Didcot Drainage Strategy

Stage 1 - Initialise/Prepare

Thames Water

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 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.

This document contains:

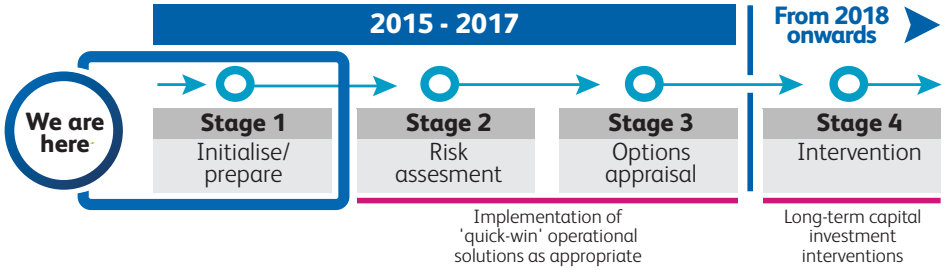
- an Introduction to the work we are undertaking to alleviate sewer flooding in our region
- a Feedback: Q&A section addressing key questions from customers and stakeholders
- the Didcot Drainage Strategy technical document.

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, the water industry economic regulator, to produce a drainage strategy for our affected catchments with a primary focus on our sewerage network. 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.

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?

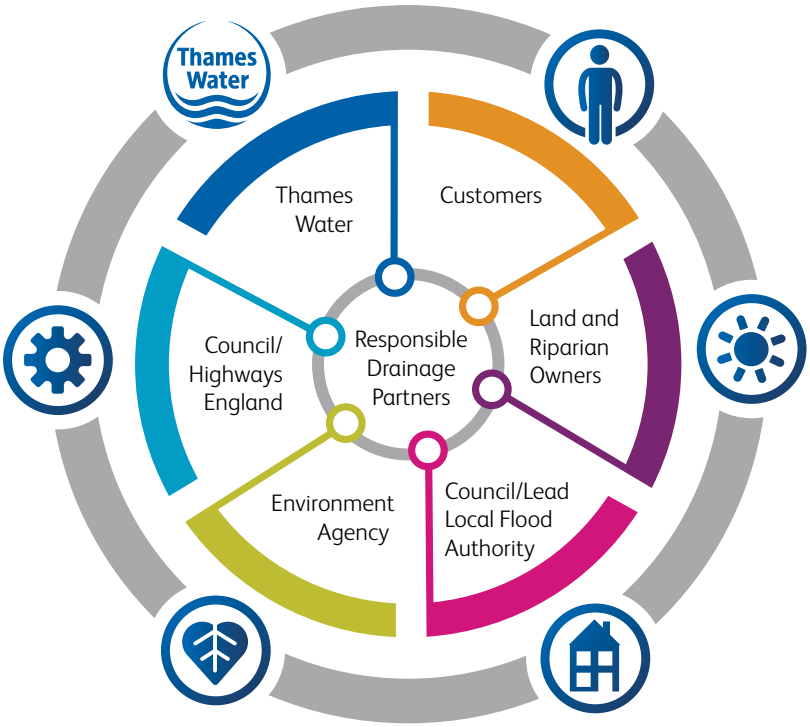
There are a number of stakeholders who, like us, have important drainage responsibilities and therefore, play an essential role in resolving sewer flooding in our region. These stakeholders include customers, private land owners and the Environment Agency; to name but a few. We are seeking to work in 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



Next steps

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

2015 - 2017

Customer Focus Actions

- 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.

Partnership Actions

- Continue to establish partnership working with the regional drainage stakeholders, and agree ongoing consultation processes.

Other Key Actions

- 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.

Feedback: Q&A

Your questions answered

We are committed to listening to, consulting and collaborating with customers and stakeholders on our sewerage network activities and plans. We have addressed key feedback and questions raised by customers and stakeholders in the Didcot 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.

We are committed to **listening to, consulting and collaborating** with customers and stakeholders on our sewerage network activities and plans.

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 and will update this as our plan develops through Stage 2 to Stage 3 –Option Appraisal. Therefore, this more detailed approach is required to ensure that the most effective and sustainable drainage strategies are implemented in the Didcot catchment.

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

Answer

As stated above, we are developing our plan for this area and will provide further details as our plan develops through Stage 2 to Stage 3 – Option Appraisal. The following drainage actions have already been undertaken, or are underway, in the Didcot catchment:

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

1. Sewer cleaning
2. Sewer surveys within the Upton sub-catchment
3. Flooding clean-up activities within the Upton sub-catchment
4. Tankering of flows from sewage pumping stations within catchment
5. Sewer CCTV surveys in Upton and Chilton
6. Installation of sewer monitors
7. Replacement of pumps and controls at Dene Hollow sewage pumping station.

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

1. Stakeholder engagement activities
2. Permanent monitoring of sewer levels
3. Permanent monitoring of pumping station
4. Customer surveys
5. Sewer and manhole surveys
6. Connectivity surveys
7. Innovative solution analysis.

Q3 Are you renovating the sewers in our area?

Answer

We will renovate sewers which have been damaged, either as they have aged or through other streetworks activities. As our 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 over the coming months.

Q4 What are the improvement plans for Didcot's sewage treatment works to manage capacity?

Answer

The Didcot sewage treatment works operates a fully-compliant permanent storm overflow which permits us to discharge into local watercourses during storm events. To meet changing performance requirements and regulatory measures the works has undergone upgrades over the years. The capacities of the sewage treatment works has been assessed to be more than adequate under normal design flow conditions. However, significant growth is being considered for Didcot in the coming years and therefore, we are working with South Oxfordshire District Council and Vale of White Horse District Council, to understand the phasing and implications of this growth on the sewage works.

Q5 How are you planning for future development in the Didcot 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. However, as per Q4 above, significant growth is being considered for Didcot in the coming years and therefore, we are working with South Oxfordshire District Council and Vale of White Horse District Council, to understand the phasing and implications of this growth on both the sewerage system and sewage treatment works.

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.

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

Answer

Based on the findings of our recent CCTV surveys, we have undertaken work to clean sections of the sewers which were congested by grit and debris. 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 highway 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 local councils 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 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.

Following extreme weather conditions during the winters of 2012/13 and 2013/14 tankering was utilised in the Didcot catchment, however temporary pumps were not used. 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.

Q8 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.

Q9 How are you ensuring that our local pumping stations are operating effectively?

Answer

The pumping stations within our sub catchments are supported by 24 hour diagnostic monitoring so that we can tightly control their 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.

The pumps and control equipment within the local pumping stations have been replaced over the years, as the equipment has worn or aged. The most recent replacement work was undertaken at the Dene Hollow sewage pumping station, we replaced the pumps and control equipment at this station in March 2015.

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 of these stations, particularly during wet weather, carefully avoiding increasing the risk of sewer flooding in doing so.

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

Answer

When compared against the rest of the Thames Water region, the urban creep rate for Didcot is just above average for the Thames Water Operational Area, but not as high as suburban areas around central London and major towns.

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 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, we are also investigating deploying mobile biological filters and screening 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.

Didcot Drainage Strategy

Technical Document

Thames Water

At the heart of daily life

Stage 1: Initialise / Prepare

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About this document

Based on customer research

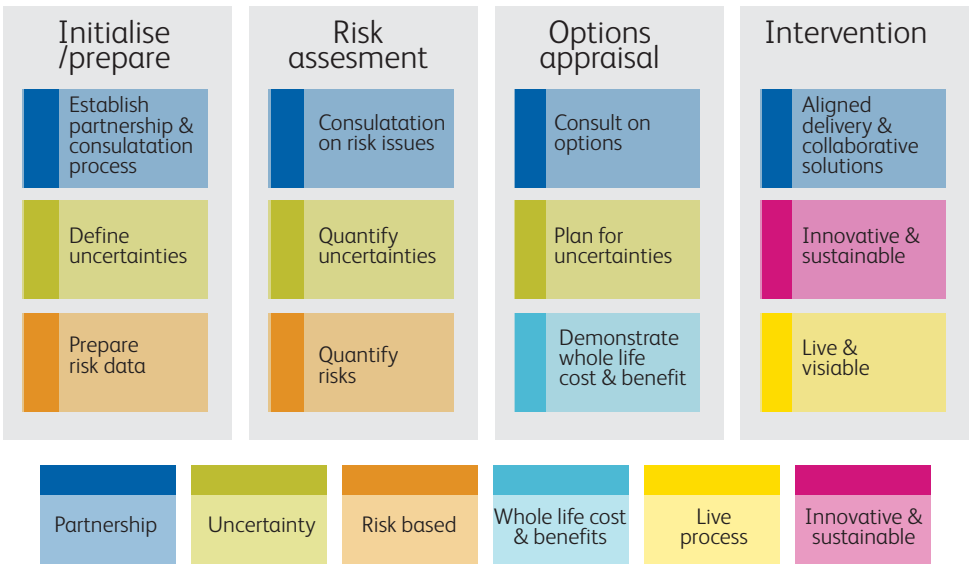
Undertaking extensive customer research has been a fundamental step in our business plan preparation for 2015-20. Our research findings have informed our business planning activities, and contributed to the development of a set of long-term customer 'outcomes'.

