Witney

(Brize Norton)

Drainage Strategy

Stage 1: Initialise / Prepare

February 2015

Revision History

Version	Date	Editor	Checked	Reviewed	Description
1.0	16/10/14	RP	KAR	SR	Internal review
1.1	13/02/15	GB	KAR	SR	For issue to stakeholders

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About this document

In preparing our business plan for 2015-20, we have carried out extensive customer research and have developed a series of outcomes that we are committed to achieving. This document describes the strategy that we will follow in delivering long-term outcomes for drainage in the village of Brize Norton within the Witney sewerage catchment in a sustainable and economic manner.

We have followed the Drainage Strategy Framework[1], which identifies 4 key stages to producing a strategy that are set out in in the diagram below. The Witney drainage strategy is currently at the Initialise/Prepare stage. In this document, we describe the activities that we plan to undertake to address current issues and future challenges and the data that we need to gather to complete the risk assessment and options appraisal stages.

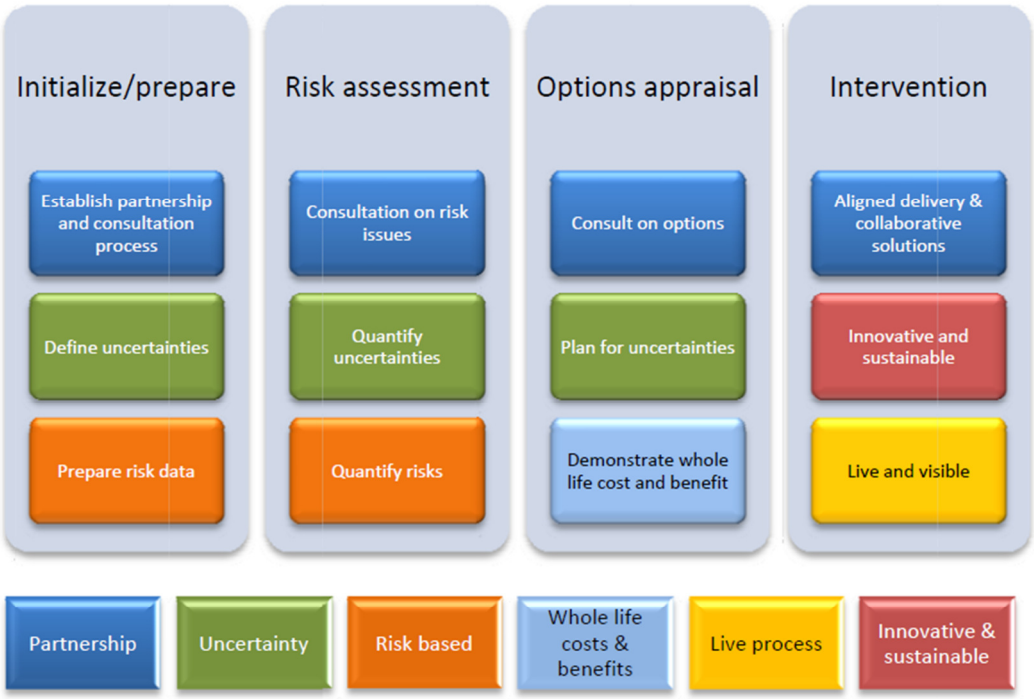


Figure 1 - The Drainage Strategy Framework

We will update and republish this document to show 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. If we consider we need to discharge to watercourses through temporary overflows to maintain service to customers during future wet weather events, details will provided about the location and intended use of any such overflows when this document is updated. This is to ensure that this Drainage Strategy fully meets the requirements of an Infiltration Reduction Plan, as set out in the Environment Agency's Regulatory Position Statement. Equally, the detailed plans may involve modifications to the receiving sewage treatment works, but these options can only be assessed at a later stage

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

Executive Summary

The village of Brize Norton lies within the sewerage catchment served by Witney sewage treatment works. The foul sewerage system in Brize Norton has become overwhelmed for weeks and even months at a time in recent years following prolonged heavy rainfall and raised ground water levels. This has been associated with flooding. We believe that the system has surcharged because of a combination of groundwater infiltration, surface water run-off from saturated fields, surface water inundation from highways and public spaces 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.

In response, this Drainage Strategy follows the EA/Ofwat 4-stage framework. The Witney 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. Research indicates that customers are willing to pay for these improvements to service.

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 Witney 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; and
- River water quality meets customer's expectations and regulatory requirements.

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

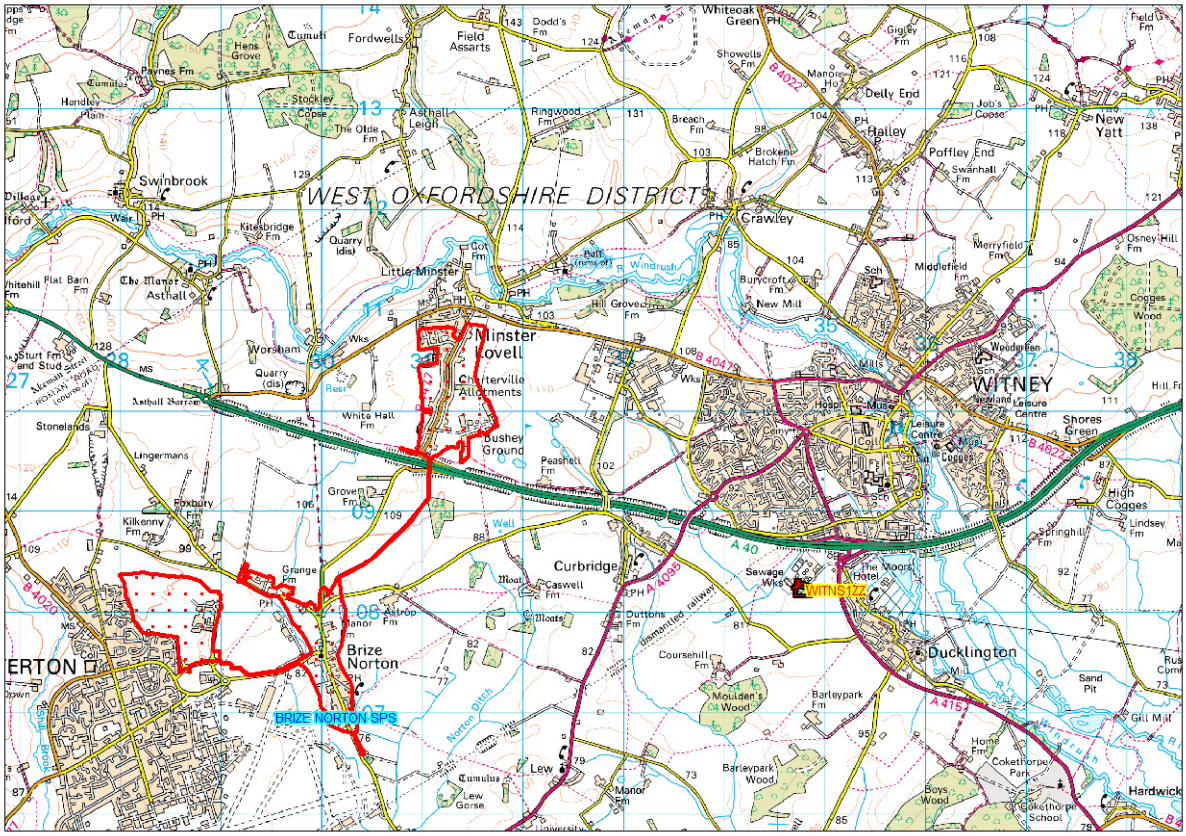
- Climate Change – analysis of the latest data suggests that rainfall could become 15% more intensive by 2080 increasing the likelihood of flooding. Longer wetter winters may also mean groundwater levels are high more often;
- Urban Creep – paving over of front gardens and loss of green space results in more strain on the sewerage network when it rains heavily. Modelling we have undertaken suggests urban creep rates in Witney are above average; and
- Population growth – the population in the South East is set to grow rapidly. Development is planned to the east of Carterton and we will continue to track its progress through the planning system.

