

# Ickford Section 19 Flood Investigation

## Final Technical Report

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Council**

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## Contract

This report describes work commissioned by Andrew Waugh, on behalf of Buckinghamshire Council, by an email dated 15 March 2021. Buckinghamshire Council’s representative for the contract was Andrew Waugh. Anna Beasley and James Fitton of JBA Consulting carried out this work.

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## Purpose

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## **Acknowledgements**

We would like to thank the following people for their input and support with the investigation: Vikki Keeble of Buckinghamshire Council, Nigel Hillier of Ickford Residents Group and Darren Trenchard of Thames Water.

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## Executive summary

### Background

Following a flood event in Ickford between the 2<sup>nd</sup> and 4<sup>th</sup> October 2020, Buckinghamshire Council (BC) as the Lead Local Flood Authority (LLFA) is undertaking a formal flood investigation under Section 19 of the Flood and Water Management Act 2010<sup>1</sup>. It is a statutory requirement for a LLFA to investigate flooding to the extent that it considers it necessary or appropriate.

Ickford is located in the north-west of Buckinghamshire. The village is situated on the edge of the River Thames floodplain, which flows to the south of the village. The flooding that occurred in Ickford caused internal flooding to at least 1 property. The village has experienced regular flooding to highways (at least four events in the last three years) causing disruption to access and egress from the village. Numbers of properties flooded internally in these previous events are unknown. Buckinghamshire Council, as the Lead Local Flood Authority for Ickford, has exercised its power to undertake a Section 19 investigation. Buckinghamshire Council has appointed JBA Consulting to undertake this investigation on its behalf.

For more information, see Section 1.

### Stakeholder engagement

As part of the Section 19 investigation, we engaged with multiple local stakeholders in Buckinghamshire, including residents, Council Members and Risk Management Authority partners. The objectives of engagement were to gather facts, opinions, and data to aid the understanding of the investigation; and enable the involvement of community representatives in the investigation.

For more information see Section 2.

### Catchment characteristics and long-term flood risk information

Section 3 describes the watercourses, drainage network, topography, and geology of Ickford. Section 4 summarises the existing long-term flood risk information on flood risk from rivers, surface water and groundwater.

Ickford has previously been flooded several times. In recent years, there have been floods in June 2008, January 2020 and January 2021, which caused flooding to roads in Ickford. For more information see Section 4.2.

### Flood risk management

Responsibility for flood risk can be divided into “flood risk management” and “emergency response”. Section 5 describes the roles and responsibilities of the various bodies involved in flood management and emergency response. Section 5.1.9 describes the existing flood risk management activities undertaken, including: flood alerts, channel maintenance and sewer flood risk reduction measures.

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<sup>1</sup> Flood and Water Management Act 2010 Section 19 (accessed 17 May 2021): <https://www.legislation.gov.uk/ukpga/2010/29/section/19>

## The 2<sup>nd</sup> to 4<sup>th</sup> October 2020 event

Prior to the event conditions had been generally dry, with several small rainfall events at the end of September. During the event, approximately 81mm of rainfall fell over 58 hours, which is approximately a 1 in 75 annual chance rainfall event.

For more information see Section 6.

## Incident response

During the event organisations worked separately in accordance with their operating instructions.

Buckinghamshire Highways issued sandbags to one property in Ickford.

Thames Water operated a tanker pumping water from the foul sewer system at the Church Road/Worminghall Road/Sheldon Road junction for an extended period during the event.

## Source-pathway-receptor analysis

The sources, pathways and receptors of flooding were as follows:

- Sources – extreme rainfall generating runoff from impermeable surfaces, high water levels in local watercourses, high associated groundwater levels in the river gravels
- Pathways – exceedance of channel capacity of the River Thames, Lappingford/Worminghall Brook and Peppershill Brook, surface water runoff forming on roads and pavements, overwhelmed highway drainage and foul sewer system, groundwater infiltration into sewer system.
- Receptors – internal flooding to at least 1 property, garden flooding, flooding of roads causing problems with access and egress, sewer system overwhelmed, mental health impacts on residents.

For more information see Section 8.

## Discussion, appraisal and recommendations

In this section, we discuss in more detail some of the aspects of flood risk management in Ickford, what worked well and not so well, and we consider potential options to mitigate flood risk and reduce damages caused by flooding.

We undertook a high-level option appraisal focussing on benefit, practical and viability considerations. We carried out a multi-criteria analysis to compare each option which included consideration of a range of different factors, for example the potential contribution towards reducing flood risk to property, people and communities.

Doing nothing was the least beneficial option, followed by continuing with a 'business as usual' approach to managing flood risk in Ickford. The options which scored the highest were those that could ultimately result in a more resilient community. These options included:

- Community flood resilience actions e.g. form a community Flood Action Group and prepare a residents' 'flood preparedness' information pack
- Investigate opportunities for installing Property Flood Resilience
- Carry out further investigations into groundwater ingress into the foul sewer
- Take opportunities to disconnect or slow down roof water drainage

There are also a number of recommendations for strengthening local planning policy on 'other sources' of flooding, and access and egress.

Recommended actions	Risk Management Authority/Stakeholder
Complete sewer monitoring and CCTV investigations to identify groundwater ingress and undertake remediation works if required	Thames Water
Undertake impermeable area survey	Thames Water
Develop Groundwater Impacted System Management Plan for Ickford	Thames Water
Take opportunities to disconnect or slow down roof water drainage on private properties and the school	Property owners
Work with the community to promote disconnection of surface water from the sewer in the longer term	Thames Water
Investigate opportunities to retrofit highway raingardens	Buckinghamshire Highways
Reducing ingress of fluvial or surface water into sewers	Residents
Set up a Flood Action Group and create a community Flood Action Plan to formalise and develop any existing arrangements.	Community, supported by Ickford Parish Council and Buckinghamshire Council (LLFA)
Prepare a 'flood preparedness' information pack for existing and future residents.	Community, supported by Ickford Parish Council and Buckinghamshire Council (LLFA)
Report internal property flooding from Main Rivers to Environment Agency	Residents
Report internal property flooding from surface water or groundwater to Buckinghamshire Council	Residents
Report sewer flooding to Thames Water	Residents
Investigate opportunities for installing PFR at relevant at-risk properties	Property owners
Watercourse maintenance plan and riparian awareness (to include activities required, frequency etc)	Riparian owners, supported by Ickford Parish Council and Environment Agency
Strengthen policy on other sources of flooding and access and egress through the emerging Local Plan for Buckinghamshire and Strategic Flood Risk Assessment	Local Planning Authority (with advice from LLFA, Emergency Planning and Environment Agency)
Increase awareness of Development Control teams of the impacts of groundwater infiltration on network capacity and flooding	Thames Water

For more information see Section 10 and Appendix A.