The water industry economic regulator, Ofwat, defines 'outcomes' as "High-level objectives that company actions, activities and achievements are intended to help deliver..[they] represent what customers and society value". As a company, we are committed to achieving our customer outcomes, a number of which are focussed on alleviating sewer flooding issues within our region, through effective, economic and sustainable drainage. This document describes the strategy that we will follow in delivering our long-term customer outcomes for drainage, specifically in the Didcot catchment, in a sustainable and economic manner.

Approved approach

We have adopted the Drainage Strategy Framework[1] 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 typically focus on the sewerage network, and not the performance of sewage treatment works The Didcot 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.

Figure 1 The Drainage Strategy Framework



[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 customers and stakeholders. We will also make the Drainage Strategy documents available on the Drainage Strategies webpage of our website.

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

Executive summary

In recent years the foul sewerage system in a number of the villages in the Didcot catchment has become overwhelmed in some locations, following prolonged and heavy rainfall and raised groundwater levels. This has resulted in certain properties suffering from sewer flooding and restricted toilet use.

We believe that the systems have surcharged because of a combination of groundwater infiltration to public and private drainage, groundwater run-off from saturated fields, surface water inundation from highways, public spaces and properties and surface water misconnections.

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. The Floods 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 a RMA, Thames Water will work with Oxfordshire County Council as lead local flood authority, South Oxfordshire District Council, Vale of White Horse District Council and the Environment Agency, to ensure that a collaborative approach can be developed to address the problems.

In response, this Drainage Strategy follows the Environment Agency and Ofwat's 4-stage framework. The Didcot strategy is currently at Stage 1 (Initialise/Prepare). We describe in this document the actions that we plan to carry out to complete the 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 service[2]; 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 Didcot 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 customers' expectations and regulatory requirements.

This Drainage Strategy must also address future challenges to the Didcot 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
- 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 Didcot are just above average for the Thames Operational Area
- Population growth – the population in the South East is set to grow rapidly. A number of possible developments are identified around Didcot, and we will continue to track these and any other emerging applications for this catchment arising in the future.

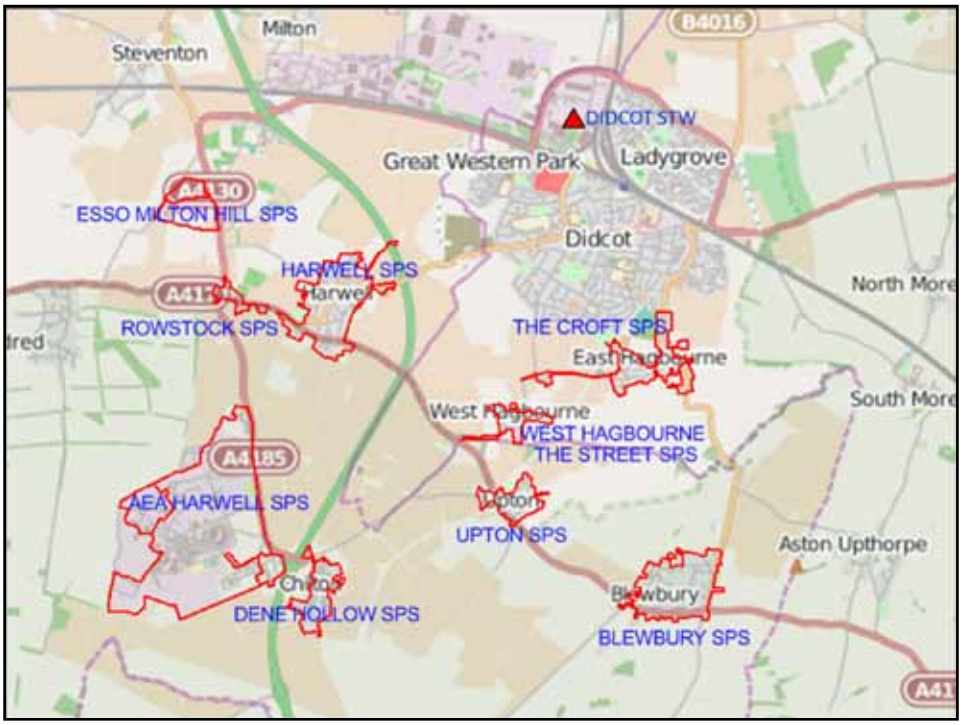
Our strategy is to understand the relative impact on this catchment of overland flow from saturated fields, groundwater infiltration and surface

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

water misconnections. We will then try to identify cost beneficial solutions to reduce the risk of sewer flooding using customer 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 are to continue to collect real-time flow information from the permanent depth monitors we installed at the end of 2014, and to collect sewer flooding information from customers. The depth monitors will remain in place as we move through this 4-stage framework and develop our plans. The priority sub-catchments we are monitoring are outlined in Figure 2 below.

Figure 2 Didcot priority sub-catchments



The extent of the priority 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 responsibility[3].

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).

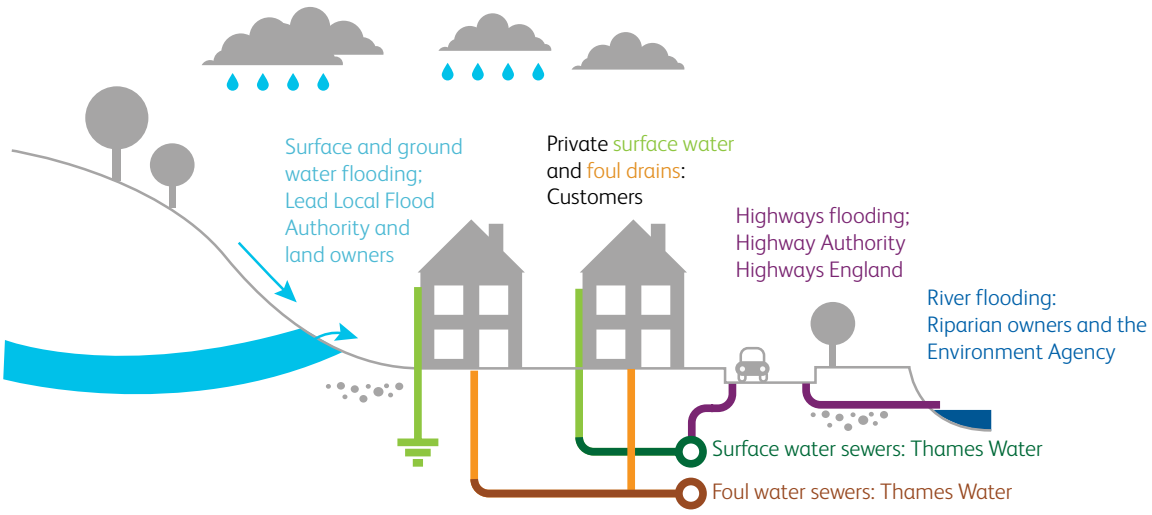
A comprehensive and detailed list of all legislation relevant to Thames Water can be found in the 'statement of obligations' published by Defra[4].

[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



Thames Water

We are responsible for removing and treating wastewater, which includes the foul sewers, and in some areas the combined sewers that are in some of the older large urbanised areas, such as London[5]. We also manage and maintain surface water sewers where they exist, these will typically discharge to a watercourse or river. 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.

Lead Local Flood Authority and District Council

Oxfordshire County Council is the Lead Local Flood Authority and has 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 culverts. 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. South Oxfordshire District Council and Vale of White Horse District Council are the Planning Authorities responsible for approving new development, but equally may have responsibility for ensuring maintenance of watercourses; particularly on council-owned land.

Highway Authority

Oxfordshire County Council is the Highway Authority and is responsible for highway maintenance and highway drainage and for clearing roadside gullies. Highways England is responsible for the drainage of motorways and certain trunk roads.

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 2011[6].

Riparian Owners

Riparian Owners are landowners who own land with watercourses or land adjacent to watercourse (ie road side ditches)[7]. 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] See http://www.thameswater.co.uk/help-and-advice/8654.htm for more information.

[7] 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.

2 Catchment description

2.1 Geology and topography

The Didcot sewerage catchment is approximately 15km south of Oxford, and comprises Didcot town centre along with the settlements of Blewbury, Chilton, Dene Hollow (part of Chilton), East and West Hagbourne, Harwell, Milton Hill and Upton. The catchments to the south of Didcot are affected during periods of prolonged heavy rainfall and high groundwater levels.

Whilst Harwell, Chilton and East Hagbourne are situated in areas of clayey soils, the remaining catchments are situated in an area that has a geological make up of permeable, sandy and loamy soils. As such, it is prone to significant seasonal fluctuations in groundwater levels, with the added likelihood of rainfall induced infiltration[8].

Appendix B includes maps showing the geology and fluvial, pluvial and groundwater flood risk areas in the catchment.

Several rivers and principal watercourses run through the area, including Mill Brook and Moor Ditch. According to the Environment Agency, the current ecological status of Mill Brook is 'Moderate' and the Moor Ditch is 'Poor'[9].

