify additional actions for inclusion in the drainage strategy for Chinnor. Share information with other agencies.
Connectivity surveys	Carry out visual inspection of properties to determine the extent of roof drainage and other surface water drainage that discharges into the foul sewer network when appropriate.	From Autumn 2015	A better understanding of the contribution that misconnections make to sewer flooding in the area.

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Activity	Purpose	Date planned	Outcome
Pilot trials biological filter	As part of our wider approach to managing high groundwater levels, we have trialled the use of biological filters within other catchments. Our findings will inform and may influence our strategy plans for Chinnor. If successful, these could be used to abstract dilute sewage from surcharged sewers and discharge it safely to a watercourse.	Ongoing	Service may be restored for customers without the need for tankering.
Update drainage strategy	Improve the drainage strategy based on the initial results from the permanent monitoring, customer surveys, misconnection surveys and feedback from stakeholders.	2017	Risk assessment, options appraisal and preferred strategy to be completed, subject to capturing weather events through monitoring and surveys.
Consider innovative solutions	Identify quicker / cheaper / collaborative options that improve the benefit to cost ratio in order to keep customers' bills down and to prioritise investment to ensure greatest benefit to customers.	Ongoing	Enhanced toolkit available to reduce the risk of sewer flooding and then apply this once data becomes available.

7 Preferred strategy and plan

We believe that the foul sewerage system in Chinnor has surcharged and flooded predominantly due to a combination of groundwater infiltration, surface water run-off from saturated fields, surface water inundation from highways, public spaces and properties and surface water misconnections. Our strategy is to understand the relative impact that each of these factors has on the risk of sewer flooding, and then to develop a plan comprising cost beneficial solutions using customer willingness to pay research.

We may carry out some repair works as this strategy develops, in the event

that our investigations identify faults or problems with the sewerage network that are highly likely to have caused flooding. Table 5 below, details the repair activities that we have identified to date.

Table 5 Activities identified in preferred plan to date

Activity	Description	Date planned	Outcome
Manhole cover replacement	Replace manhole covers in Henton with leak tight covers where identified through survey work.	Ongoing	Reduce ingress of surface water through manholes located in flood plain.
Clearance of drainage ditch that runs through Thames Water's Land	Contractors have been to site to quote to clear the ditch and have contacted UK Power Networks for confirmation of what would be considered a safe working distance from the power cables for plant machinery. More widespread maintenance of land drainage may be required by third parties.	Ongoing	To ensure free flow of surface water in the ditch that TW are responsible for and minimise risk of upstream land drainage flooding.
Permanent monitoring of sewer levels	Continued monitoring of depth monitors for at least 5 years and to capture next wet weather event as a minimum.	Ongoing	Initial data from our monitors indicates significant discharge into the sewer network occurs at regular intervals, suggesting some form of pumped flow, which is to be investigated.

Our plan will be updated once the Risk Assessment and Options Appraisal sections have been completed, in accordance with the Drainage Strategy Framework.



8 Temporary overflows

We have not installed temporary pipework and pumps in the sewerage network during wet weather events in Chinnor to maintain service, but we would consider doing so to prevent the backup of sewerage into customers' properties and uncontrolled spilling from the sewer system into the environment.

As part of the stage 2 risk assessment and stage 3 options appraisal, we will be investigating the circumstances under which emergency discharges would be required in future, such as the use of temporary overflows, to pump out from the sewerage network through biological filters to maintain service to customers and prevent homes from flooding. As this drainage strategy develops, in this section we will describe the location of any proposed temporary overflows and the circumstances under which we would use them, in order that this drainage strategy, together with our plans to reduce infiltration, fully meets the requirements of an Infiltration Reduction Plan as set out in the Environment Agency's Regulatory Position Statement. We will continue to identify sewer rehabilitation and other permanent works to reduce groundwater infiltration alongside refining the use of temporary overflows.