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## Abbreviations

AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
BGS	British Geological Society
BC	Buckinghamshire Council
CCTV	Closed Circuit Television
DTM	Digital Terrain Model

EA	Environment Agency
FEH	Flood Estimation Handbook
GIS	Geographic Information Systems
JBA	Jeremy Benn Associates
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
OS	Ordnance Survey
PFR	Property Flood Resilience
RMA	Risk Management Authority
RoFSW	Risk of Flooding from Surface Water (Environment Agency mapping)
TfB	Transport for Buckinghamshire

## Definitions

Culvert	Where a watercourse flows through a pipe or conduit, often underground.
Foul sewer	Sewer which carries wastewater (e.g., from toilets, sinks, showers and kitchen appliances) to a sewage works for treatment.
Gully	Drainage pit covered by an open metal grating, located at the edge of a road. Drains rainwater from the road into the sewerage system.
HYRAD	Real-time radar display system for weather.
Lead Local Flood Authority	County councils and unitary authorities which lead in managing local sources of flood risk (i.e. flooding from surface water, groundwater and ordinary watercourses)
Main river	A large river or stream designated on the Main River Map. The Environment Agency has permissive powers to maintain and carry out improvements on main rivers, to manage flood risk.
Non-return valve	Hinged valve placed on a pipe outlet into a river. Stays open during normal flow but closes when it is submerged, to prevent flow from backing up the pipe.
Ordinary Watercourse	All rivers which are not designated as 'Main rivers'. Lead local flood authorities and internal drainage boards can carry out flood risk management work on ordinary watercourses.
Public sewer	Sewers owned and maintained by a Sewerage Company (e.g. Thames Water). Are usually located in roads or public open spaces and may run through private gardens.
Riparian owner	The owner of land that is next to a watercourse or has a watercourse running through or beneath it.
Soil moisture deficit	The difference between the amount of water actually present in the soil and the amount of water which the soil can hold.
Surface water sewer	Sewer which carries rainwater directly to a watercourse.

# 1 Introduction

## 1.1 Background to investigation

Following flooding in Ickford between 2<sup>nd</sup> and 4<sup>th</sup> October 2020, Buckinghamshire Council (BC) as the Lead Local Flood Authority (LLFA) is undertaking a formal flood investigation under Section 19 of the Flood and Water Management Act 2010<sup>2</sup>.

It is a statutory requirement for a LLFA to investigate flooding to the extent that it considers it necessary or appropriate. Buckinghamshire Council has outlined its criteria for undertaking a Section 19 investigation in its Local Flood Risk Management Strategy<sup>3</sup>.

- Internal flooding (including to basements) to five or more residential properties within an area of 1km<sup>2</sup>;
- Internal flooding of two or more business premises within an area of 1km<sup>2</sup>;
- Internal flooding (including to basements) of at least one property for one week or longer;
- Flooding of one or more critical infrastructure assets, which could include hospitals, health centres, clinics, surgeries, colleges, schools, day nurseries, nursing homes, emergency services (police, fire, ambulance) stations, utilities and substations; and
- Any flooding event that a risk management authority deems significant but does not meet the agreed thresholds may be assessed for consideration by the strategic flood management group.

Buckinghamshire Council, as the LLFA for Ickford, has exercised its power to undertake a Section 19 investigation as the flooding has been deemed significant under the final criteria listed above. The event caused internal flooding of at least one property in the village, and it is suspected that other properties may have flooded internally although it has not been possible to confirm this, as there was a low response to the online questionnaire. Several properties are known to have experienced flooding externally. The village has experienced regular flooding to highways (at least four events in the last three years) causing disruption to access and egress from the village. The number of properties flooded internally in these events are unknown.

## 1.2 Aims of the investigation

Section 19 of the Flood and Water Management Act 2010 sets out that a Lead Local Flood Authority (LLFA) must, to the extent that it considers it necessary or appropriate, investigate which risk management authorities have relevant flood risk management functions, and whether each of those authorities has exercised, or is proposing to exercise, those functions in response to the flood.

Within Buckinghamshire, the aims of such an investigation are extended to providing an overview of the flooding incident and its impact, any history of flooding, a rainfall analysis, and determining the main factors and mechanisms involved in the flooding. This investigation also seeks to outline the actions of the relevant authorities, with some discussion of what went well and where improvements could be made in future. However, it is not within the remit of a Section 19 Flood Investigation to apportion blame to any organisation nor hold any risk management authority to account for their response to the floods.

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<sup>2</sup> Flood and Water Management Act 2010 Section 19 (accessed 17 May 2021): <https://www.legislation.gov.uk/ukpga/2010/29/section/19>

<sup>3</sup> Buckinghamshire Local Flood Risk Management Strategy (2017): <https://www.buckscc.gov.uk/media/4511603/bcc-lfrms-final-version-may-2017.pdf>

We have also proposed a list of recommendations to help the various stakeholders learn from the event and improve the management of flood risk locally. We have undertaken a high-level appraisal of these recommendations, focussing on benefit, practical and viability considerations. However, it is not within the remit of a Section 19 Flood Investigation to provide designed solutions. The investigation process does not provide Buckinghamshire Council, nor any other authority, with the funding or mandate to undertake flood management works on the ground.

The intention is instead to provide a clear understanding of the issues, since this is the first step towards being able to help address a flooding problem.

Given that the scope of the investigations is limited to developing a preliminary high-level screening of options, the reports should not be viewed as an action plan nor strategy that will set out definitive flood management actions that will be taken. However, it does make several recommendations that may be actioned in the short to medium term. It will be for the relevant responsible party to assess these recommendations in terms of their legal obligation, resource implications, priority and the costs and benefits of undertaking such options.

### **1.3 Site location**

Ickford is located in the north-west of Buckinghamshire. The village is situated on the edge of the River Thames floodplain, which flows to the south of the village.

### **1.4 Data collection**

A wide range of different data has been collected and assessed to inform the Section 19 investigation. This has been used to understand the causes and impacts of flooding in Ickford and to establish the context of the area. This includes the following:

- Open source data from GOV.UK – for example the Risk of Flooding from Surface Water mapping (RoFSW), the Flood Map for Planning, LiDAR etc;
- Local asset datasets e.g. sewer network data, highway asset data
- Historic flood records
- Rainfall data (Wheatley R22 raingauge)
- Questionnaires
- Data from the event, such as photographs, observations/notes, newspaper articles, road closure announcements and flooded property information

## 2 Stakeholder engagement

We engaged with multiple local stakeholders, including residents, community representatives, landowners, other Council departments, Council Members and RMA partners.

The objectives of engagement are to:

- Gather facts, opinions and data to aid the understanding of the investigation
- Enable the involvement and buy-in of the community in the investigation
- Disseminate the findings of the investigation to the community

A list of key stakeholders and how we engaged with them is given in Table 2-1. The engagement terminology is taken from Environment Agency's 'Working with Others' (2013) methodology:

- Inform - provide information
- Consult - receive, listen, understand and feedback
- Involve - decide together
- Collaborate - act together
- Empower - support independent action

Only one response to the online questionnaire was received so it has been difficult to confirm the exact number of properties flooded internally.

**Table 2-1: Key stakeholders**

Role	Organisation	How to engage	Type of engagement
Community representatives	Ickford Residents Group (TBC)	Involve	Site visit, online questionnaire, correspondence
Water and Sewerage Company	Thames Water	Involve	Invitation to contribute, correspondence, data provision
LLFA SuDS Team	Buckinghamshire Council	Involve	Invitation to contribute, correspondence
Council Members	Buckinghamshire Council	Consult	All - Invitation to contribute.
Residents		Consult	Online questionnaire, correspondence

### 3 Catchment characteristics

#### 3.1 Drainage system and river network

Figure 3-1 shows the watercourses within and around Ickford. Larger watercourses are often designated as 'main rivers'. The Environment Agency has permissive powers to carry out maintenance and improvements to main rivers to manage flood risk. All other rivers are known as 'ordinary watercourses'. The roles and responsibilities of different organisations in managing flood risk are explained in Section 5.

The River Thames is a Main River, which flows to the south of Ickford. The Lappingford or Worminghall Brook (Main River) flows to the west of the village between Ickford and Worminghall, and the Peppershill Brook (Main River) between Ickford and Shabbington. The land between the watercourses is drained by a network of ditches<sup>4</sup>.

Within the village, a small ordinary watercourse runs along the north side of Church Road, which is connected to the outfall of the surface water network along Worminghall Road. This watercourse flows through a culvert at the southern end of Church Road and across fields before it joins the River Thames.