2.2 Sewage treatment works

The Didcot sewerage treatment works serves the settlements of Blewbury, Chilton, Dene Hollow (part of Chilton), East and West Hagbourne, Harwell, Milton Hill and Upton as well as Didcot town centre, a population equivalent of circa 37,000. The works treats a daily dry weather flow of around 11,500 m^3/day, and the treated effluent is discharged to the Moor Ditch.

During extended wet periods, treated flows at Didcot sewage treatment works can be in excess of 30,000 m^3/day. The works includes storm tanks to handle excess flows above the flow to full treatment during storms prior to being returned to the inlet should flows allow. If the flows are too great and the storm tanks are full then the storm tanks will discharge to the Moor Ditch.

The sewage treatment works had a number of upgrades over the years to meet changing performance criteria, on both effluent and sludge streams. Its most recent major upgrade was undertaken in 2009. The capacities of the treatment works have been assessed to be adequate under current normal design flow conditions. However, significant growth is being considered for Didcot in the coming years and therefore, we are working with South Oxfordshire District Council and Vale of White Horse District Council to understand the phasing and implications of this growth on the sewage treatment works.

[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 sewerage system serving the villages in the priority catchment, is believed to date from the 1950/60s and is likely to have been implemented by the District Council as a first-time sewerage scheme. Each village within the catchment has a local foul gravity sewerage system that drains to a pumping station. The station transfers flow to the next village's gravity system and then to the sewers in the town of Didcot, before draining by gravity to the Didcot sewage treatment works. This is outlined in the catchment schematic in Figure 4 below.

Sewer design criteria ensures the appropriate sizing and laying of pipes at a gradient to maintain a satisfactory self-cleansing characteristic. The capacity of sewers is typically set to cater for six times Dry Weather Flow and a 10% allowance is included for infiltration[10]. A 225mm diameter sewer laid at a gradient of 1 in 150 will have 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 with diameters 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.

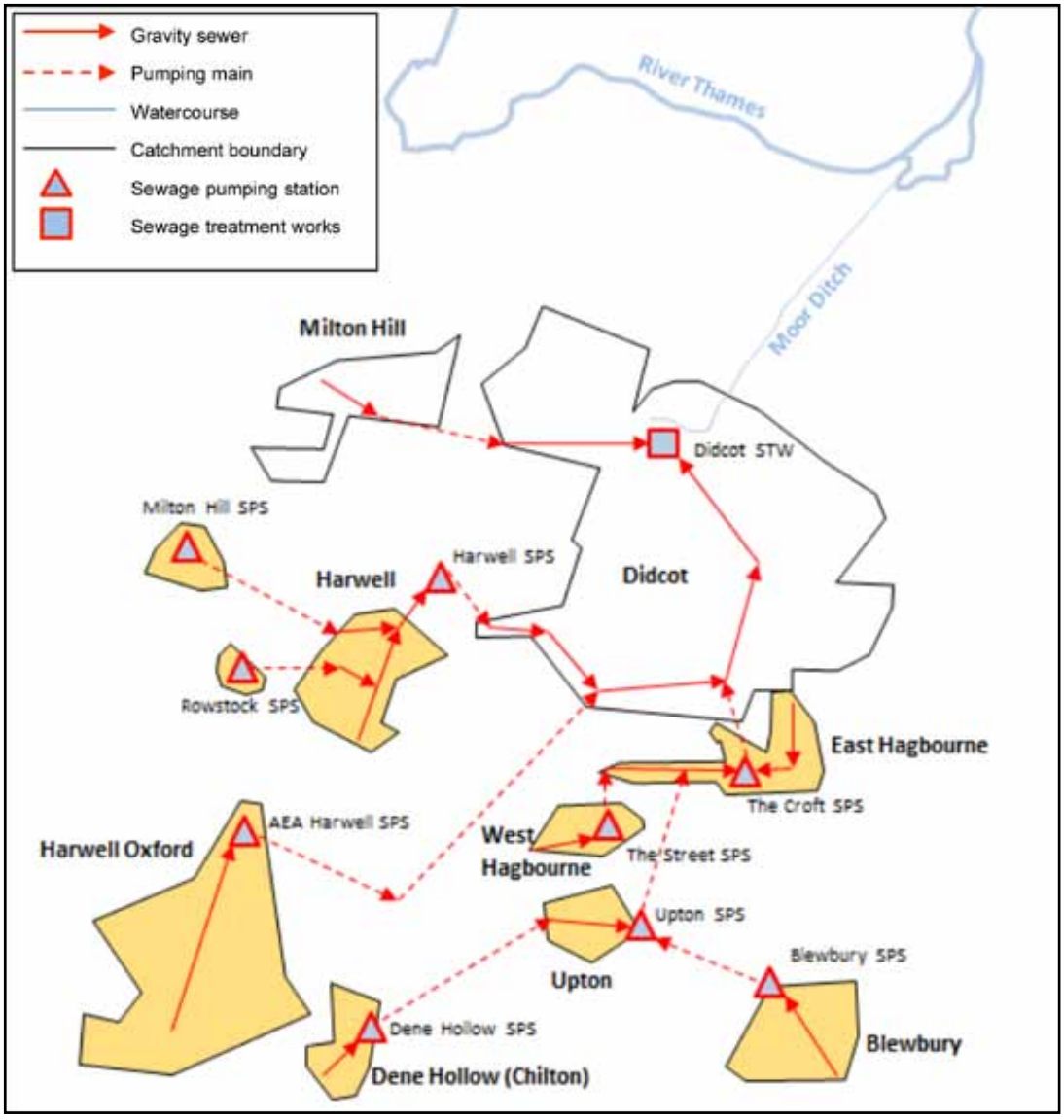
Harwell and Chilton both drain via gravity sewer and then pump their flows directly to the southwest of the Didcot catchment. Dene Hollow sewage pumping station pumps its flow to West Upton where flows combine and drain via gravity sewer to Upton sewage pumping station in the east. Flows from Blewbury combine here and all sewage is pumped to East Hagbourne. Flows from West Hagbourne are also pumped to East Hagbourne and all drain into the Didcot sewerage network and continue to Didcot sewage treatment works. The foul sewerage pipes range from 100mm and 300mm within the network to the south of Didcot, and serve a population of approximately 1450. The capacity of the foul sewers is therefore more than adequate under normal dry weather conditions.

A number of the catchment's sewage pumping stations have had pump and control equipment replacements over the years, as the equipment has worn or aged. Most recently, the pumps and control equipment at Dene Hollow pumping station were replaced in 2015.

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 deteriorate over time. The 1950s pipes were laid on bedding material such as pea shingle, with the trenches likely to have been backfilled with 'as dug' material. More recent drains and sewers, i.e. since the 1980s, are typically surrounded with pea shingle. This protects the pipe but also acts as a good conduit for groundwater. The layout of the village suggests that most properties are likely to have their own foul drains (as opposed to shared drains), that connect directly into the public sewer. The private foul water drains within the property boundaries in villages are the responsibility of the property owners, where they are not shared.

[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 Didcot sewerage catchment, showing principal assets



2.4 Surface water sewers

There are very few surface water sewers in the priority sub-catchments. There are a few surface water sewers in Blewbury, Dene Hollow, Harwell and Upton. The majority of the surface water within the catchment is likely to drain to local drainage ditches or nearby soakaways. Soakaways can only function satisfactorily when ground conditions allow soakage and may be completely ineffective when groundwater levels are high. In some areas, we have seen examples of customers draining surface water through their foul drains when their soakaways do not work. This exacerbates capacity problems for other customers connected further downstream in the sewerage network.

The sub-catchments are mostly rural and incorporate minor watercourses that are intended to take surface water from roads and public spaces. As per Section 1.2, the responsibility for the operation and maintenance of these local watercourses and general land drainage lies mostly with riparian owners. Oxfordshire County Council as lead local flood authority has overall responsibility for managing groundwater.

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

The Environment Agency has the duty and the authority to ensure that main rivers are maintained appropriately. The responsibility for the maintenance lies with the riparian owners.

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 in Table 1 below and on our website[11].

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 require it.	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.
	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.

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 Didcot 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 re-routing 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 design 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 systems in the catchments south of Didcot have 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 network:

- Restricted toilet use and external foul flooding of properties in Dene Hollow and Upton
- Pollution incidents caused by sewage spilling from manholes.

Sewage pumping stations in each sub-catchment were in constant operation during the winters of 2012/13 and 2013/14, indicating that significant quantities of groundwater and surface water were in the foul sewers in addition to the foul water which they are designed to pump.