Our strategy is to understand the relative impact of misconnections, overland flow and the capacity of our network and then to identify cost beneficial solutions to reduce the risk of sewer flooding using willingness to pay research. We may carry out some repair 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.

A number of investigations and remedial works have been completed in Brize Norton to maintain service over the last 2 years. The network has been cleansed and some manholes sealed, but this activity has not been sufficient to prevent the surcharging and flooding that took place in January and February 2014. Our

next steps are to quantify and monitor flows into Brize Norton sewage pumping station and identify sources of ingress. We will also gather customer evidence of flooding and restricted toilet use, to inform an assessment of options for capital works.

Figure 2 – Brize Norton priority sub-catchment



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[2].

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).

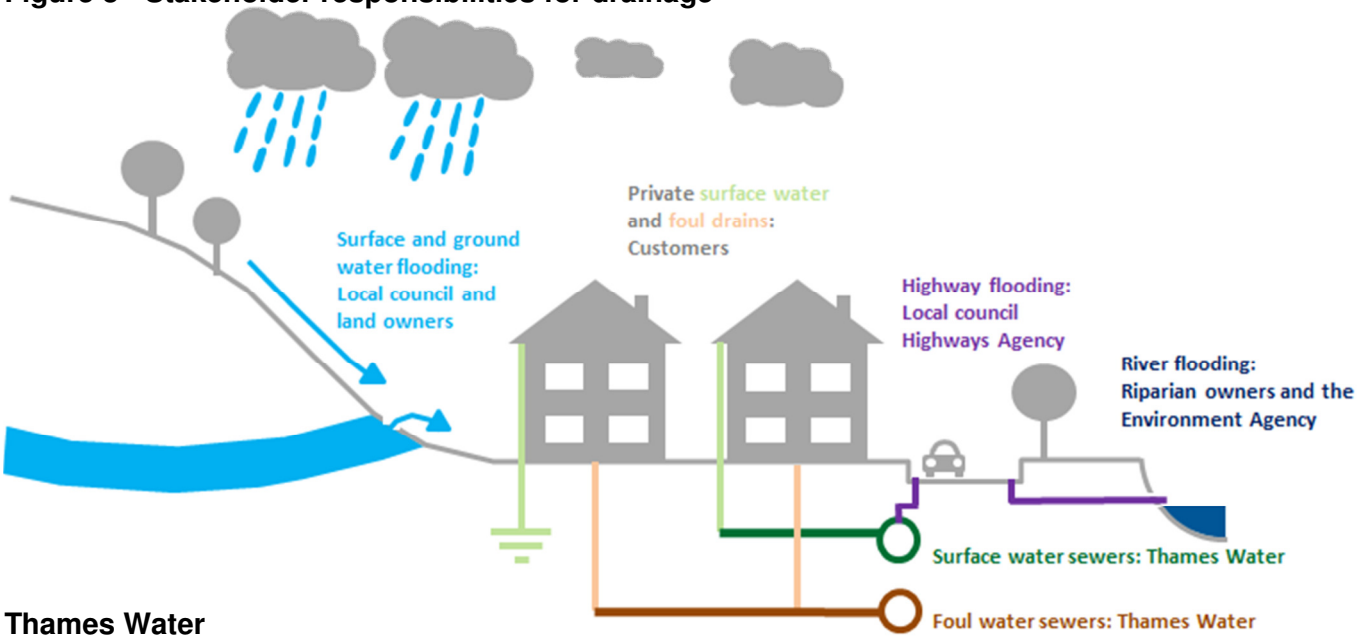
A comprehensive and detailed list of all legislation relevant to Thames Water can be found in the 'statement of obligations' published by Defra[3].

1.2 Working in partnership with other stakeholders

Other organisations 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 the figure below.

[2] See http://www.thameswater.co.uk/help-and-advice/8654.htm for more information
[3] See https://www.gov.uk/government/publications/statement-of-obligations

Figure 3 - Stakeholder responsibilities for drainage



Thames Water

We are responsible for removing and treating wastewater, which includes the foul sewers and surface water sewers in some areas[4]. 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 our 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 authorities

Local 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 culverts[5]. Local authorities are also responsible for highways gullies and drains. 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 feed into Thames Water sewers, so Thames Water works with all parties to deal with the excess flow.

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].

[4] 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.

[5] 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.

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

2 Catchment Description

2.1 Geology and topography

The Witney sewerage catchment is located approximately 16km west of Oxford and includes Witney town centre along with the villages of Crawley, Delly End, Poffley End, Ducklington, Curbridge, Minister Lovell and Brize Norton. The village of Brize Norton is known to experience drainage problems during periods of prolonged wet weather and high groundwater levels.

The catchment is generally made up of sandstone, limestone and argillaceous bedrock with mudstone and siltstone to the south. The geotechnical make-up is mainly very permeable soils in Witney, Ducklington, Crawley and the southern half of Brize Norton. The other villages and surrounding area have clayey soils with an impermeable layer at shallow depth. This catchment is situated in an area that is prone to significant seasonal fluctuations in groundwater levels.

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

The Environment Agency identifies that the current ecological status of the River Windrush is 'Moderate'[7], although there is no suggestion that this is a result of discharges or escapes from the sewer network or treatment works.

2.2 Foul sewers

The Brize Norton sub-catchment drains under gravity to the to the Brize Norton sewage pumping station, which pumps flows directly to Witney sewage treatment works. The pumping station serves Brize Norton, Minster Lovell, part of Shilton Park to the north of Carterton and part of the Brize Norton RAF base – a total area of 175 hectares with a population of approximately 6,000. The drainage consists of a network of public gravity sewers varying in size from 150mm to 450mm diameter. The majority of the network (15km of a total 24km) is served by 150mm diameter sewers. There are two other sewage pumping stations in Minster Lovell – Minster Lovell and Ripley Avenue – which lift flows from low lying areas towards Brize Norton. See Figure 4 for a schematic diagram of the local foul drainage network.

We understand that the Brize Norton sewerage system was constructed in the 1960s by Witney Rural District Council and drained to Brize Norton sewage treatment works, which was decommissioned and replaced by the present pumping station in the mid 1990s. The Shilton Park development was added to the Brize Norton network in the early 2000s.