On the Ordnance Survey (OS) 1:10,000 maps from as recently as 1970<sup>5</sup> this watercourse appears to run in an open channel further to the north, on the western side of Worminghall Road to the junction with Ickford Road (also known as Shabbington Road).

A small ditch also runs along the south side of Church Road for a short distance.

At the junction of Sheldon Road and Little Ickford there is a pond, whose outfall is culverted and which re-emerges as an ordinary watercourse to the south of the village before entering the River Thames.

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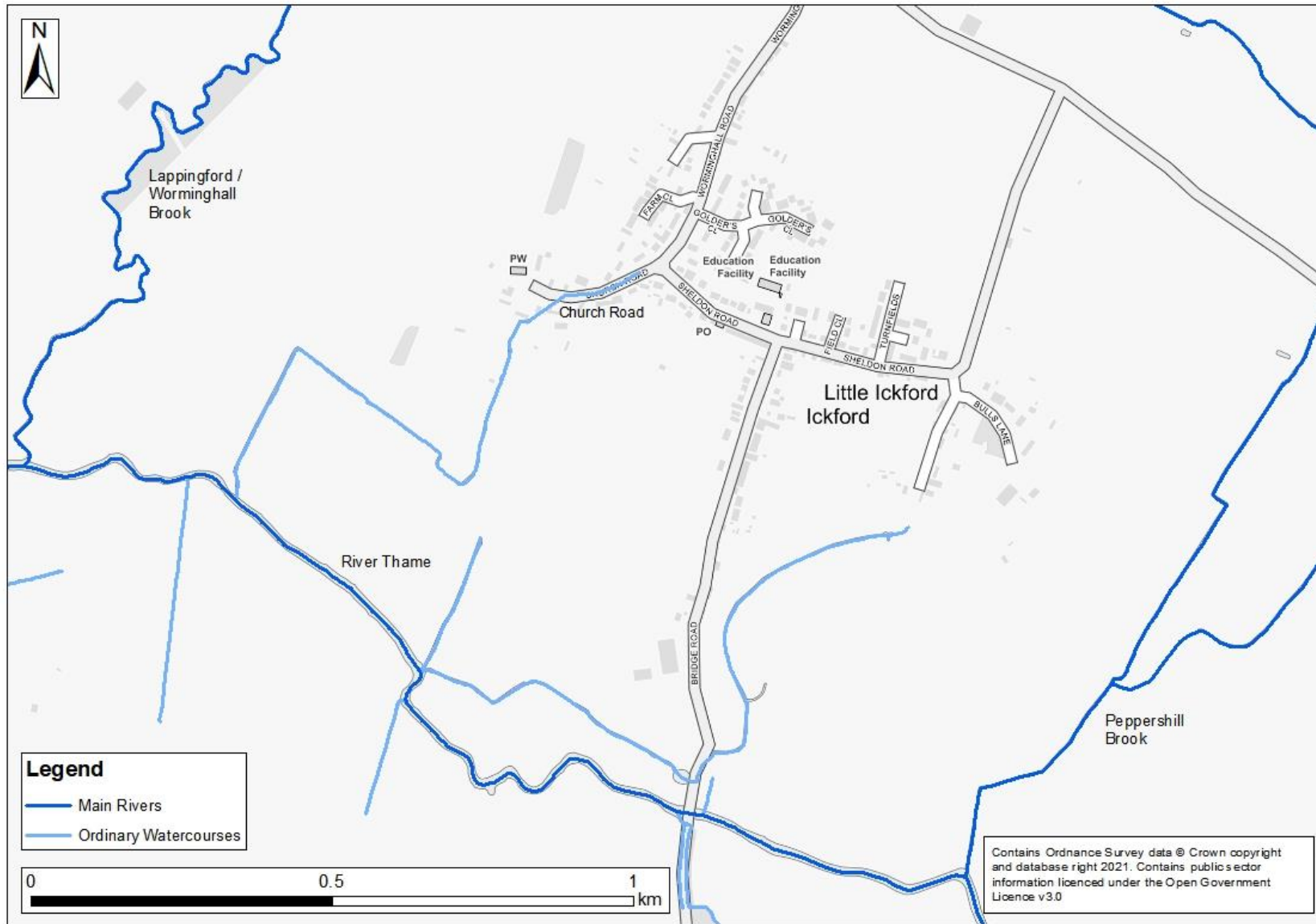
4 'Flooding in Ickford'

[https://ickfordcommunity.files.wordpress.com/2015/10/agenda73g\\_floodsummary1.pdf](https://ickfordcommunity.files.wordpress.com/2015/10/agenda73g_floodsummary1.pdf)

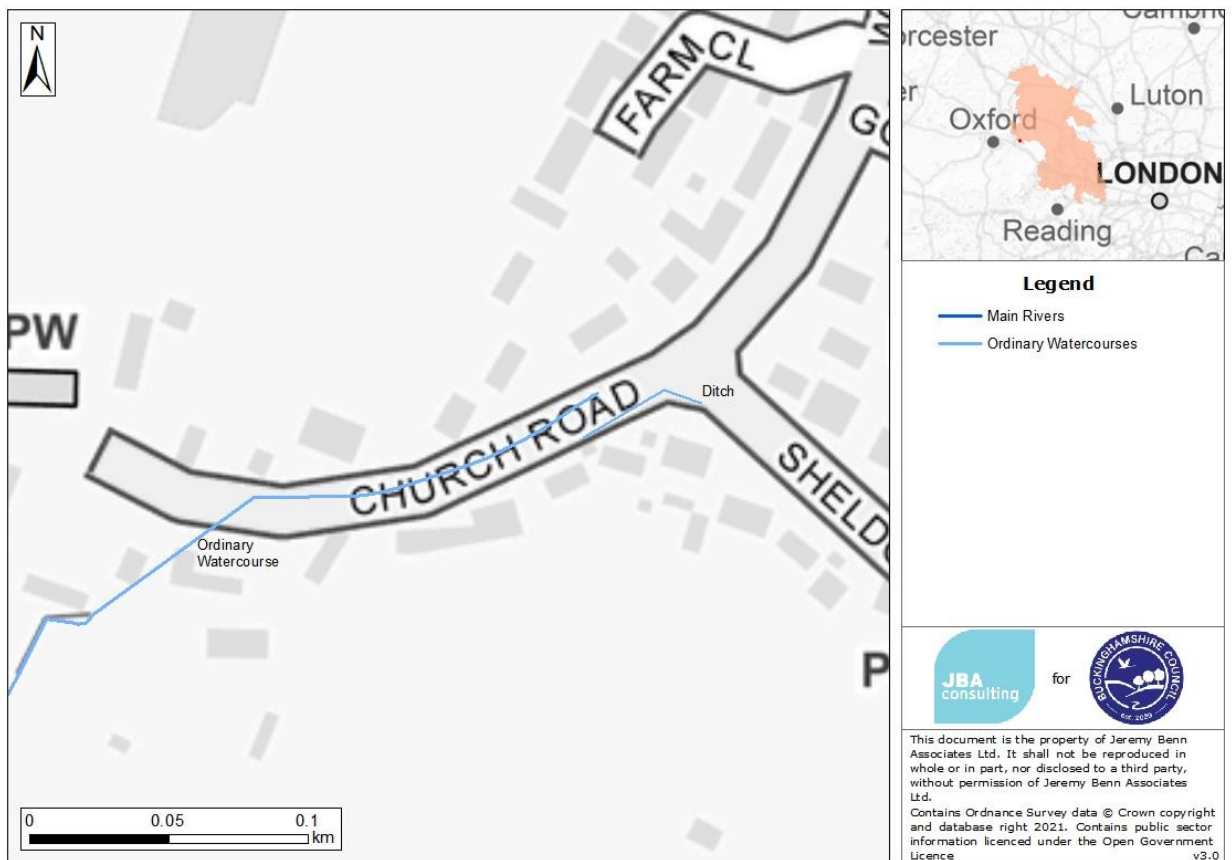
5 View map: Ordnance Survey, SP60NW - A/ - Ordnance Survey National Grid Maps, 1940s-1970 (nls.uk)