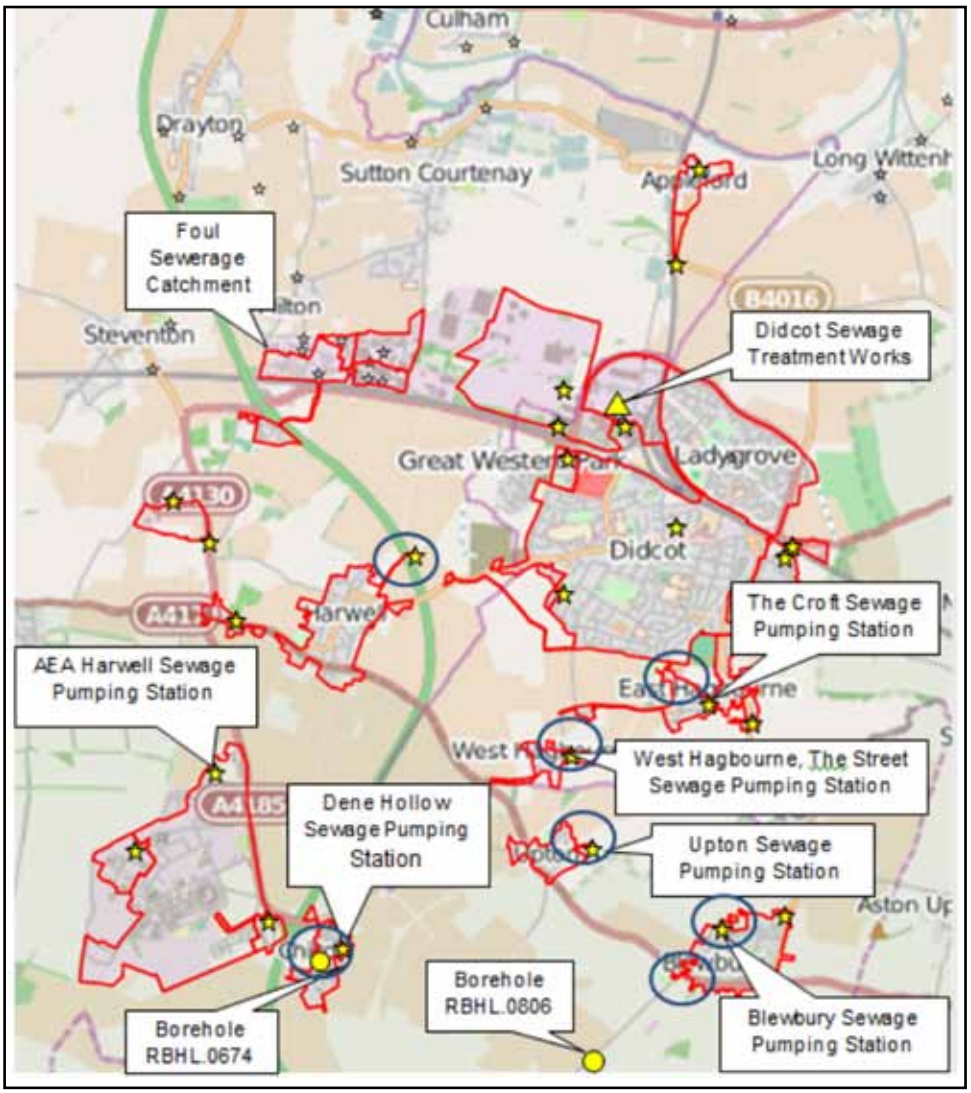
During these events, other sources of flooding have also been observed:

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

To reduce the risk of flooding, in some locations residents have had to pump floodwater onto the highway or protect their properties with sandbags.

The locations of the recorded issues are identified in Figure 5 below.

Figure 5 Didcot sewerage catchment performance issues



The red lines indicate the extent of the foul water catchment and the blue circles indicate the extent of flooding in the area. The yellows stars indicate the location of sewage pumping stations.

4.2 Our operational response

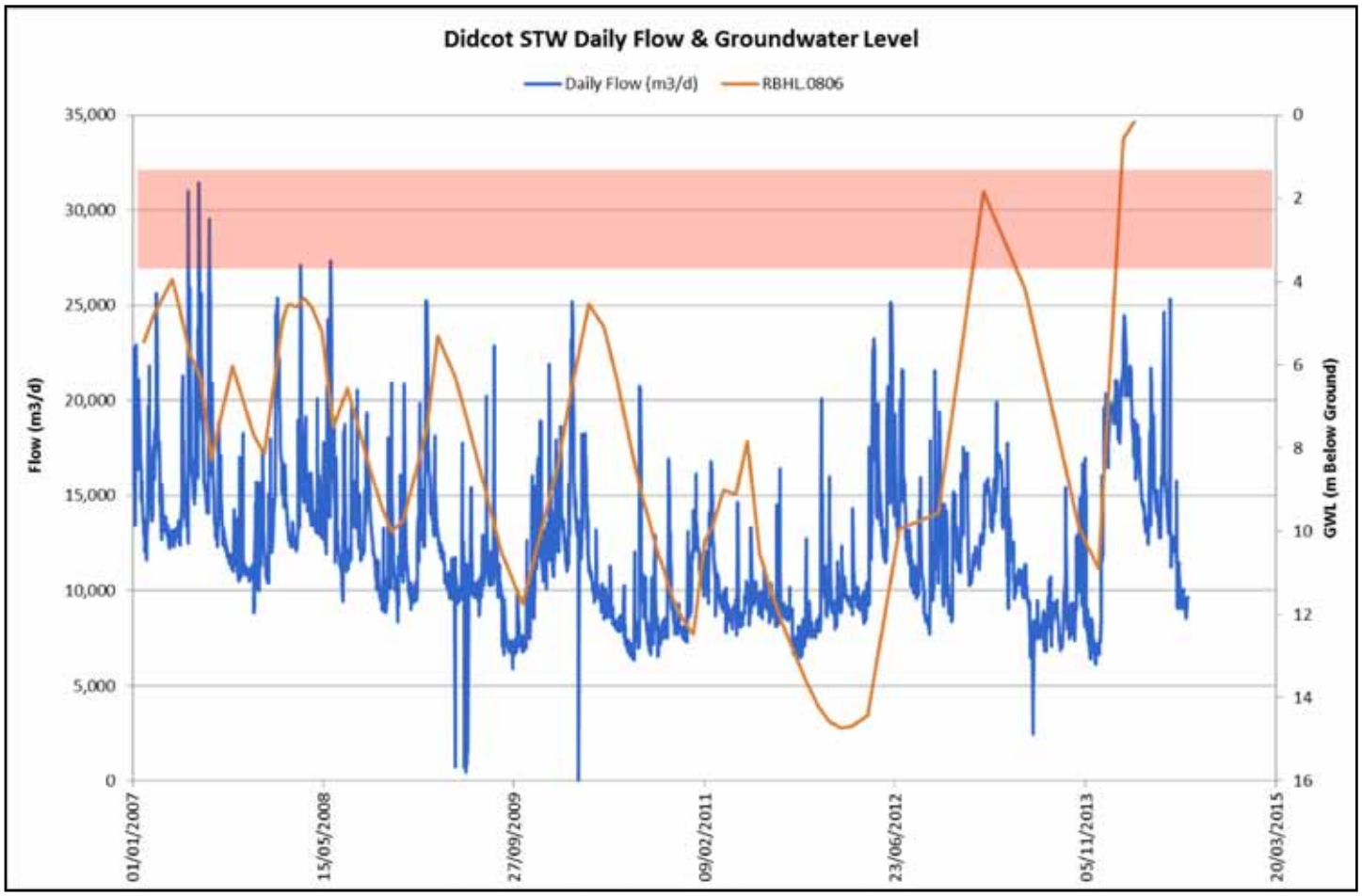
To maintain service, tankers were used regularly in the winter of 2012/13 in Harwell, Upton, West Hagbourne and Dene Hollow, to manage flows within the sewer network and prevent flooding in the vicinity of the sewage pumping stations and other locations. Tankers have limited capacity and can only draw 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 most at risk of flooding inside their homes. For this reason, and recognising the limited effectiveness of tankering following more extreme weather conditions, tankering was only utilised in the Didcot catchment on a limited basis and the majority of tankers were deployed in other areas.

To date we have not installed temporary pumps to discharge excess flows to neighbouring watercourses during prolonged wet weather, but we will investigate the benefits of doing so as this Drainage Strategy develops. There may be circumstances that might necessitate this practice. Even if flows can be contained within the sewer network, excessive flows arriving at the treatment works may not always be given full treatment prior to discharge to the watercourse. The use of such storm sewage overflows is accepted by our regulators, subject to conditions. During extended wet periods, treated flows at Didcot sewage treatment works can be in excess of 30,000 m^3/day, which is nearly three times greater than the typical daily dry weather flow of 11,491 m^3/day.

Figure 6 below, compares the treated flows at Didcot sewage treatment works with groundwater levels recorded at Environment Agency borehole RBHL.0806, located to the south of Blewbury. This shows that the ground water levels rose in 2012/13 and peaked during the 2013/14 winter at ground level. This also compares to the sewer levels within the sub-catchments, which are typically 1.0m to 3.5m deep and so will have been within the groundwater table for both of these periods. The flow data also indicates increased flows at a time when the ground water is much lower, suggesting that rainfall and surface water misconnections may also contribute to high flows within the foul sewerage network.

Figure 6 Didcot 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 Didcot sub-catchments. These form the extent of our current understanding of issues.