Sewer design criteria ensures the appropriate sizing and laying of pipes at an appropriate gradient to maintain a satisfactory self-cleansing characteristic. Capacity of sewers is typically set to cater for six times Dry Weather Flow with a 10% allowance for infiltration[8]. In terms of design capacity, a 225mm diameter sewer laid at a gradient of 1 in 150 will have sufficient capacity to cater for the foul sewage from 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

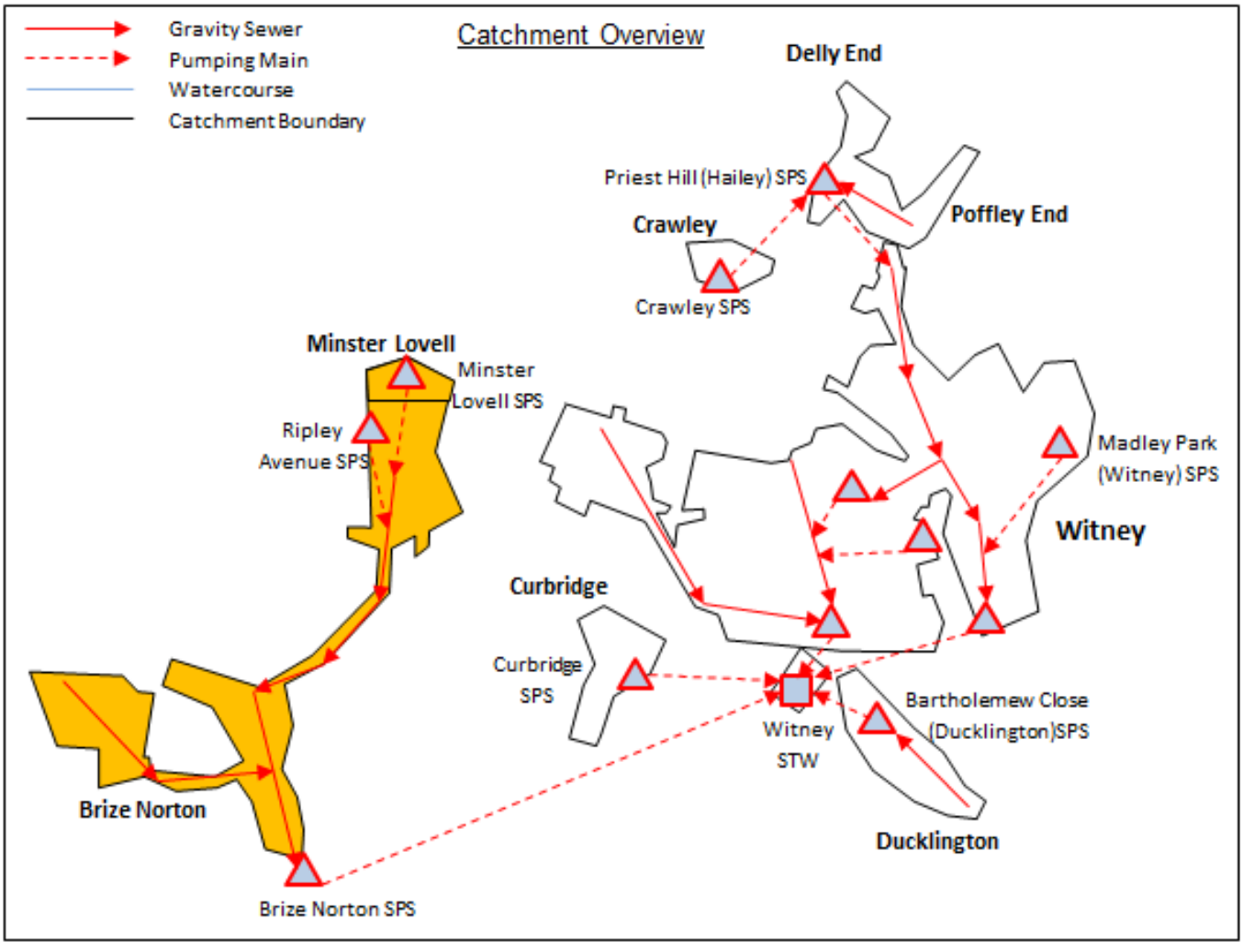
[7] Environment Agency website, interactive map, Basin Management Plans
[8] Dry Weather Flow is the term given to the average flow rate observed over a 24 hour period and based on Sewers for Adoption, the industry standard, includes an allowance for infiltration of 10% of the calculated flow rate.

heavily. The run-off from a single roof into a foul water sewer can easily match the total foul water flow along an entire street.

Materials used in the construction of the sewerage system are typical of the time, with vitrified clay pipework for smaller diameter pipes and concrete for larger diameter pipes. The clay pipework can have a very long service life, but typically 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, will have been laid on and backfilled 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 Brize Norton are the responsibility of the property owners, where they are not shared.

The sewage treatment works currently has a full treatment flow capacity of around 25,000 m^3/day, beyond which flows pass through storm tanks and receive only settlement and screening prior to discharge into the River Windrush.

Figure 4 - Witney sewerage catchment, showing principal assets



The red lines indicate the extent of the foul water catchment and the blue triangles show the location of the pumping stations within the catchment. The Brize Norton sub-catchment is highlighted orange.

2.3 Surface water sewers

The Brize Norton sub-catchment is mostly rural and incorporates a network of roadside ditches and minor watercourses that are intended to drain the surface water from roads and public spaces in the area. The responsibility for the operation and maintenance of these ditches, local watercourses and general land drainage lies mostly with riparian owners. The local authority has overall responsibility for managing groundwater.

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

There are few surface water sewers in the Brize Norton sub-catchment. The Shilton Park area to the north of Carterton, however, is served by a surface water network ranging from 150mm to 1350mm in diameter, which discharges via a flow balancing pond to a local drainage ditch between Carterton and Brize Norton. This drainage ditch is known to flood during periods of heavy rainfall such as the rainfall event in December 2012. There are other smaller surface water networks in the sub-catchment which are likely to drain to nearby soakaways or other local drainage ditches.

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 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. West Oxfordshire District Council is responsible for the highway drainage and culverts crossing the highway.

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 customers are prepared to pay for an improvement to the current levels 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:

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 our 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
	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

Company outcome	Wastewater service outcome	Why is this service outcome chosen
	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 and properties and public areas protected from flooding service outcomes, as these are relevant to the Witney 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:

Firstly, 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.

Secondly, 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 designed to take foul flow only, but investigation shows that a substantial amount of surface water is in the foul sewers.

3.3 River water quality meets customers' expectations and regulatory requirements

We have a performance commitment to reduce 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 the village of Brize Norton within the Witney catchment has become overwhelmed for weeks and even months at a time in recent years following prolonged heavy rainfall and high groundwater levels. We believe that the system has surcharged because of a combination of groundwater infiltration, surface water run-off from saturated fields, surface water inundation from highways and public spaces and surface water misconnections.

We are confident that this is a comprehensive list of factors that have caused flooding. Whilst there may be some groundwater infiltration in our sewers, our view is that we are unlikely to use temporary overflows in the near future to pump out directly to watercourses to maintain service to customers. However, this position may change as our investigations progress.