Figure 3-1: Watercourses in Ickford



**Figure 3-2: Ordinary watercourse and ditch at Church Road**



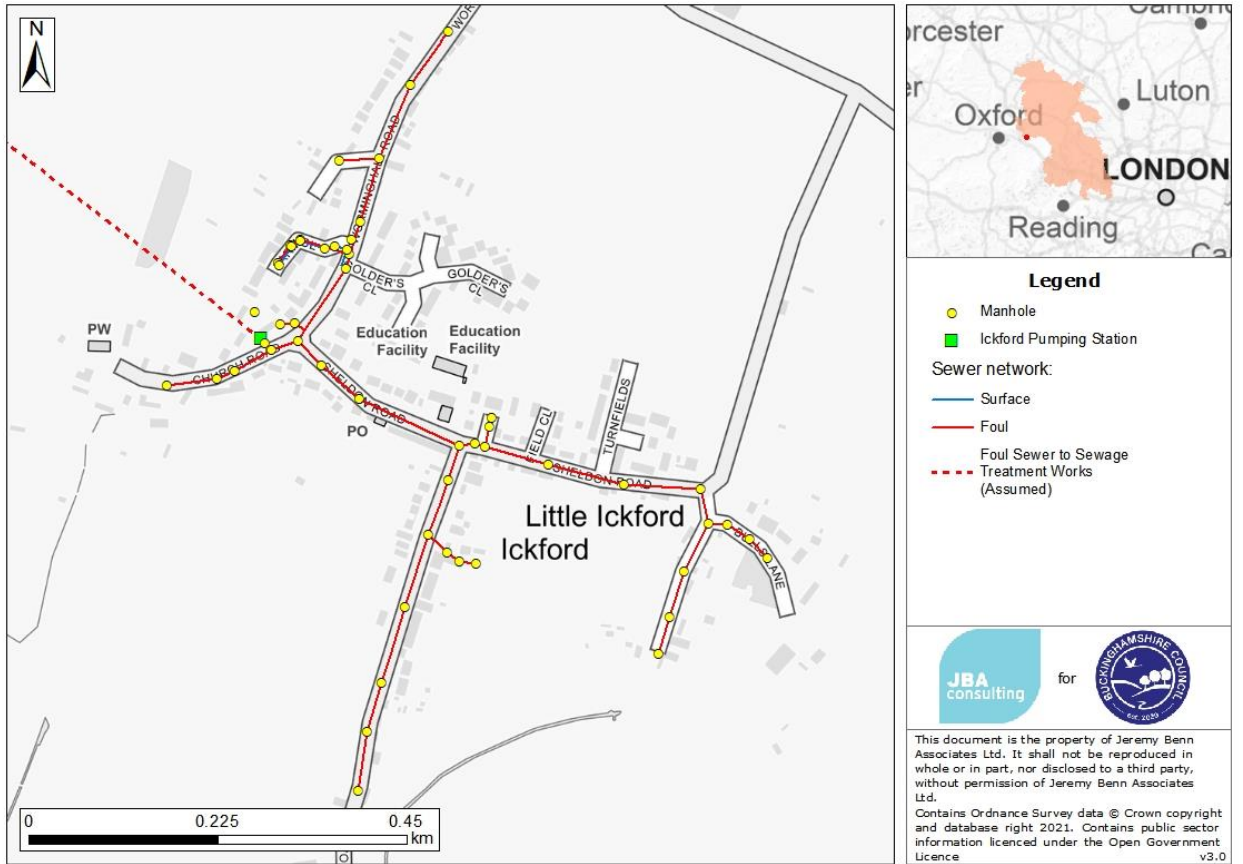
### 3.2 Sewer network

The foul and surface water sewer networks within Ickford are shown in Figure 3-3.

The majority of the Thames Water sewer network in Ickford carries foul sewage only, similar to many rural villages. The foul system drains to Ickford Pumping Station and from there is pumped to Worminghall sewage treatment works (STW). Thames Water is currently investigating whether the pump rate is adequate for the site.

There is a small surface water sewer serving Farm Close. It is assumed this system connects to the highway drainage before discharging into the ditch at Church Road, as shown in Figure 3-4.

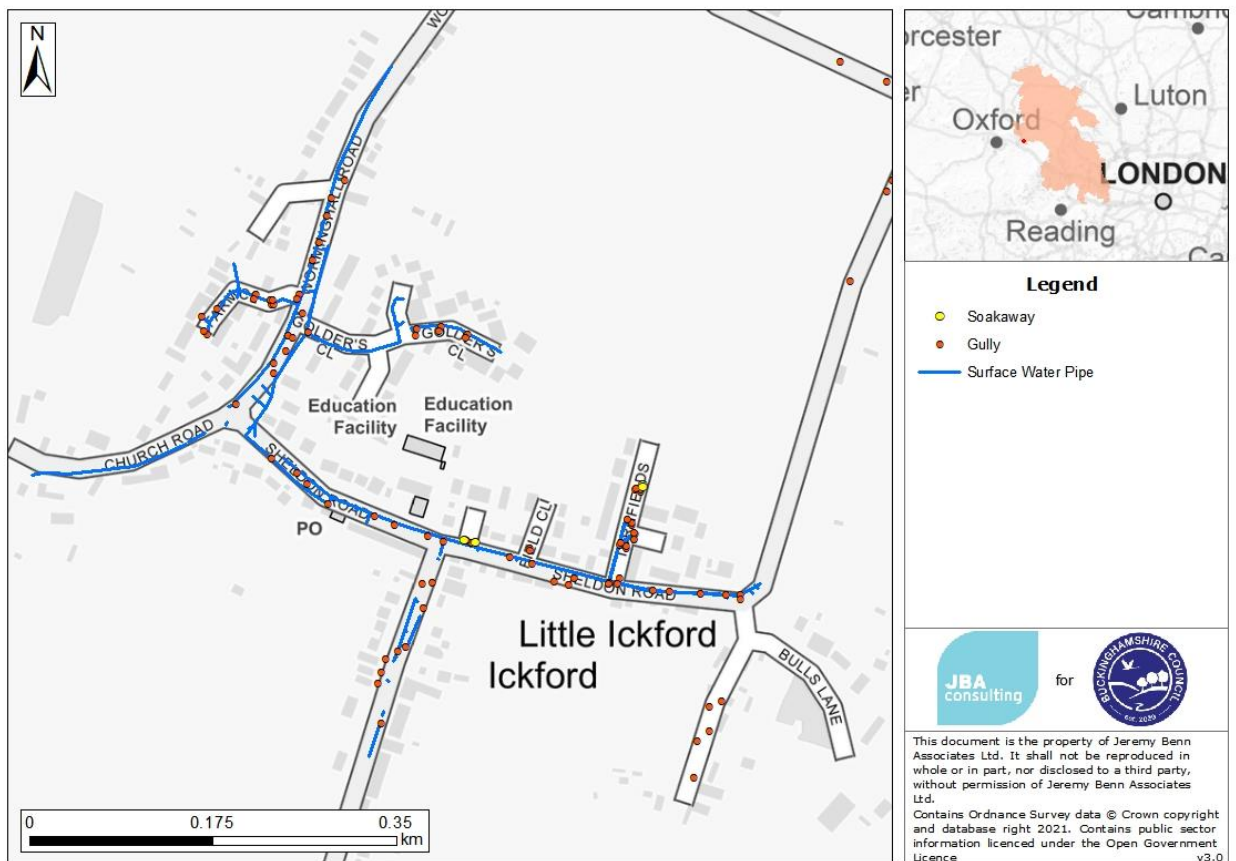
**Figure 3-3: Sewer network**



### 3.3 Highway drainage

Highway drainage data has been provided by Buckinghamshire Highways. Figure 3-4 shows that, within the village itself, there are many highway gullies, most of which connect into surface water pipes running under the roads and verges. The majority of these drain towards Church Road, where they discharge into the ditch along the southern side of the road. This in turn discharges to the River Thames.