Table 2 Investigations and activities completed

Activity	Purpose	Date complete	Outcome
Sewer cleaning	Sewer cleaned (removal of clay) along Crafts End & Main Street, Chilton.	April 2012	Maintain 'asset health'.
Sewer surveys	Ascertain sewer condition and evidence of infiltration within the Upton Sub-catchment.	May 2012	Assess 'asset health'.
Flooding clean-up	3 clean-up activities undertaken between December 2012 & January 2014 within Upton.	Jan 2013	Public health and safety.
Maintenance of flows	Tankering of flows from sewage pumping stations within catchment.	Feb 2013	Short term discharges to reduce impact of surcharged sewers.
Sewer cleaning	Sewer cleaned (removal of grit, debris & blockage) along Reading Road & Church Street, Upton.	Feb 2013	Maintain 'asset health'.
Flooding clean-up	19 clean-up activities undertaken between December 2012 & January 2014 within Upton.	March 2013	Public health and safety.
Sewer CCTV surveys	Identification of possible defects on foul sewer in Upton – includes 140m section in Reading Road and 70m in Church Street.	April 2013	Assess 'asset health'.
Sewer CCTV surveys	Identification of possible defects on foul sewer in Main Street, Chilton.	March 2014	Assess 'asset health'.
Maintenance of Flows	Twice daily tankering during Feb 2013 and March 2014.	March 2014	Short term discharges to reduce impact of surcharged sewers.
Permanent monitoring of sewer levels	Installation of permanent depth monitors into the foul sewers at three locations in Blewbury and East Hagbourne. 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. Analysis of the recorded depths and compare with other catchment variables, such as rainfall events and changes in groundwater levels.	Dec 2014	Use information to identify additional actions for inclusion in the drainage strategy for Didcot. Share information with other agencies.
Pumping station refurbishment	Replacement of pumps and control equipment at Dene Hollow sewage pumping station.	March 2015	Maintain 'asset health'.

In summary, following previous concerns that the foul sewerage network becomes overwhelmed by groundwater and surface water, considerable effort has been made to identify potential points of ingress on the public network. Although maintenance carried out may have been locally successful, it has not impacted significantly on the extent of surcharging and flooding seen in the winter of 2013/14. This may due to our earlier work focussing only on public sewers within our ownership, and not private sewers and drains, or inundation from surface water ponding or misconnected properties.

Survey works have been carried out in the catchment over recent years and further survey and investigation is required to identify sources of inflow and their resolution. Permanent depth monitors were installed in the catchment in 2014, and further monitoring is planned to better understand this impact. We will continue to assess this data as our strategy develops through this 4-stage framework process.

4.4 Activities carried out by drainage partners

Table 3 below, details the activities carried out by other stakeholders with drainage responsibilities within the Didcot catchment, 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.

Table 3 Actions by other stakeholders to prevent flooding

Activity	Purpose	Impact on sewerage
Routine maintenance of local watercourses and local ditches	Ensure free flow of river and ditches.	Less risk of surface water inundation into the foul sewers and hence less risk of sewer flooding, pollution incidents and storm tank overflows at the sewage treatment works.
Routine maintenance of private surface water drainage and soakaways	Ensure adequate surface water drainage from properties.	Less risk of surface water inundation into the foul sewers and hence less risk of sewer flooding, pollution incidents and storm tank overflows at the sewage treatment works.
Routine maintenance of highway drainage	Ensure adequate highway drainage. Ensure effective land drainage.	Less risk of surface water inundation into the foul sewers and hence less risk of sewer flooding, pollution incidents and storm tank overflows at the sewage treatment works.
Routine maintenance of land drainage Strategy for infiltration through private drains*	Consider a strategy for reducing infiltration into the sewer network via private drains if the permanent monitoring identifies this as a significant cause for concern.	Less risk of surface water inundation into the foul sewers and hence less risk of sewer flooding, pollution incidents and storm tank overflows at the sewage treatment works.
Monitoring and control of construction standards for private drains	Local Authority Building Control to ensure private drainage is fit for purpose.	Less risk of groundwater infiltration into private drains and hence less risk of sewer flooding, pollution incidents and storm tank overflows at the sewage treatment works.
Sharing of information	Agencies to share information to ensure collaborative approach to groundwater infiltration, surface water inundation, pluvial and fluvial flooding. Use forums as appropriate.	Identification of most cost beneficial solutions and quicker resolution of issues.
Addressing misconnected properties	Seek to address properties which may have rainwater down pipes connected into the foul drains.	Work with local authority to identify alternative sources of surface water disposal.

*Thames Water does not have powers to compel customers to repair defective private drains at their cost. At this stage, we do not have the data to show how significant infiltration from private drains is within the Didcot catchment, but we will develop an appropriate strategy when this information becomes available. 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 Didcot catchment in this section.

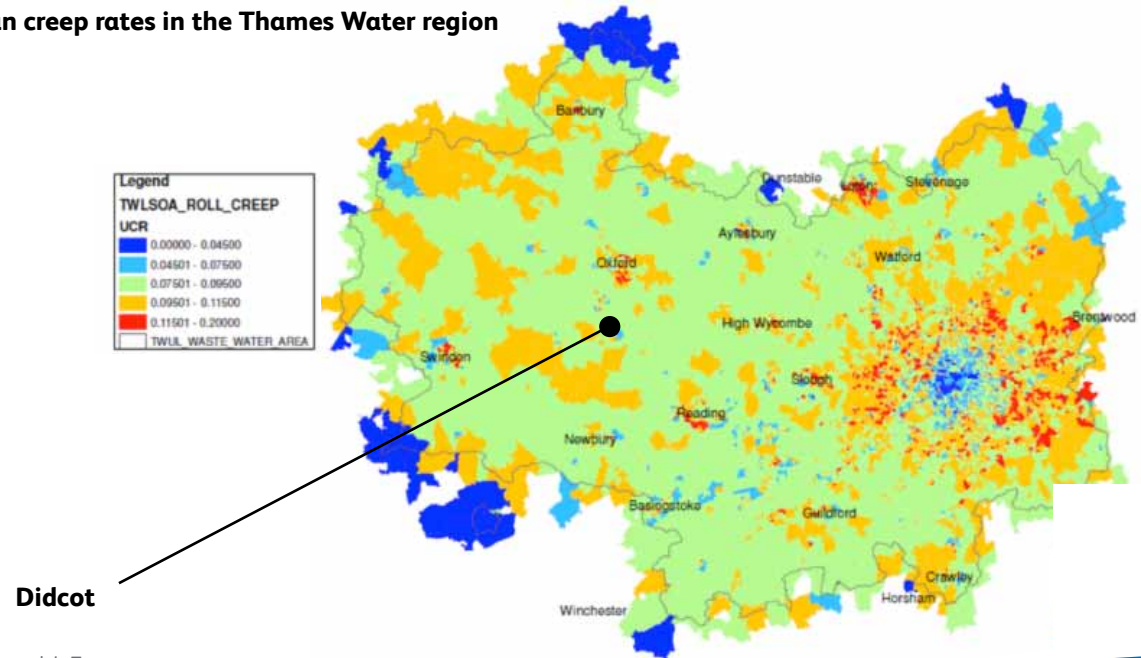
5.1 Urban creep

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 semi-detached 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 7 below. The urban creep rate for Didcot is 0.0956%. 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, Didcot is slightly above average, but not as high as suburban areas around central London and major towns. Whilst the immediate issues in Didcot 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 Oxfordshire County Council who are responsible for managing surface water in the majority of the catchment (including the primary catchment. 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.

Figure 7 Urban creep rates in the Thames Water region



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

5.2 Climate change

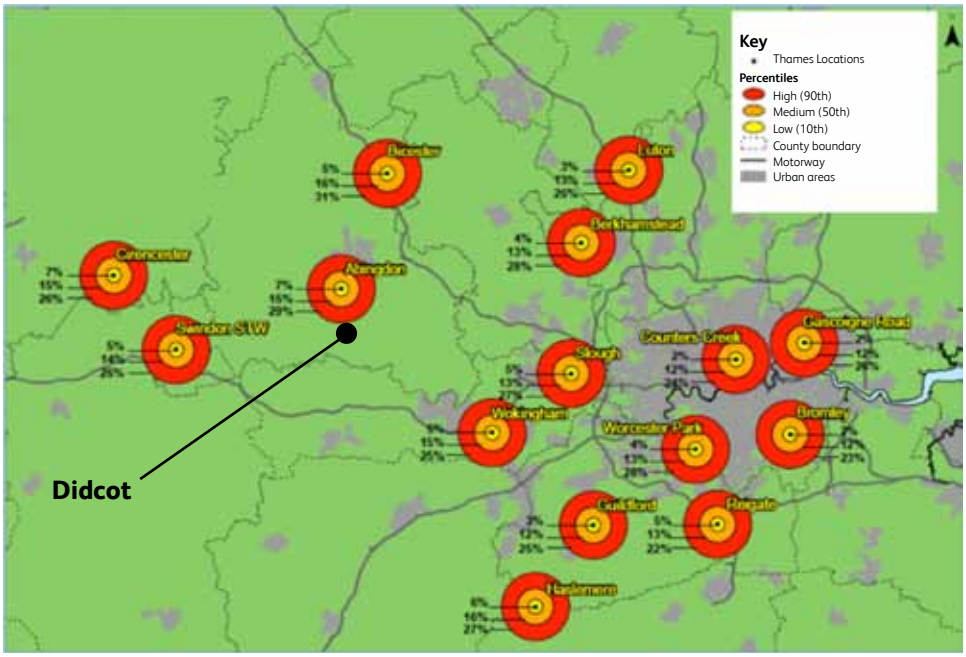
We have analysed the 2009 UK Climate Projections (UKCP09) to determine the likely increase in rainfall intensity due to climate change in 15 catchments across our region[13]. More intensive rainfall in the future will increase the peak flow in sewerage networks and with it the likelihood of sewer flooding.