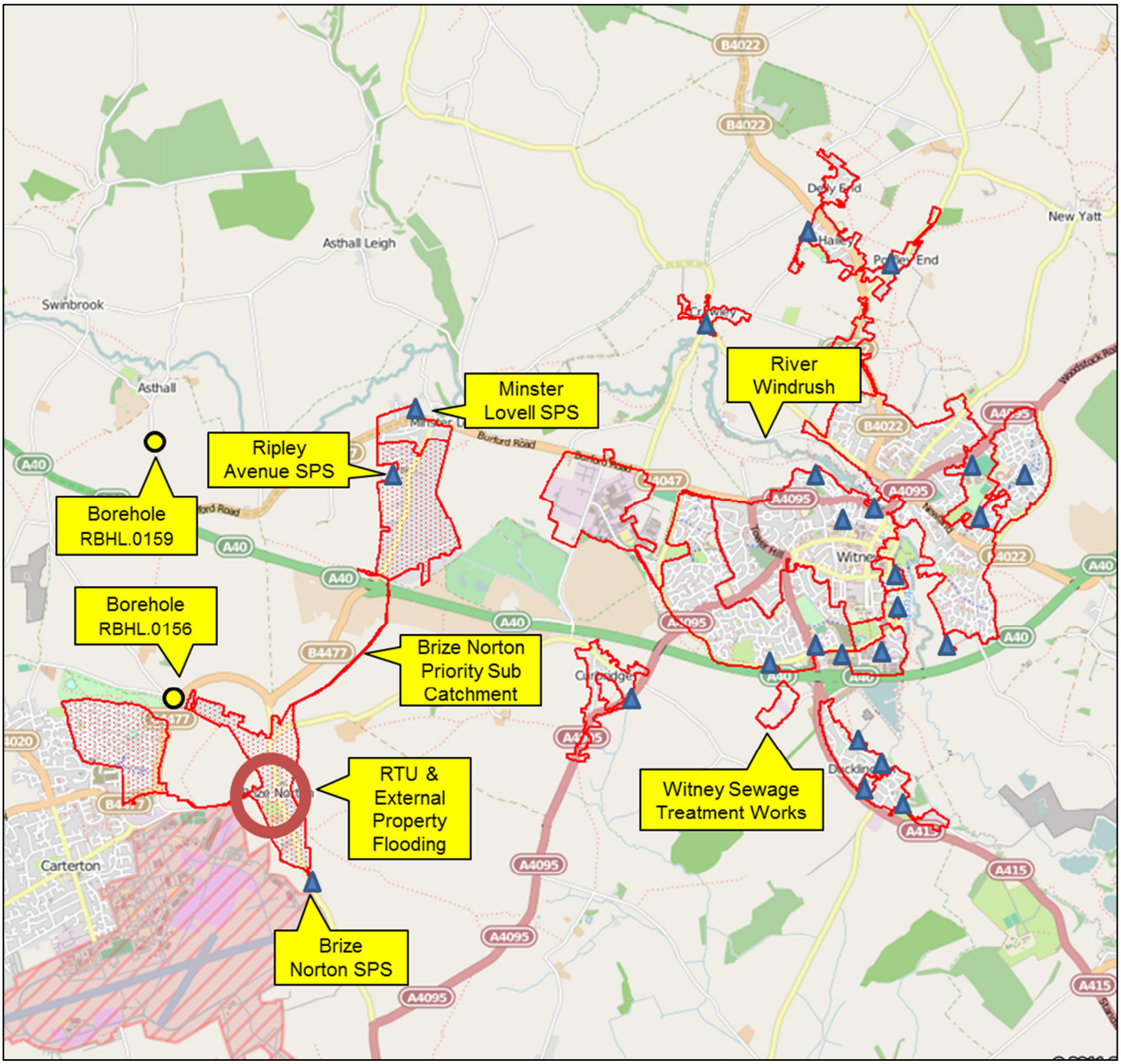
The following incidents have been observed with respect to the sewerage network:

- Restricted toilet use and external foul flooding to properties in Brize Norton;
- 2 'Category 3' pollution incidents caused by surcharging sewers spilling out of manholes;
- Brize Norton pumping station site flooded from the local watercourse during winter 2012/13; and
- Manholes located in low lying areas have become inundated with surface water.

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; and
- surface water ponding across highways, public spaces and fields.

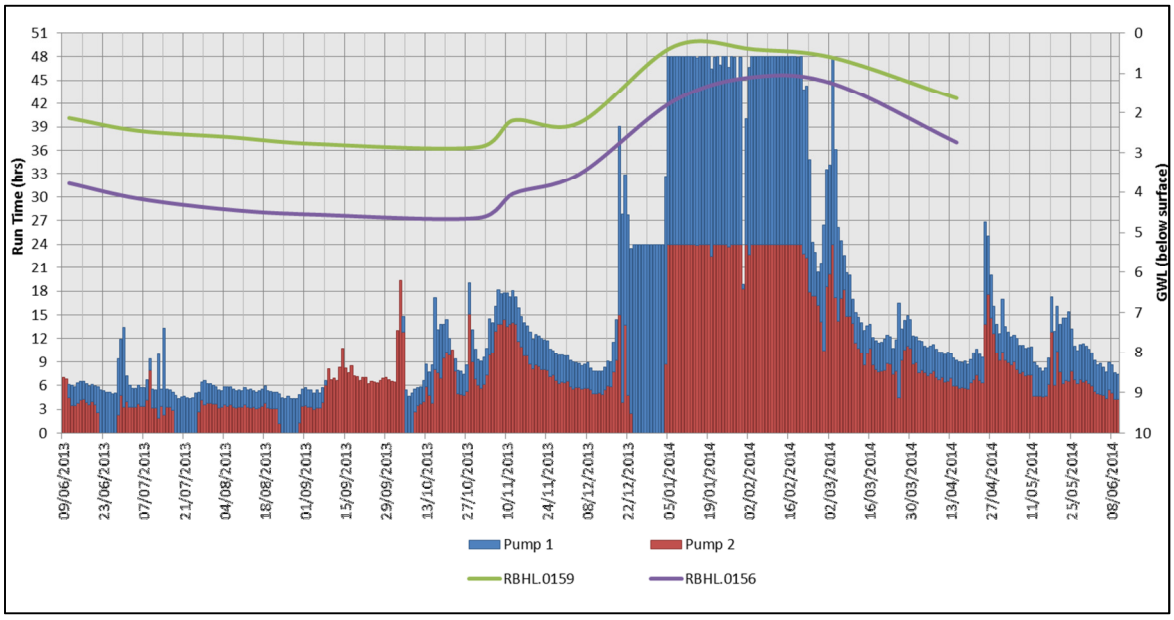
Figure 5 - Witney sewerage catchment, identified catchment issues



The red lines indicate the extent of the foul water catchment, and the red circle indicates the extent of flooding in the area.