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Appendix A Glossary of terms

Term	Definition	Term	Definition
Blockages	Obstacles or the build-up of fat and grease, block or obstruct our sewerage pipes. This is normally caused by things which should not be flushed, or poured, into drains and sewers.	Inundation	the brickwork or defects in manhole structures. Accumulated surface water from rain and/or river floodwater that has resulted in localised flooding, finds its way into the sewerage
Combined sewer	A pipe conveying the combined rainwater and contaminated wastewater from two or more properties. A combined sewer is designed to carry wastewater to a sewage works for treatment but during periods of heavy rainfall or snowmelt, the volume in a combined sewer system can exceed the capacity of the sewer	Lateral drain Misconnections (surface water to foul water)	system through manhole covers and drains. These may be public or private. See definition for Foul drain. Property owners have connected rainwater and/or land drainage to our sewers (e.g. roof drainage, paved driveways drains, soakaway overflows), and can cause major issues for the performance of the sewerage system.
	system or treatment plant. For this reason, combined sewer systems are designed to overflow occasionally and discharge excess wastewater directly to nearby streams, rivers, or other water courses	Misconnections (foul water to surface water) Private sewers Painfall induced	A plumbing mistake resulting in wastewater appliances being misconnected to the surface water system. See definition for Foul sewer.
Dry weather flow	The average flow rate observed over a 24 hour period in dry weather and based on Sewers for Adoption, the industry standard, includes an allowance for infiltration of 10%	Riparian owner	of rainfall percolating into the ground impacting the sewer on route to recharging the groundwater table. If you own land adjoining, above or with a
Foul drain	of the calculated flow rate. A pipe conveying the contaminated wastewater from a single property. If the pipe extends beyond the property boundary, the portion of the pipe outside of the boundary is termed a lateral drain. The		watercourse running through it, you have certain rights and responsibilities. In legal terms you are a 'riparian owner'. If you rent the land, you should agree with the owner who will manage these rights and responsibilities
	portion of the pipe inside the boundary is a private drain. On 1 October 2011 water and sewerage companies in England and Wales became responsible for lateral drains, which were previously the responsibility of property owners. Private drains remain the	Soakaway Surface water	Surface water from a roof and driveway of a property is piped to an underground pit, usually filled with gravel or similar material. Some soakaways are situated within the boundary of the property. A pipe conveying uncontaminated rainwater
Foul sewer	responsibility of property owners. A pipe conveying the sewage from two or more properties. On 1 October 2011, water and sewerage companies in England and Wales also became responsible for private sewers, which were previously the	drain Surface water sewer	from a single property. A pipe containing uncontaminated rainwater from two or more properties. A surface water sewer is designed to dispose of rainwater from roofs, driveways, patios, roads etc to a local watercourse
	responsibility of property owners. A foul sewer is designed to carry contaminated wastewater to a sewage works for treatment. It disposes of wastewater from sources including toilets, baths, showers, kitchen sinks, washing machines and dishwashers.	Sustainable Drainage Systems (SuDS)	Measures designed to attenuate and slow down surface water before it enters sewers to reduce the risk of flooding following heavy rainfall. Includes green infrastructure such as raingardens, green roofs as well as other measures, such as permeable paving and water butts.
Infiltration	Groundwater finds its way into the sewerage system (including private drains), via defective pipes or pipe joints and through		



Appendix B Supporting figures and photographs

Figure B1 Fluvial Flood Risk for Chinnor based on Environment Agency plans

This flood risk map information has been sourced from the Environment Agency website. For more detailed flood map information for this catchment, please access the Environment Agency website.



Figure B2 Surface water flood risk for Chinnor based on Environment Agency plans

This flood risk map information has been sourced from the Environment Agency website. For more detailed flood map information for this catchment, please access the Environment Agency website.







ESI Groundwater Flood Risk Map of England and Wales © www.esinternational.com

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Figure B4 Watercourses in Chinnor

This geological map information has been sourced from the British Geological Survey website. For more detailed geological information for this catchment, please access the British Geological Survey website.



Figure B5 Chinnor Bedrock and Drift Geology showing chalk extent

This geological map information has been sourced from the British Geological Survey website. For more detailed geological information for this catchment, please access the British Geological Survey website.





Photographs taken during wet weather events



Photo 1 - Surface flooding and field runoff inundating Manor Farm Road SPS, Sydenham



Photo 2 - Surcharging manhole in Sydenham







At the heart of daily life