Fifteen catchments across our region were 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.

The nearest catchment to Didcot that was analysed for climate change was Abingdon. The results show a central estimate of an increase of 15% in rainfall by 2080, but in some scenarios this could be as high as 29% or as low as 7% as per Figure 8. We will ensure that our strategy takes account of these potential increased peak flows as it develops.

Figure 8 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 to 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 'flash-flooding' which occurs when rainwater rapidly flows into the public sewerage and drainage systems, causing overloading and back-up of water. Typically, SuDS slow the rate of surface water run-off entry into the drainage system and improve the percolating feature, ie rainfall recharging the groundwater system, thus mimicking natural drainage processes. In April 2015, the Government made changes to the planning process effecting planning policies and decisions on planning applications of 10 dwellings or more (or equivalent non-residential or mixed development), to ensure that sustainable drainage systems are put in place, unless demonstrated to be inappropriate. This requires that when considering planning applications, local planning authorities should consult the relevant Lead Local Flood Authority (County Council or Unitary Authority), on the management of surface water, to satisfy themselves that the proposed standards of operation are appropriate and ensure, through the use of planning conditions or planning obligations, that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

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

Using sources that include the South Oxfordshire District Council Development Plan, South Oxfordshire Strategic Land Availability Assessment, Vale of White Horse District Council Local Plan and third party planning enquiries, we are currently tracking:

- The proposed Great Western Park development which includes the construction of 3300 new residential properties, located just off the A4130 to the west of Didcot town centre
- The proposed Valley Park (to the north west of Great Western Park), which includes the construction of 2150 units over 15 years
- Land to the West of Great Western Park (Valley Park), Didcot (in the parishes of Harwell and Milton), 4250 dwellings
- The proposed North East Didcot development, which includes the construction of 2030 new residential

properties, 32 flats, a retail food store, two primary schools, one secondary school, two care homes, retail space, a 60-bed hotel, a pub and a nursery
- The proposed Ladygrove East development containing 642 units which has been permitted subject to s106 but still contains issues
- The Vauxhall Barracks development for 300 units has an LP allocation but is being retained by the MoD until at least 2016
- The proposed Orchard Centre Phase 2 which includes the construction of 300 units
- The proposed Didcot Windfalls development which would include the construction of 365 units over a 20 year period
- The Harwell Oxford Campus (phase 1 and 2), which would bring 400 new units – currently under consideration
- The proposed development south of Chilton Fields involving the construction of 275 units – currently under consideration.

Other applications exist but relate to developments in which detailed numbers have not been confirmed, or are single 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. Concerns have been raised with both Oxfordshire District Council and Vale of White Horse District Council regarding the capacity of the sewerage system and waste water treatment capacity, in relation to proposed new developments. Additionally, we have requested that drainage conditions should be imposed on the recent planning applications.

6 Strategy development

The Drainage Strategy for the Didcot 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

Activity	Purpose	Date planned	Outcome
Stakeholder engagement	This document will be circulated to the Environment Agency, Lead Local Flood Authority (Oxfordshire County Council), 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	Continue to monitor sewer depth monitors installed into the foul sewers at three locations in Blewbury and East Hagbourne. The plan is for the 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.	Ongoing	Use information to identify additional actions for inclusion in the drainage strategy for Didcot. Share information with other agencies.
Permanent monitoring of pumping station	Install permanent monitor on rising mains at five pumping stations to establish pumped flows.	From spring 2016	Use information to identify additional actions for inclusion in the drainage strategy for Didcot. 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 spring 2016	Use information to help test the cost benefit of options to improve drainage and reduce the risk of sewer flooding in Didcot.
Sewer and manhole surveys	Ascertain sewer and manhole condition and evidence of infiltration via CCTV survey and manhole "lift and look" surveys when appro-priate.	From spring 2016	Use information to identify additional actions for inclusion in the drainage strategy for Didcot. Share information with other agencies.
Connectivity surveys	Undertake visual inspection of properties to determine the extent of roof drainage and other surface water drainage that discharges into the foul sewer network.	From spring 2016	A better understanding of the contribution that misconnections make to sewer flooding in the area.

Activity	Purpose	Date planned	Outcome
Pilot trials of mobile treatment plant	As part of our wider approach to managing high groundwater levels, we have trialled the use of biological filters within other catch-ments. Our findings will inform and may influence our strategy plans for Didcot. 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 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 systems in the villages to the south of Didcot have experienced a number of performance issues because of a combination of groundwater infiltration, groundwater run-off from saturated fields, surface water inundation from highways and public spaces and surface water misconnections.

Our network 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. In parallel, we will assess the extent to which new developments may be significant in the context of challenges currently experienced and where necessary we will develop solutions to accommodate the proposed development in the catchment. 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 lists the activities that we have identified to date.

Table 5 Activities identified in preferred plan to date

Activity	Purpose	Date planned	Outcome
Localised sewer rehabilitation	Undertake localised sewer rehabilitation to include lining, patch repairs, localised pipe replacement and manhole repairs identified through survey work and where considered cost effective in reducing ingress of ground water.	When identified	Reduce infiltration into the public sewers.
Manhole cover replacement	Replace manhole covers with leak tight covers where identified through survey work.	When identified	Stop ingress of surface water through manholes located in flood plain.
Permanent monitoring of sewer levels	Continue to monitor sewer depth monitors installed into the foul sewers at three locations in Blewbury and East Hagbourne. 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.	Ongoing	Use information to identify additional actions for inclusion in the drainage strategy for Didcot. Share information with other agencies.

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 Didcot 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.

Appendix A
Glossary of terms

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.
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 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.
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% of the calculated flow rate.
Foul drain	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 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 responsibility of property owners.
Foul sewer	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 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.
Infiltration	Groundwater finds its way into the sewerage system (including private drains), via defective pipes or pipe joints and through the brickwork or defects in manhole structures.
Inundation	Accumulated surface water from rain and/or river floodwater that has resulted in localised flooding, finds its way into the sewerage system through manhole covers and drains. These may be public or private.
Lateral drain	See definition for Foul drain.
Misconnections (surface water to foul water)	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.
Misconnections (foul water to surface water)	A plumbing mistake resulting in wastewater appliances being misconnected to the surface water system.
Private sewers	See definition for Foul sewer.
Rainfall induced infiltration	Sewer infiltration that occurs as a result of rainfall percolating into the ground impacting the sewer on route to recharging the groundwater table.
Riparian owner	If you own land adjoining, above or with a 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.
Soakaway	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.
Surface water drain	A pipe conveying uncontaminated rainwater from a single property.
Surface water sewer	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.
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.

Appendix B
Supporting figures and photographs

Figure B1 Fluvial flood risk for Didcot 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.