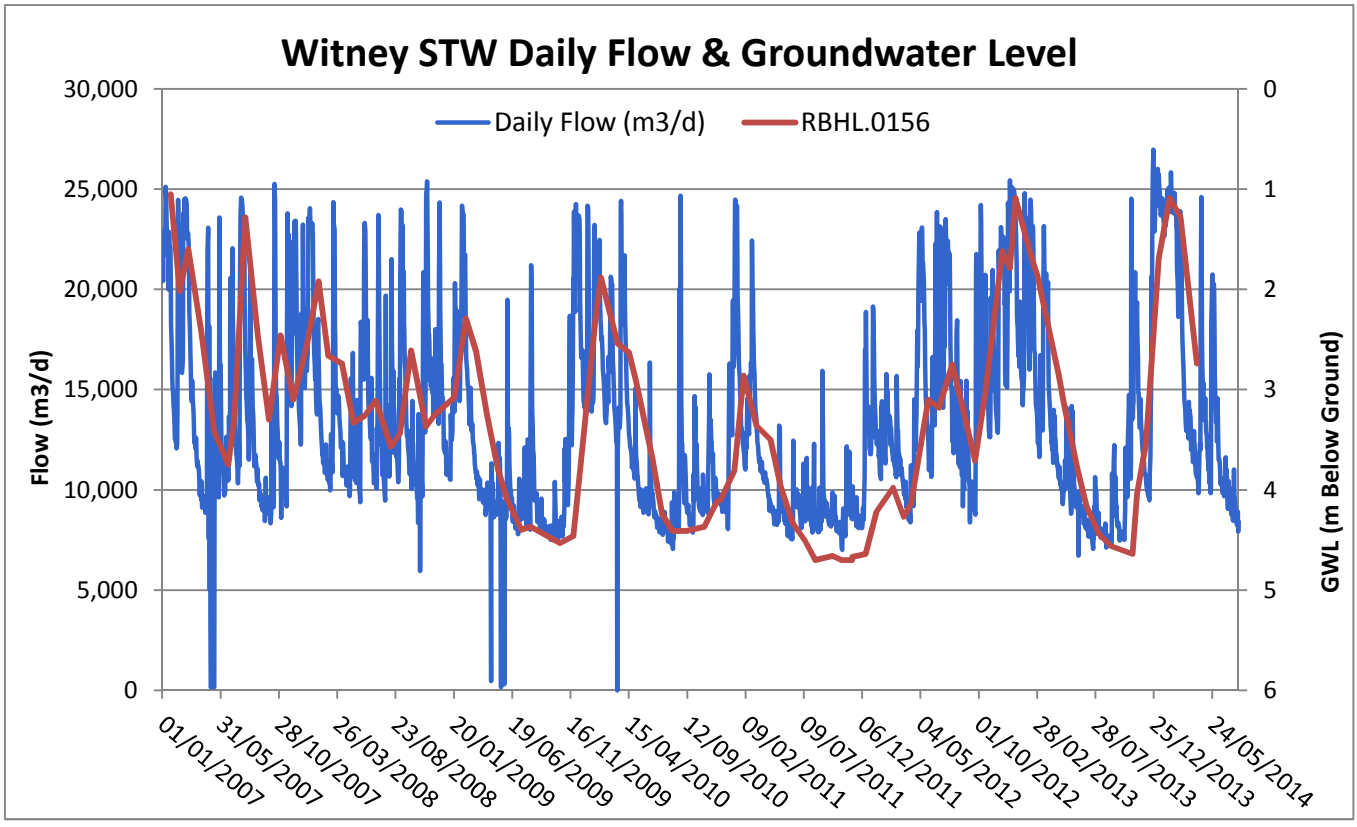
Brize Norton sewage pumping station was in constant operation between 5 January 2014 and 19 February 2014, rather than operating 5 or 6 times a day as it would normally be expected to do. This demonstrates that the sewage pumping station was handling flows well in excess of those from foul sewage. Figure 6 compares the pump run times at Brize Norton pumping station during the winter of 2013/14 with the groundwater levels recorded at two local Environment Agency boreholes (RBHL.0156 and RBHL.0159).

Figure 6 - Brize Norton sewage pumping station pump run times and groundwater levels



During extended wet periods, treated flows at Witney sewage treatment works can be in excess of 25,000m^3/day, which is over two times greater than the dry weather flow consent limit of 11,883 m^3/day. Figure 7 shows that treated flows at Witney sewage treatment works correlate well with ground water levels.

Figure 7 - Witney STW treated flows and groundwater levels



4.2 Our operational response

To maintain service, tankers were used in the winter of 2012/13 in the Witney sewerage catchment to prevent external foul water flooding of properties. 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 not utilised in the Witney sewerage catchment and the full fleet of tankers was deployed in other areas.

To date, we have not installed temporary pipework and pumps during wet weather events in Witney to maintain service, but we would consider doing so to prevent the backup of sewage into customers' properties and uncontrolled spilling from the sewer system to the environment. As part of the survey works that commenced in winter 2014, we are investigating the circumstances under which emergency discharges would be required in future. Even if flows can be contained within the sewerage network, excessive flows arriving at the treatment works may not always be given full treatment prior to discharge to the River Windrush. The use of such storm sewage overflows is accepted by our regulators, subject to conditions.

4.3 Investigations and activities completed to date

Table 2 sets out the investigations and actions that we have completed in recent years within the Witney catchment. These form the extent of our current understanding of issues.

Table 2 - Investigations and activities completed

Activity	Purpose	Date complete	Outcome
Pumping Station Cleaning	Pumping station wet well clean to maintain maximum pass forward flows	Nov 2011	Maintain 'asset health'
Sewer Flooding clean-up	Thames Water schedule clean-ups after sewer flooding events to ensure public health and safety	January 2014	10 clean-up activities undertaken after flood events between June 2012 and January 2014
Manhole cover replacement	Manhole covers replaced with leak tight covers in Bluebell Way, Carterton.	October 2013	Stop ingress of surface water through manholes located in flood plain
Maintenance of flows	Regular tankering during winter 2012 / 2013 to maintain flows and prevent pollution	Dec 2013	Short term discharges to reduce impact of surcharged sewers
Camera surveys - (network ops)	Assess structural and service grade of the sewerage network and if possible detect sources of infiltration.	March 2014	180m of 450mm diameter sewer surveyed from manhole 3703 down to the pumping station
Sewer Blockages Cleared	48 blockages cleared from public sewer between 04/04/2012 and 31/03/2014	March 2014	Improve flow through pipework and reducing flooding problems

In summary, following previous concerns that the sewerage network suffers excessive infiltration from groundwater, a number of investigations and remedial works were undertaken to maintain service. The network has been cleansed and some manholes sealed, but this activity has not been sufficient to prevent the surcharging and flooding that took place in January and February 2014. We need to quantify and monitor flows into Brize Norton sewage pumping station and identify sources of ingress.

4.4 Actions carried out by drainage partners

Table 3 lists the activities that other stakeholders are carrying out alongside our work, to reduce the risk of flooding in the Witney catchment.

Table 3 - Actions by other stakeholders to prevent flooding

Activity	Purpose	Impact on sewerage
Routine maintenance of River Windrush, watercourses and local ditches	Ensure free flow of river and ditches	Less risk of surface water flooding and inundation into the foul sewers and hence less risk of sewer flooding and pollution incidents
Routine maintenance of private surface water drainage and soakaways	Ensure adequate surface water drainage from properties	Less risk of surface water flooding and inundation into the foul sewers and hence less risk of sewer flooding and pollution incidents
Routine maintenance of highway drainage	Ensure adequate highway drainage	Less risk of surface water flooding and inundation into the foul sewers and hence less risk of sewer flooding and pollution incidents
Routine maintenance of land drainage	Ensure effective land drainage	Less risk of surface water flooding and inundation into the foul sewers and hence less risk of sewer flooding and pollution incidents
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 groundwater flooding and infiltration into private drains and hence less risk of sewer flooding and pollution incidents
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 flooding and infiltration into private drains and hence less risk of sewer flooding, pollution incidents
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

*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 Witney 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)[9] 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 Witney catchment in this section.