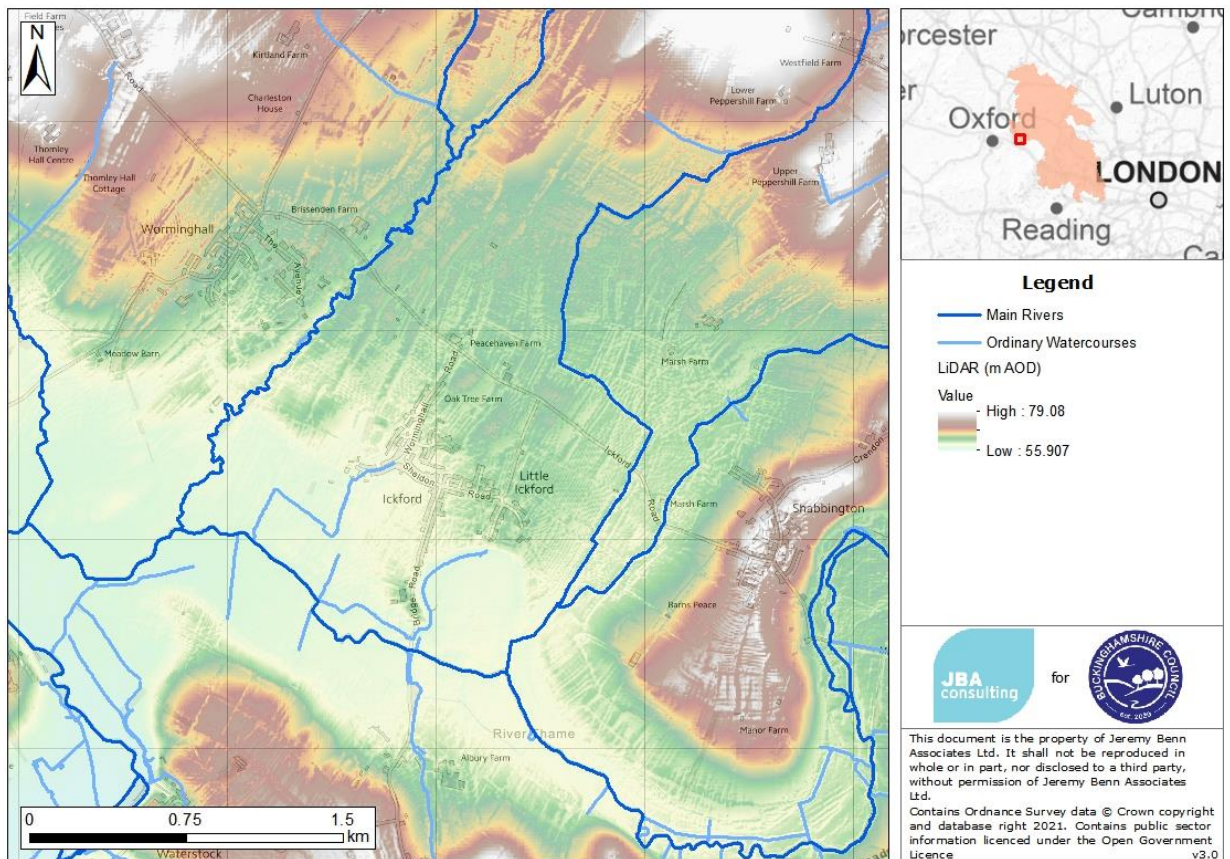
**Figure 3-4: Highway drainage network**



### 3.4 Topography

Ickford is located on the edge of the River Thames floodplain. The majority of the village is elevated above the floodplain with the greatest elevations located in the north and north-east of the village. The lowest areas include Church Road where elevations range between 58.02m AOD at the bottom (south) and 58.3m AOD at the top (north).

**Figure 3-5: Topography of Ickford**



### 3.5 Geology

Ickford is underlain by bedrock geology of Ampthill Clay Formation which consists of mudstone. The south-east corner of Little Ickford is underlain by bedrock geology of Kimmeridge Clay Formation which consists of Mudstone. Ickford has a superficial geology of River Terrace deposits which is comprised of sand and gravel.