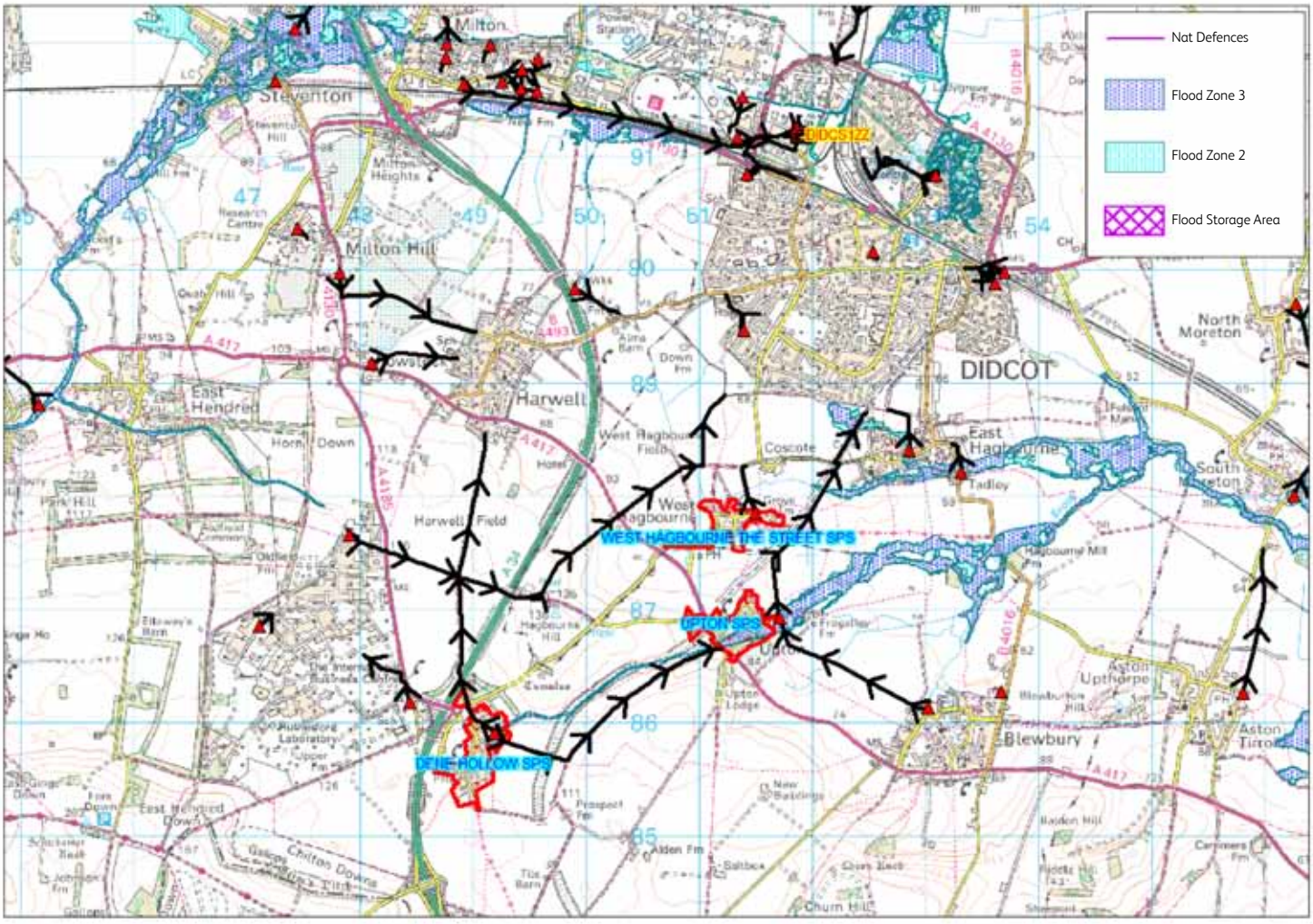


Figure B2 Surface water flood risk for Didcot from Environment Agency plans

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.

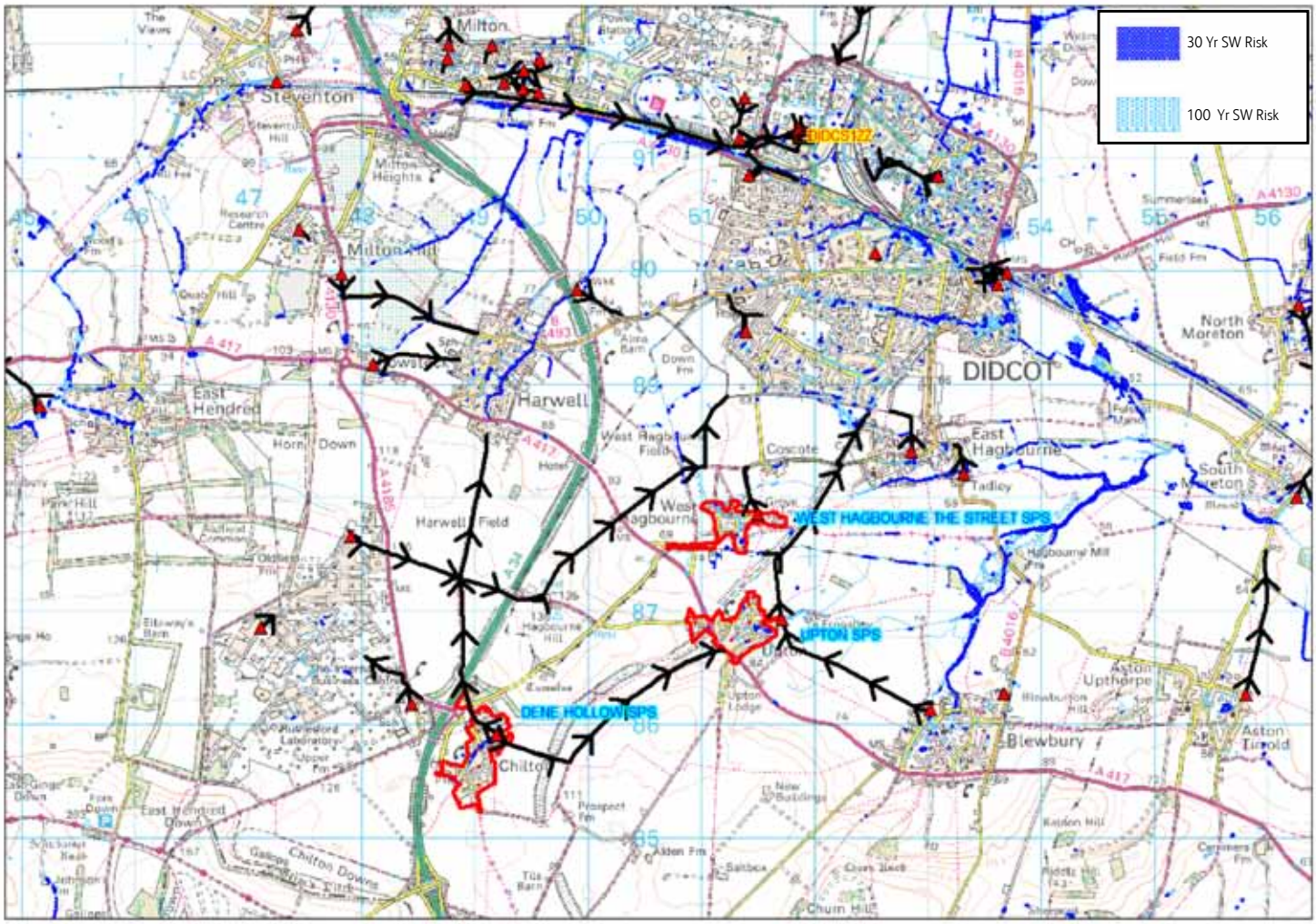
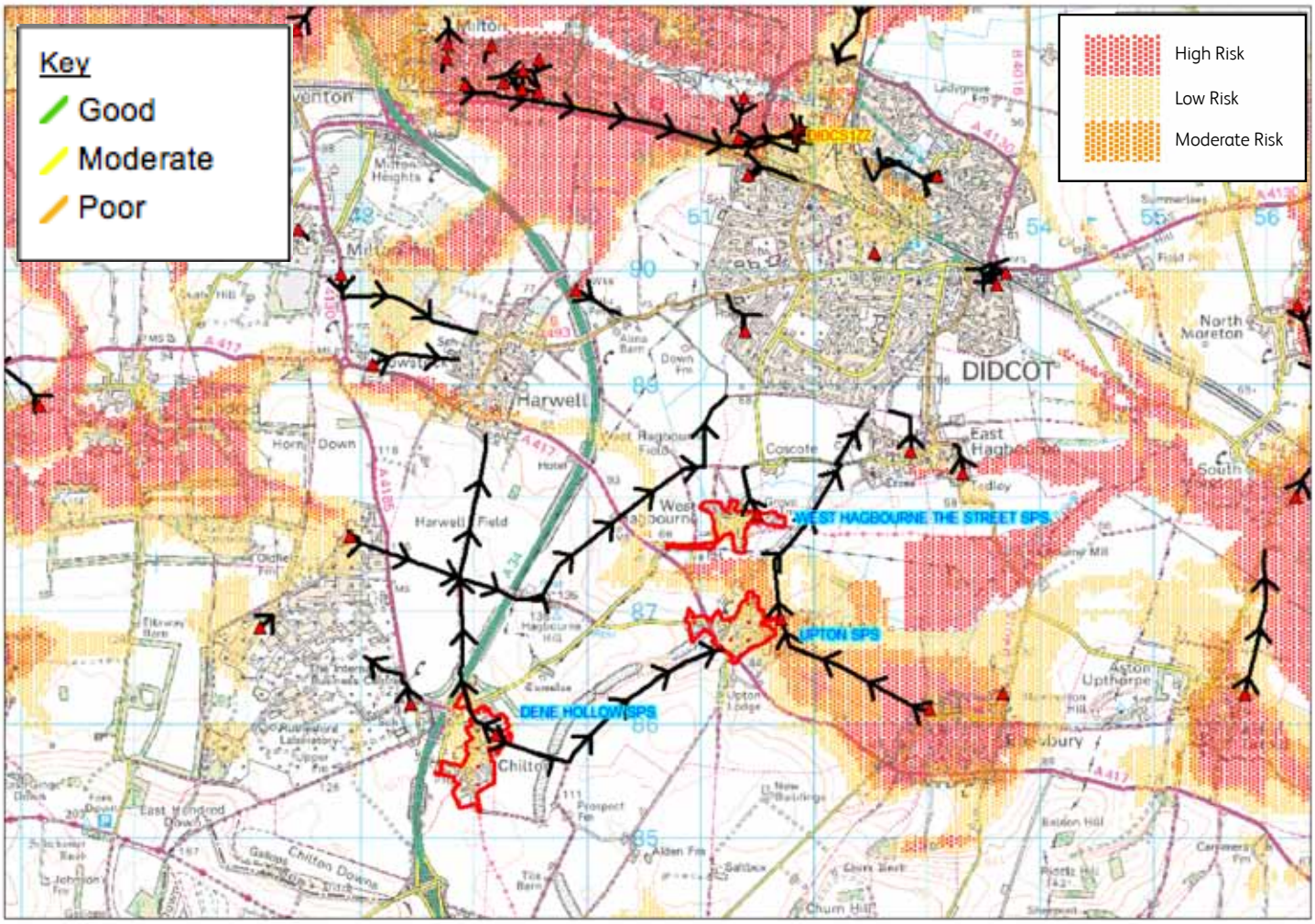


Figure B3 Didcot groundwater flood risk

This groundwater flood risk map information has been sourced from ESI Ltd.