5.1 Urban creep

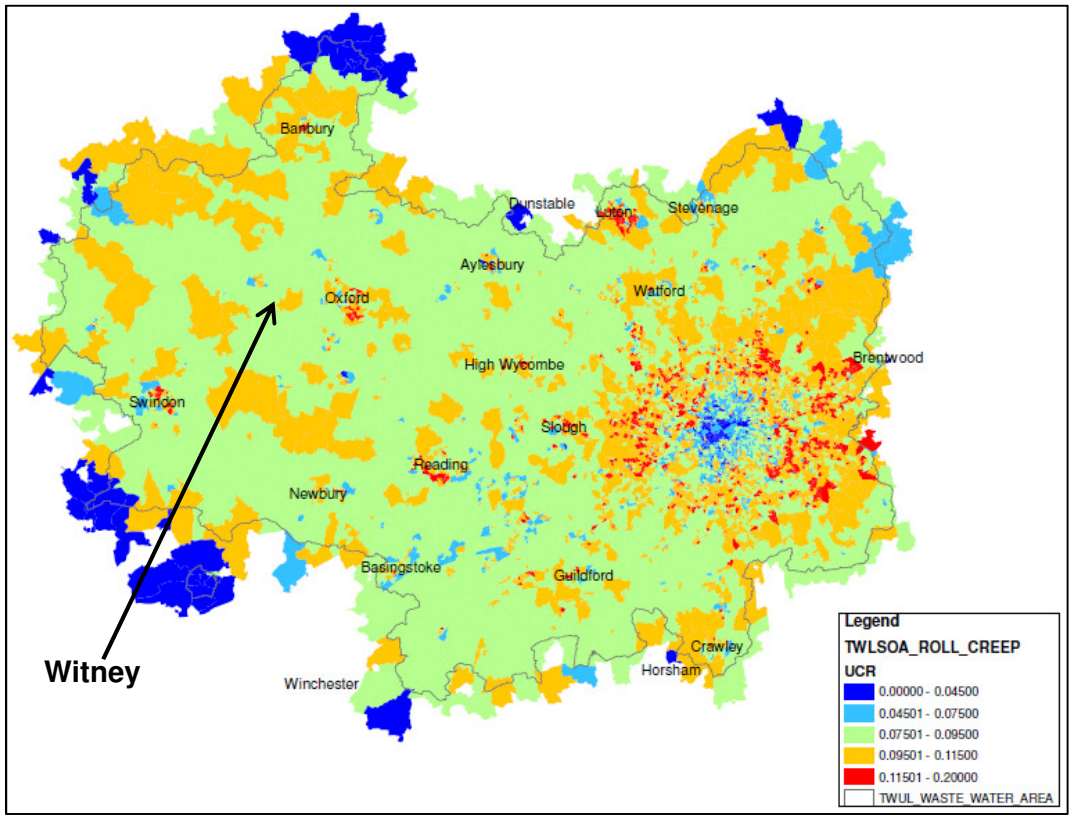
Urban creep is defined as the transformation of a catchment by the paving over of previously permeable areas. Rather than surface water soaking into the ground when it rains heavily, more water runs off into the sewerage network and can cause the sewers to surcharge and flood. It is therefore important 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 8 below. The urban creep rate for Witney is 0.098%. 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, Witney is above average, but not as high as suburban areas around central London and major towns. Whilst the immediate issues in Witney 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 West 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.

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

Figure 8 - Urban creep rates in Thames Water



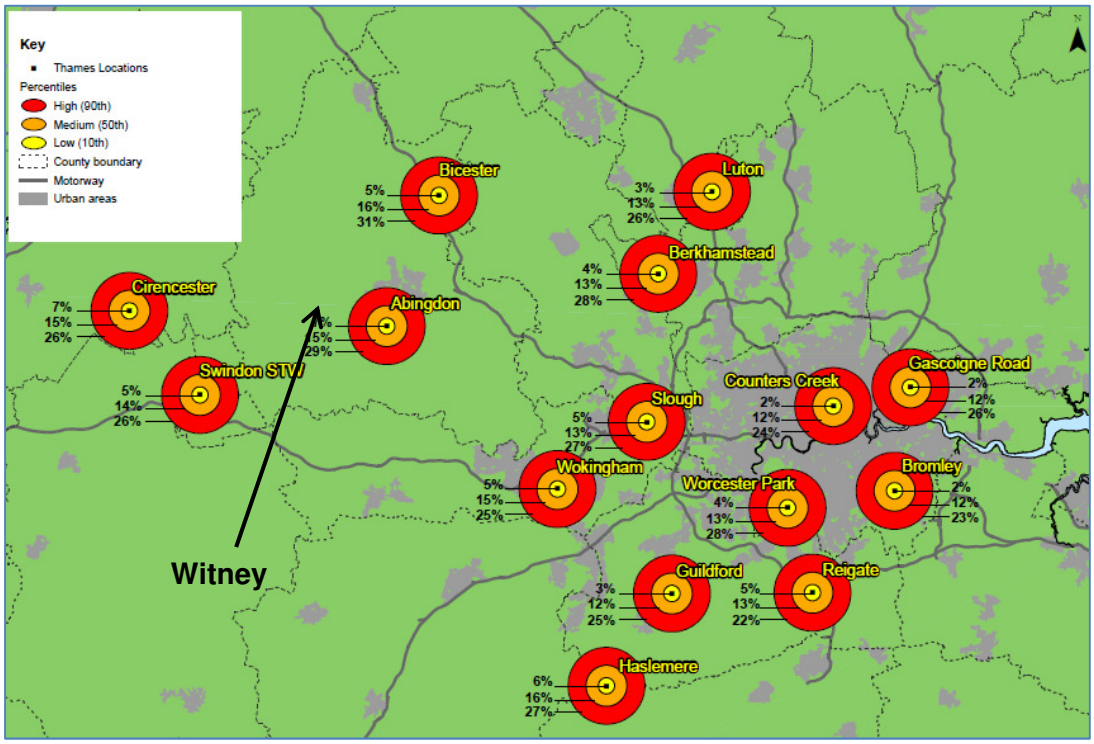
5.2 Climate change

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. More intensive rainfall in the future will increase the peak flow in sewerage networks and with it the likelihood of sewer flooding.

15 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 Witney 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%. We will ensure that our strategy takes account of these potential increased peak flows as it develops.

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.

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 that 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 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 Witney, 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.

The key development that we are currently tracking around Brize Norton is a large site called Carterton East, which would sit to the north of Brize Norton. 700 dwellings are planned with a density of 35 dwellings per hectare. Our current view is that new foul flows arising from this development will drain to Carterton sewage treatment works and not to Witney via Brize Norton.

Other planning applications exist but relate to single properties.

A key element of our assessments will be to establish the extent to which these developments may be significant in the context of challenges currently experienced.

6 Strategy development

The Drainage Strategy for the Witney catchment is currently at the initialise/prepare stage. The following activities are planned in order to carry out our risk assessment and development of strategy options.

Table 4 - Activities planned to enable strategy development

Activity	Purpose	Date planned	Outcome
Stakeholder engagement	This document will be circulated to the Environment Agency, Lead Local Flood Authority and District Council before being published on our website. The Local Flood Forum will continue to be used as the primary route for stakeholder engagement. All third party data will contribute to drainage strategy development.	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	Install permanent depth monitors into the foul sewers in Brize Norton. 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. Analyse the recorded depths and compare with other catchment variables, such as rainfall events and changes in groundwater levels.	From winter 2014	Use information to identify additional actions for inclusion in the drainage strategy for Witney. Share information with other agencies.
Permanent monitoring of pumping station	Install permanent monitors on rising mains to establish pumped flows to the sewage treatment works.	From winter 2014	Use the information to identify additional actions for inclusion in the drainage strategy for Witney. 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 winter 2014	Use information to help test the cost benefit of options to improve drainage and reduce the risk of sewer flooding in Witney.
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 winter 2014	Use information to identify additional actions for inclusion in the drainage strategy for Witney. 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	From winter 2014	A better understanding of the contribution that misconnections make to sewer flooding in the area.

Pilot trials of mobile treatment plant	As part of our wider approach to managing high groundwater levels, we are trialling the use of mobile package treatment plant. If successful, these could be used to abstract dilute sewage from surcharged sewers and discharge 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	Spring/ Summer 2015	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	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 Brize Norton has surcharged and flooded because of a combination of groundwater infiltration, surface water run-off from saturated fields, surface water inundation from highways and public spaces and surface water misconnections. Our strategy is to understand the relative impact that each of these factors has on the risk of flooding and then to develop a plan comprising cost beneficial solutions using willingness to pay research. We are confident that we have identified a comprehensive list of factors that have caused flooding.

We are keeping a close eye on the development of Carterton East. If these plans are accepted, they may have a significant impact on this drainage strategy. The development plans include construction of storm water storage ponds to the northeast of the catchment which should reduce the flood risk of both the new development and current network in Brize Norton. Our current view is that foul drainage from this site will drain to Carterton sewage treatment works and will not therefore affect Brize Norton.