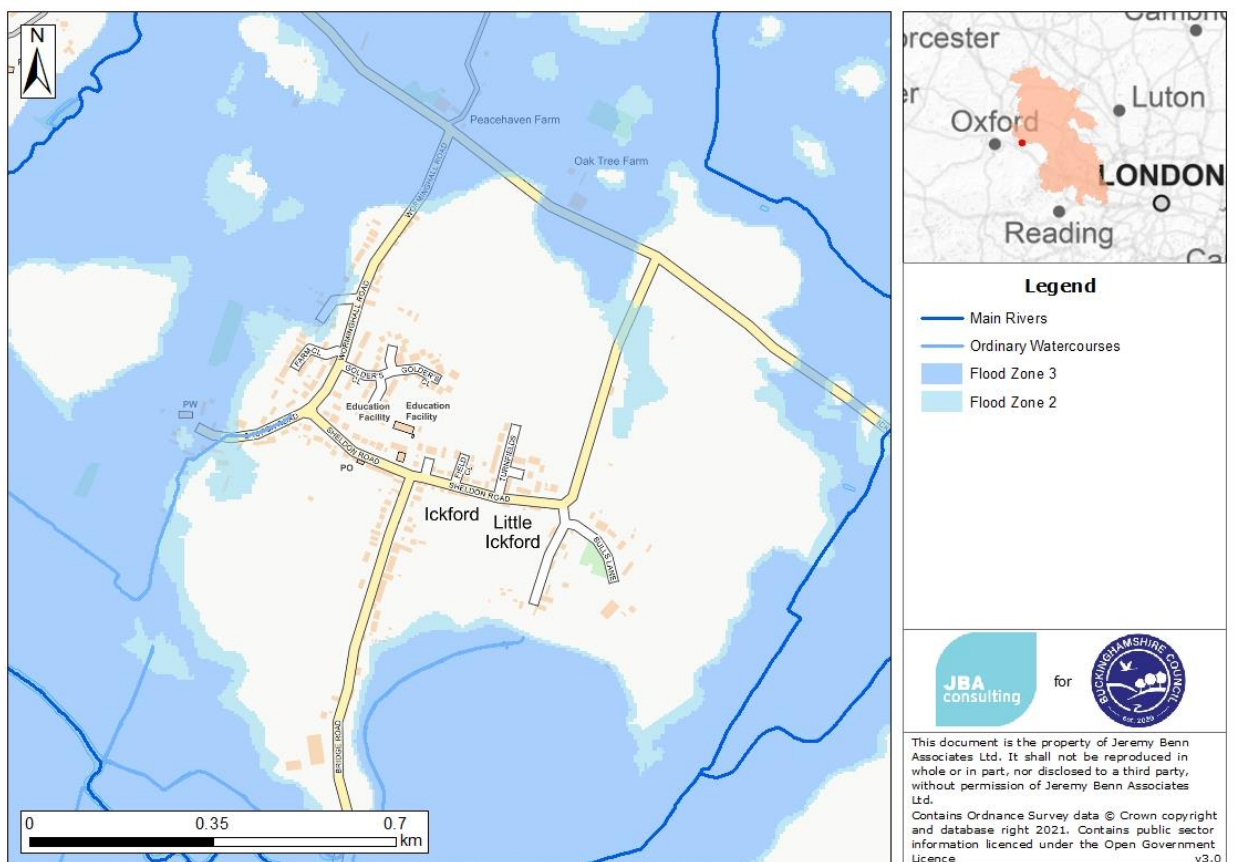
## 4 Flood risk

### 4.1 Long-term flood risk information

Maps of long-term flood risk information are available from the Environment Agency in England (Learn more about flood risk - GOV.UK). Figure 4-1 shows the Environment Agency’s Risk of Flooding from Rivers and the Sea within Ickford. Much of the village is located outside of the risk areas, with the exception of the south of Church Road and part of Worminghall Road.

Although Ickford is not at high risk of flooding from rivers and sea, all access routes to the village are at medium to high risk: via Worminghall Road/Ickford Road towards Worminghall; via Sheldon Road/Ickford Road towards Shabbington; and via Bridge Road towards Draycot. As such the village can become isolated when these roads flood.

**Figure 4-1: Risk of flooding from rivers and the sea**



**Figure 4-2: Risk of flooding from surface water**

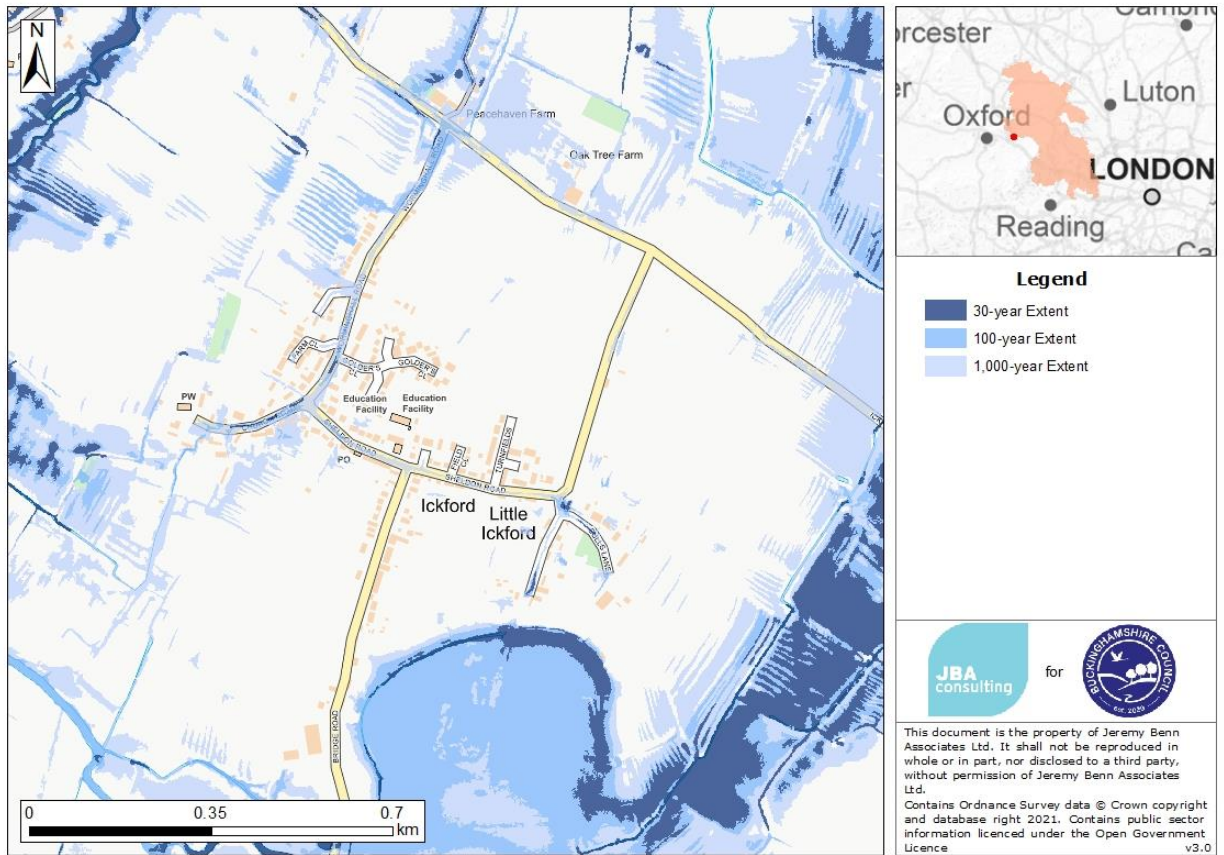


Figure 4-2 shows the Risk of Flooding from Surface Water (RoFSW) within Ickford. Aside from the risk shown within the fluvial floodplain of the River Thames and along the ordinary watercourses, there are several locations at risk from surface water flooding, including Worminghall Road, Church Road and Sheldon Road. Similarly to the risk of flooding from rivers and sea, the access routes to Ickford are also at risk of flooding from surface water.