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

Figure B4 Didcot watercourses

This watercourse 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.

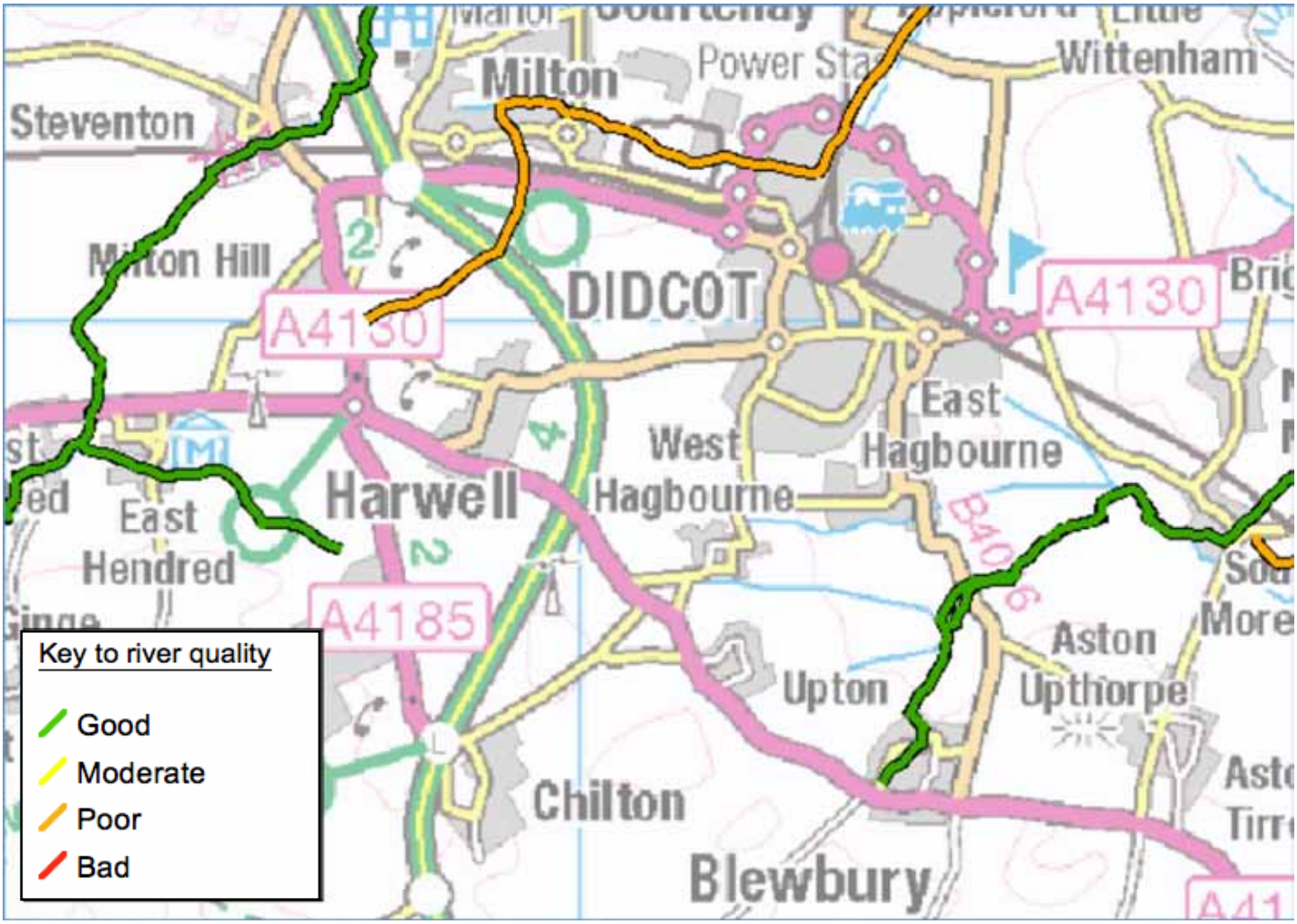
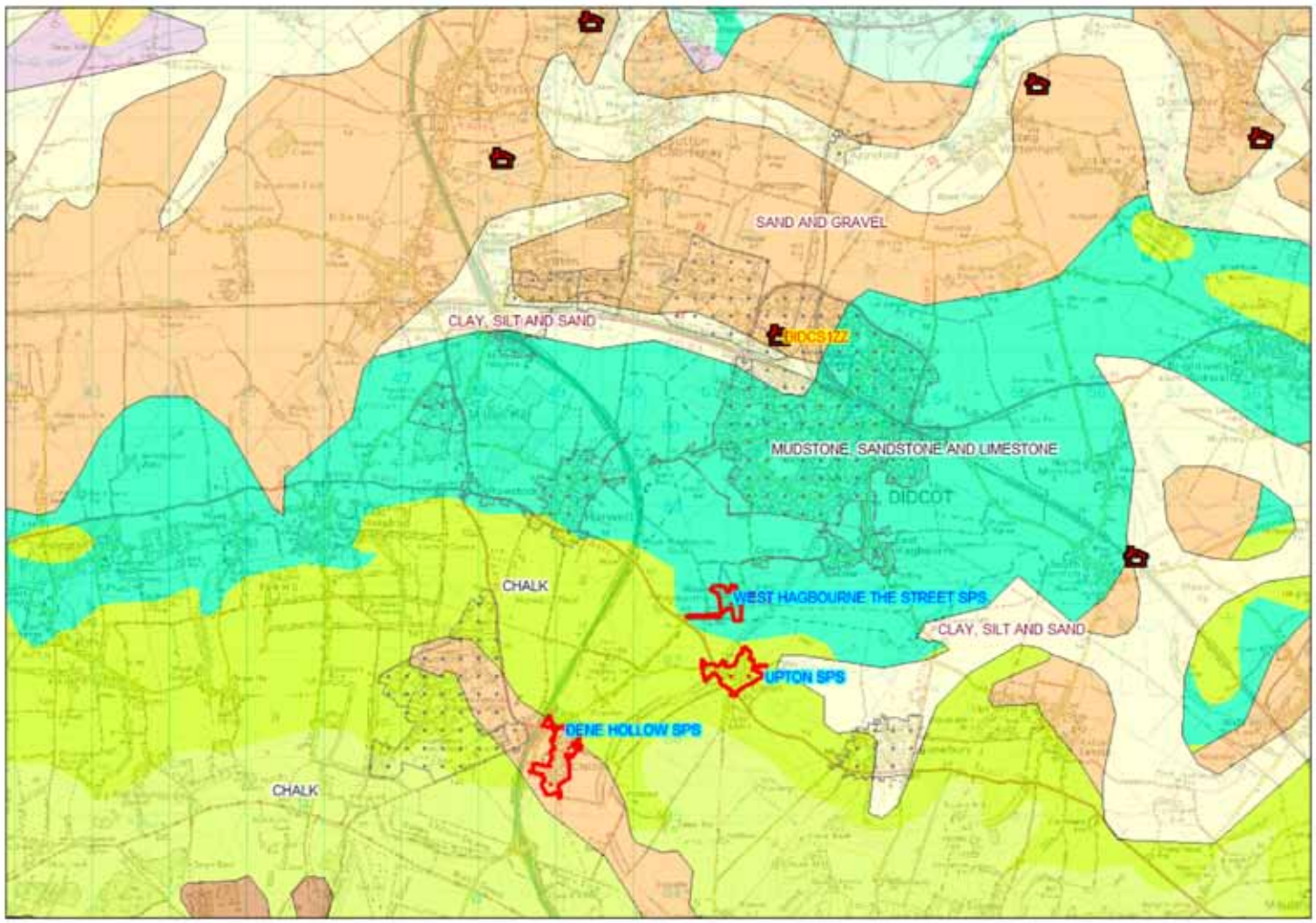


Figure B5 Didcot bedrock and drift geology

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 of 2013/14

Photo 1 – Submerged manhole cover in Main Street.

Photo 2 – Temporary pumping in Main Street.

Photo 3 – Surcharged manhole in The Lane.

Photo 4 – Surcharged manhole.

Photo 5 – Groundwater discharging from old well.

Photo 6 – Temporary pumping in Main Street.

Photo 7 – Diverted groundwater flows in Blewbury.

Photo 8 – Culvered watercourse in Blewbury.

Photo 9 – Flooding in Upton.

Photo 10 – Flooding in Upton.

At the heart of daily life