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
Manhole cover replacement	Replace manhole covers with leak tight covers where identified through survey work.	From winter 2014	Stop ingress of surface water through manholes located in flood plain

8 Temporary overflows

Whilst there may be some groundwater infiltration in our sewers, our view is that temporary overflows are unlikely to be required in Brize Norton to maintain service to customers in future wet weather events. It is unlikely that we will need to pump out from the sewerage network directly into Colwell Brook or the River Windrush in the near future to prevent customers' homes from flooding.

However, this position may change as our investigations progress. In the event that temporary overflows are required, we will describe their location and the circumstances under which we would use them, in order that this Drainage Strategy fully meets the requirements of an Infiltration Reduction Plan as set out in the Environment Agency's Regulatory Position Statement.

Appendix A – Glossary of Terms

Blockages – this is where obstacles or the build-up of fat and grease, block or obstruct our pipes. This is normally caused by things which should not be flushed or poured into drains and sewers.

Dry Weather Flow - the term given to 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 – this is where 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 – this is where 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) – this is where property owners have connected rainwater and/or land drainage to our sewers (e.g. roof drainage, paved driveways drains, soakaway overflows). The amount of inflow these connections can contribute is hundreds of times greater than the design capacity of the sewer and can cause major issues for the performance of the sewerage system.

Misconnections (foul water to surface water) – this is where a plumbing mistake results in wastewater appliances being misconnected to the surface water system.

Private sewers – see definition for foul sewer.

Rainfall induced infiltration – 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

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 Witney based on Environment Agency plans

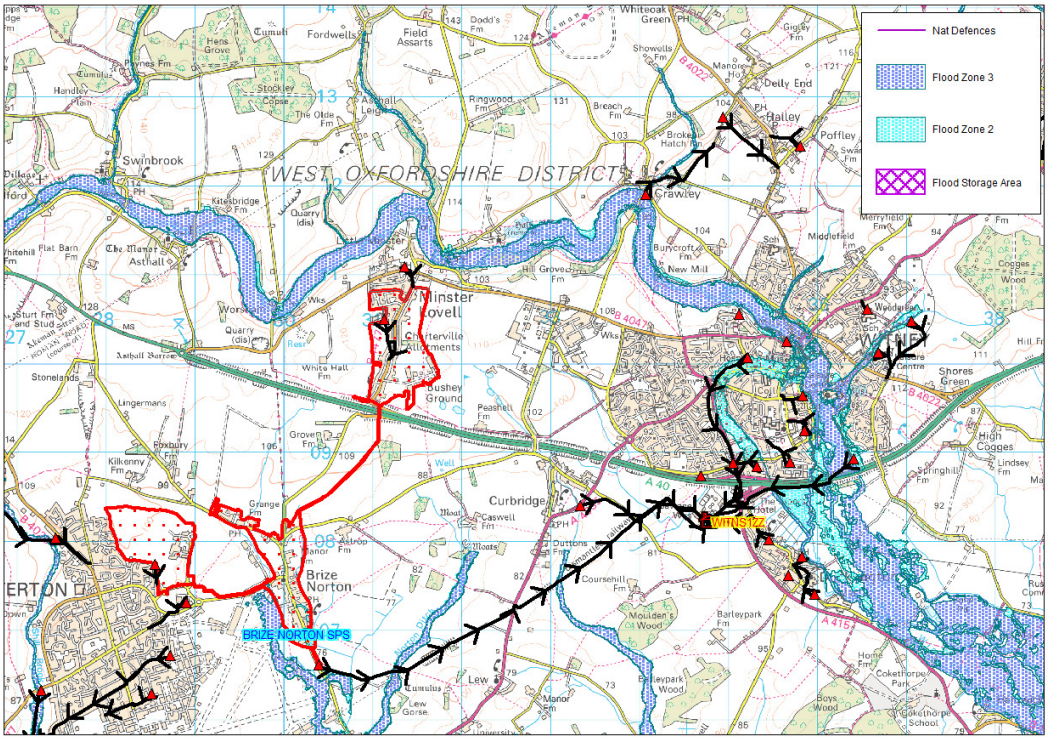


Figure B2 - Surface water flood risk for Witney based on Environment Agency plans

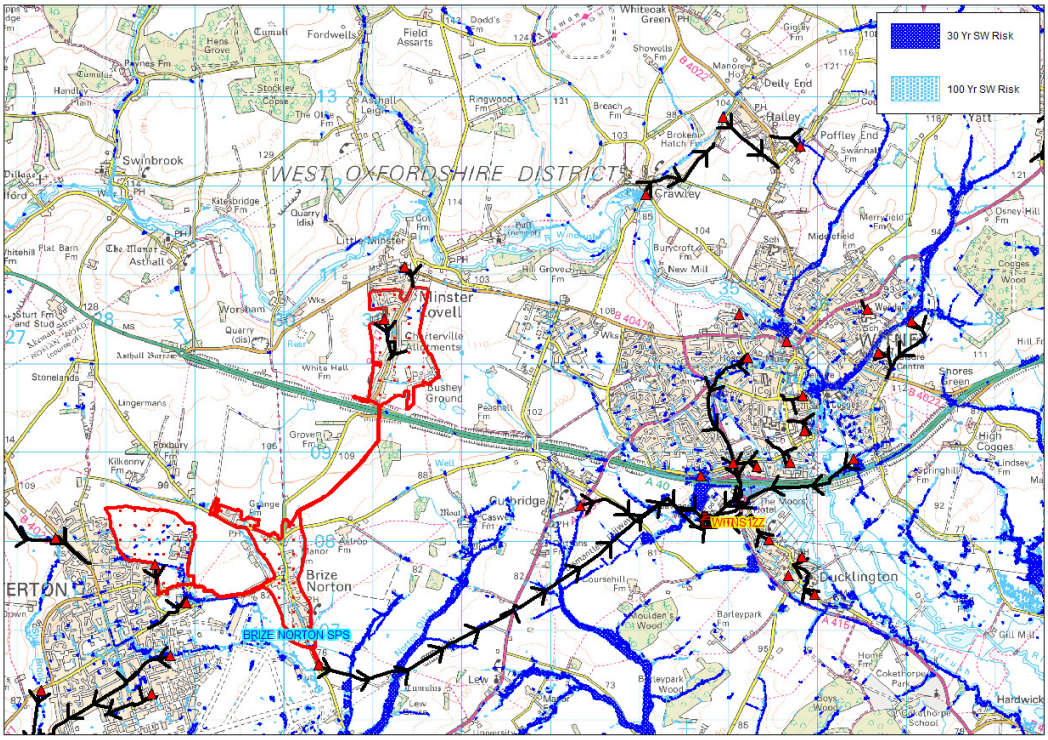
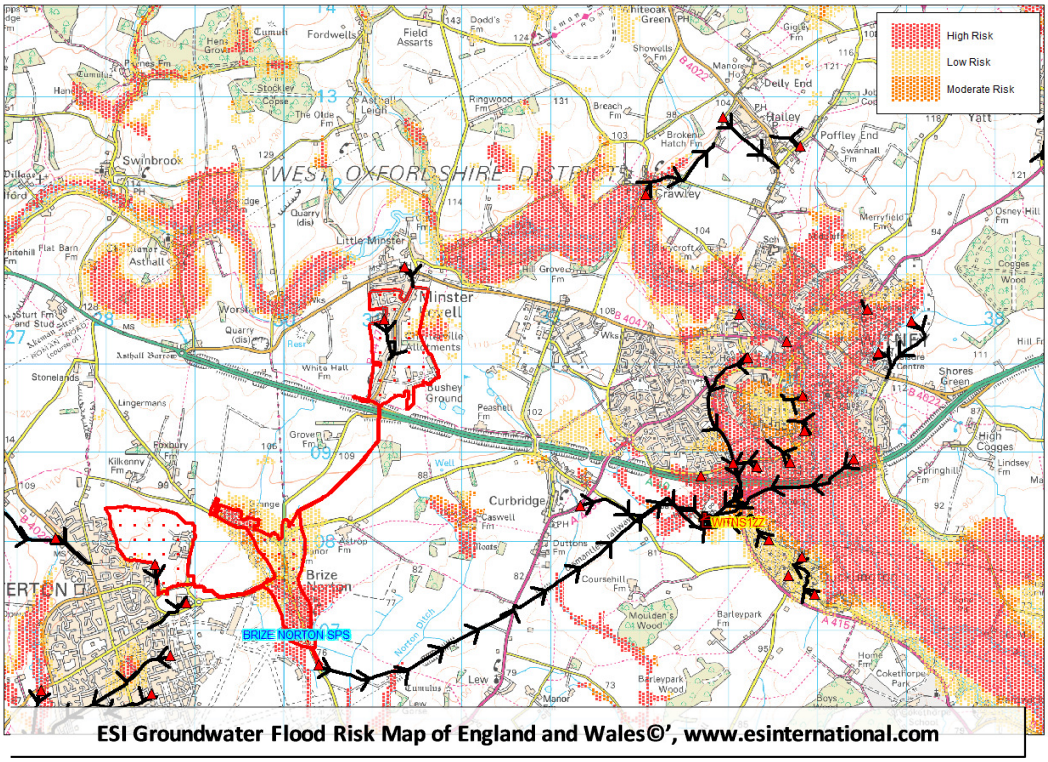