**Figure 4-3: Risk of flooding from groundwater**

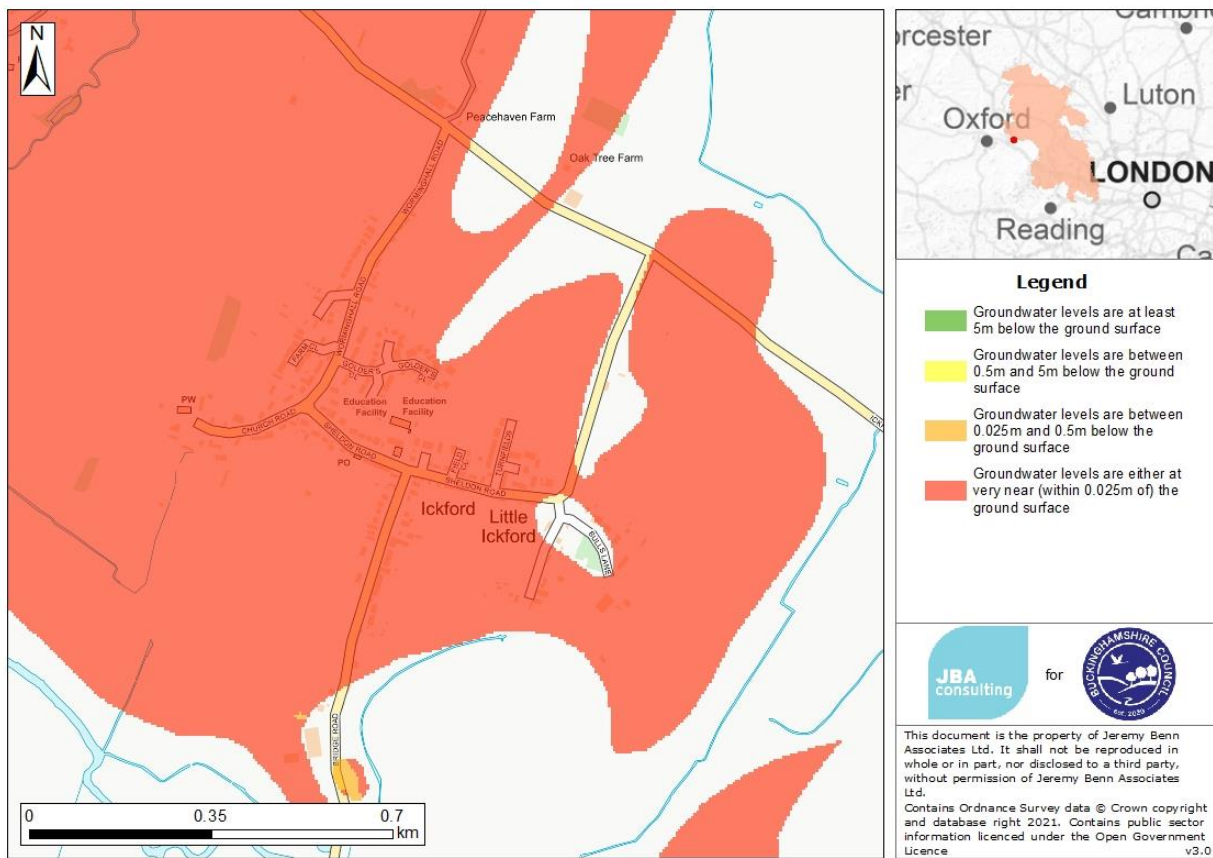


Figure 4-3 shows the risk of flooding from groundwater within Ickford from the JBA Groundwater Flood Map. Ickford is located within the highest risk band for groundwater flooding, i.e. groundwater levels are within 0.025m of the surface during a 1 in 100-year event. This is likely to be because of the presence of superficial floodplain deposits.

**4.2 Flood history**

Table 4-1 details the known flood history in Ickford. While numbers of properties internally flooded are not high, nuisance/highway flooding happens very regularly, with four events reported by residents in the last three years.

**Table 4-1: Flood history**

Date	Source of flooding	Description of impacts
September 1992	Fluvial – River Thame	Environment Agency Recorded Flood Outline covers the River Thame and parts of the Worminghall/Lappingford Brook floodplain. No properties in Ickford are shown as flooding.
Winter 2001	Fluvial – River Thame	High water levels in the River Thame caused the ditch to back up and flood properties on Church Road.
January 2003	Fluvial – River Thame	High water levels in the River Thame. Highest recorded level on the Thame Bridge level gauge. This event was also a high groundwater event.



Date	Source of flooding	Description of impacts
2007	Unconfirmed – likely surface water	Sheldon Road was frequently flooded during 2007 <sup>6</sup> .
3 June 2008	Fluvial (Worminghall Brook) and surface water	Heavy rainfall (50mm in 12 hours) caused the Worminghall Brook to exceed channel capacity and flow across fields towards Worminghall Road and down to Church Road. Sheldon Road was impacted by surface water flooding. The event caused flooding to several properties <sup>6</sup> . There were three flood events between January and July 2008 within Ickford <sup>6</sup> .
February 2014	Fluvial - River Thame	High water levels in the River Thame. Second highest recorded level on the Thame Bridge level gauge. This event was also a high groundwater event.
July 2019	Surface water	Flooding along Worminghall Road and Golders Close.
January 2020	Fluvial and surface water	Flooding at the junction of Worminghall Road and Ickford Road and which made the junction impassable for regular vehicles. Surface water along Sheldon Road
October 2020	Surface water	Heavy rainfall (81mm in 58 hours) Flooding at the junction of Worminghall Road and Ickford Road and which made the junction impassable for regular vehicles. Surface water and foul flooding along Sheldon Road. Exceedance of channel capacity at Church Road.
January 2021	Fluvial and surface water	Flooding along Worminghall Road and Sheldon Road. In several locations the water level exceeded the kerb height. Along Church Road the drainage ditch overtopped onto the road and surface water flowed down from The Worminghall Road junction

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6 This information was taken from a document (agenda73g\_floodsummary1.pdf) downloaded from the Ickford Community website in August 2021. The website was updated in April 2022 and the document is no longer available.

## 5 Flood risk management roles and responsibilities

Flood risk in England is managed by a range of different Risk Management Authorities (RMAs)<sup>7</sup>. The Flood and Water Management Act places a duty on all flood risk management authorities to co-operate with each other. The act also provides Lead Local Flood Authorities and the Environment Agency with a power to request information required in connection with their flood risk management functions.

### 5.1.1 Lead Local Flood Authority (LLFA)

LLFAs are responsible for coordinating the mitigation of risk of flooding from surface water, groundwater (water which is below the water table under the ground) and ordinary watercourses (non-main rivers). The LLFA is also responsible for developing, maintaining and applying a strategy for local flood risk management in their area and for maintaining a register of flood risk assets. LLFAs also have a statutory duty to investigate significant flood events to the extent they consider necessary.

Buckinghamshire Council is the LLFA for Ickford.

### 5.1.2 Environment Agency

The Environment Agency is sponsored by the Government's Department for Environment, Food & Rural Affairs (Defra), and is tasked with the protection and conservation of the water environment in England, the natural beauty of rivers and wetlands and the wildlife that lives there.

The Environment Agency's responsibilities include: water quality and resources; fisheries; conservation and ecology; and operational responsibility for managing the risk of flooding from main rivers (usually large streams and rivers), reservoirs, estuaries and the sea.

Flood risk management work can include: constructing and maintaining 'assets' (such as flood banks or pumping stations) and works to main rivers to manage water levels and make sure flood water can flow freely; operating flood risk management assets during a flood; dredging the river; and issuing flood warnings.

The Environment Agency can also do work to prevent environmental damage to watercourses, or to restore conditions where damage has already been done.

The strategies for flood and coastal erosion risk management show how communities, the public sector and other organisations can work together to manage this risk.

### 5.1.3 Internal Drainage Board (IDB)

Internal drainage boards (IDB) are independent public bodies, established in areas of special drainage need known as drainage districts. The IDB is responsible for the supervision of land drainage, water level management and flood risk management works and regulation of ordinary watercourses. The IDB also plays an important role in the areas they cover (approximately 10% of England at present) in working in partnership with other authorities to actively manage and reduce the risk of flooding.

Ickford is not within a IDB drainage district.

### 5.1.4 Water and Sewerage Company

Water and sewerage companies are responsible for the provision of wastewater collection and treatment systems, including for managing the risks of flooding from surface water and foul or combined public sewer systems providing drainage from buildings and yards.

Thames Water is the water and sewerage company for Ickford.

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<sup>7</sup> <https://www.gov.uk/guidance/flood-risk-management-information-for-flood-risk-management-authorities-asset-owners-and-local-authorities>

**5.1.5 Highway Authority**

The Highway Authority for Ickford is Buckinghamshire Council, and the highways function is managed by Buckinghamshire Highways. It is responsible for maintaining the highway drainage system to an acceptable standard and ensuring that road projects do not increase flood risk.

**5.1.6 Riparian landowners**

Riparian landowners who own land or property next to a river, stream or ditch, (including where this runs through a pipe or culvert), have rights and responsibilities over the management of the land including: a responsibility to let water flow through the land without any obstruction, pollution or diversion which affects the rights of others; keeping banks clear of anything that could cause an obstruction and increase flood risk; maintaining the bed and banks of the watercourse; and keeping structures clear of debris. There is more information on these rights and responsibilities in the Environment Agency guide 'Owning a Watercourse'<sup>8</sup> and in Buckinghamshire Council's guidance, "Maintaining a river or stream you own"<sup>9</sup>.

**5.1.7 Local residents**

Local residents should find out about any flood risk in the area, sign up for the Environment Agency's free flood warnings, where available, and make a written plan of how they will respond to a flood situation. Business owners should also make a flood plan for their business. There are measures that can be taken to reduce the amount of damage caused by flooding and properties at risk should be insured. Local residents can find out if their property is at risk, prepare for flooding, get help during a flood and get help after a flood (see section 10.4).