Figure B3 - Groundwater flood risk for Witney



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

Figure B4 - Witney Bedrock and Drift Geology

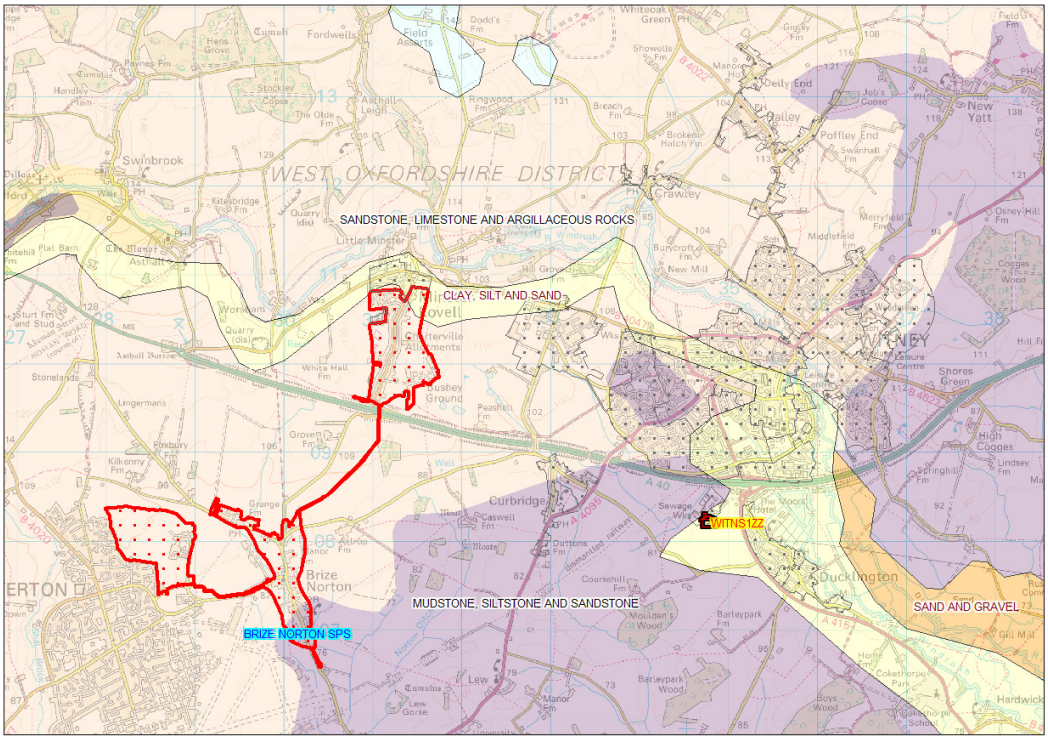
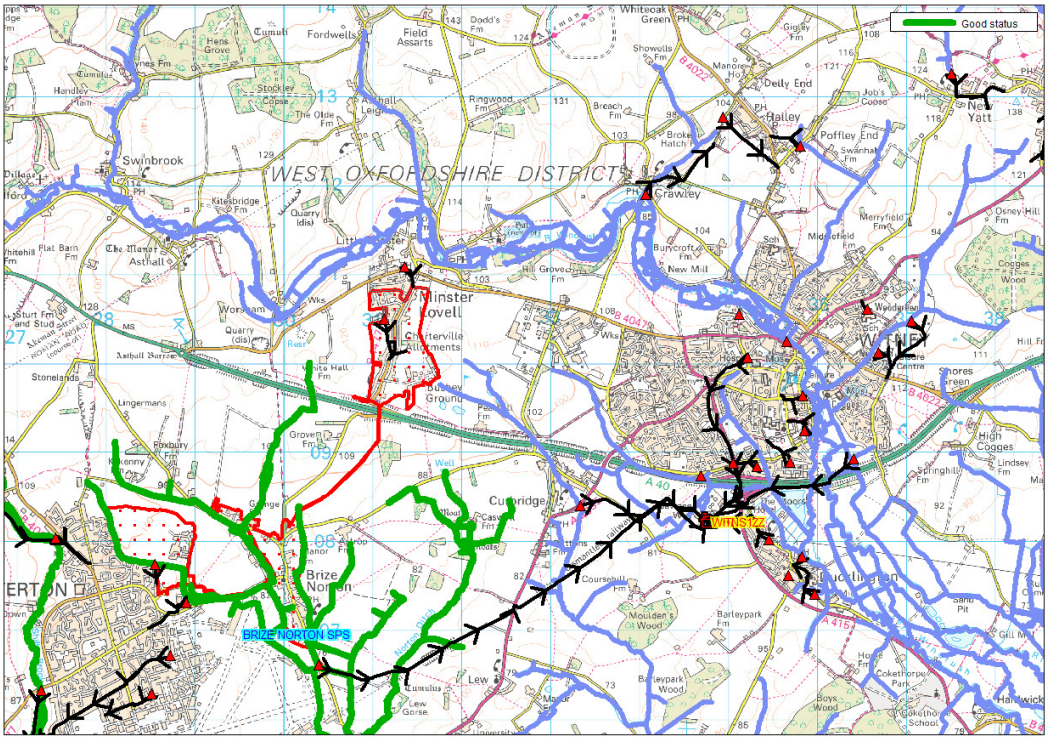


Figure B5 - Witney Watercourses



Photographs taken during wet weather of 2013/14

All photos taken from http://www.brizenorton.org.uk/

Photo 1 – Tankering at the SPS (09/12/2012)

Photo 2 – Flooding on Station Road (Dec 2012)

Photo 3 – the Road on 23/11/12 looking towards the RAF Medical Facility.

Photo 4 – Flooding on Station Road, including drainage ditch on left (Dec 2012)

Photo 5 – Flooding of Brize Norton SPS (09/11/12)