**5.1.8 Emergency responsibilities**

The emergency responsibilities of different organisations are outlined in Table 5-1 below. Please note that Parish and Town Councils do not have a legal obligation to respond to emergencies. Whatever service they provide is voluntary and unique to each Parish or Town Council.

**Table 5-1: Roles and responsibilities in an emergency, during and after a flood event**

Local Authorities
Coordinate emergency support within their own functions
Deal with emergencies on 'non main rivers'
Coordinate emergency support from the voluntary sector
Liaise with central and regional government departments
Liaise with essential service providers
Open rest centres
Manage the local transport and traffic networks
Mobilise trained emergency social workers
Provide emergency assistance

8 Owning a watercourse (<https://www.gov.uk/guidance/owning-a-watercourse>)

9 <https://www.buckinghamshire.gov.uk/environment/flooding-and-flood-risk-management/maintaining-a-river-or-stream-you-own/>

Deal with environmental health issues, such as contamination and pollution  
 Coordinate the recovery process  
 Manage public health issues  
 Provide advice and management of public health  
 Provide support and advice to individuals  
 Assist with business continuity

<b>Police Force</b>	<b>Utility Providers</b>
Save life Coordination and communication between emergency services and organisations providing support Coordinate the preparation and dissemination	Attend emergencies relating to their services putting life at risk Assess and manage risk of service failure Assist with recovery process, that is, water utilities manage public health considerations

<b>Fire and Rescue Service</b>	<b>Internal Drainage Board</b>
Save life rescuing people and animals Carry out other specialist work, including flood rescue services Where appropriate, assist people where the use of fire service personnel and equipment is relevant	Operate strategic assets to reduce flood risk in partnership with RMAs and public

<b>Ambulance Service</b>	<b>Town and Parish Councils</b>
Save life Provide treatment, stabilisation and care at the scene	Support emergency responders Increase community resilience through support of community emergency plan development

<b>Voluntary Services</b>
Support rest centres Provide practical and emotional support to those affected Support transport and communication Provide administration Provide telephone helpline support

<b>Environment Agency</b>
Issue Flood Warnings and ensure systems display current flooding information Provide information to the public on what they can do before, during and after a flood event Monitor river levels and flows Work with professional partners and stakeholders and respond to requests for flooding information and updates

Receive and record details of flooding and related information  
 Operate water level control structures within its jurisdiction and in line with permissive powers  
 Flood event data collection  
 Arrange and take part in flood event exercises  
 Respond to pollution incidents and advise on disposal  
 Assist with the recovery process, for example, by advising on the disposal of silt, attending flood surgeries

### 5.1.9 Local Resilience Forum (LRF)

Local resilience forums (LRFs) are multi-agency partnerships made up of representatives from local public services, including the emergency services, local authorities, the NHS, the Environment Agency and others. These agencies are known as Category 1 Responders, as defined by the Civil Contingencies Act, 2004.

LRFs are supported by organisations, known as Category 2 responders, such as the Highways Agency and public utility companies. They have a responsibility to co-operate with Category 1 organisations and to share relevant information with the LRF. The geographical area the forums cover is based on police areas.

The Local Resilience Forum is not a legal entity, nor does a Forum have powers to direct its members. Nevertheless, the Civil Contingencies and the Regulations provide that emergency responders, through the Forum, have a collective responsibility to plan, prepare and communicate for emergencies in a multi-agency environment.

The Local Resilience Forum for Ickford is the Thames Valley Local Resilience Forum (TVLRF).

TVLRF have Emergency Response Arrangements which provides the response framework for a multi-agency response. The current arrangements for TVLRF require a Partner Activated Teleconference (PAT) to be convened by any TVLRF agency or organisation who feels that this is necessary, or an event meets the trigger criteria. A PAT is not Command and Control but could identify the need for the implementation of Command and Control structures. The purpose of a PAT is information sharing and situational awareness.

The TVLRF Multi-Agency Flood Plan (MAFP) provides the framework for the multi-agency response to a flooding incident in the TVLRF area.

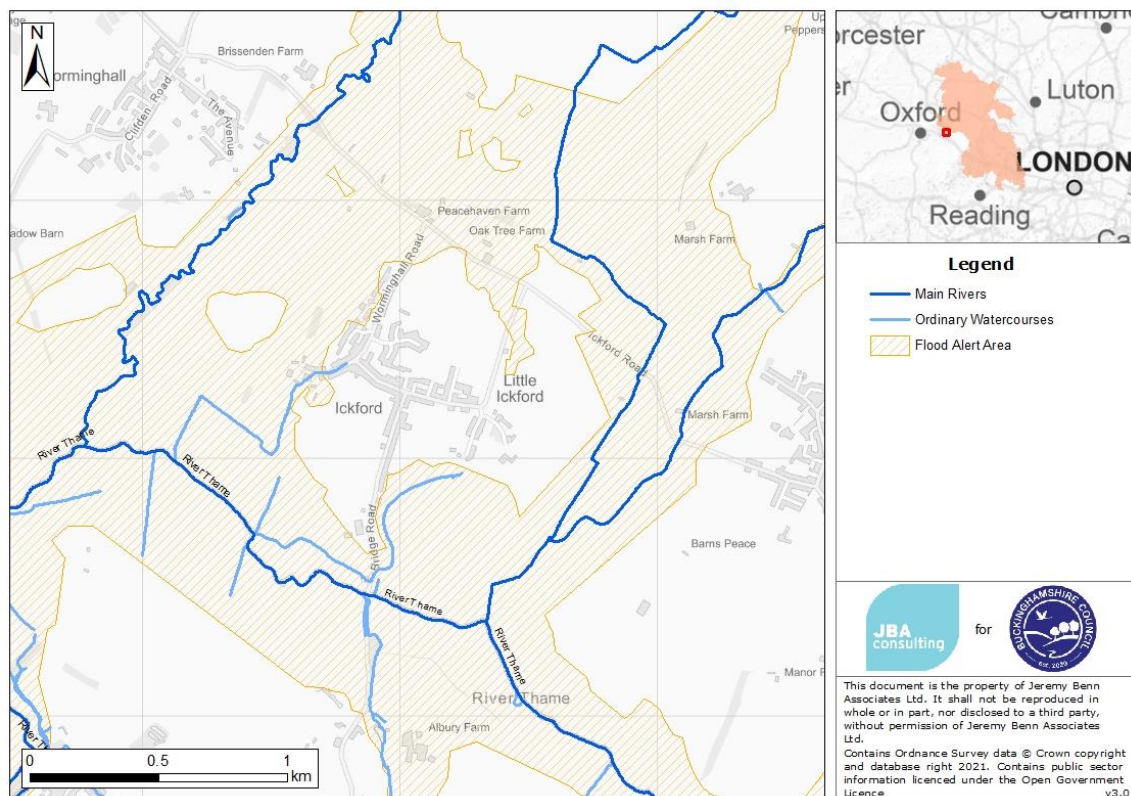
In this case, the flood incident did not trigger a PAT.

## 5.2 Existing flood risk management activities

### 5.2.1 Flood alert information service

Small parts of the edges of Ickford are located within an Environment Agency Flood Alert Area, which covers the fluvial floodplain surrounding the village. The Flood Alert Area covers "River Thame from Marsworth to Dorchester including, Long Marston, Rowsham, North Aylesbury, Cuddington, Thame, Shabbington, Ickford, Waterperry, Cuddesdon, Wheatley, Quarrendon, Drayton St Leonard, Overy, the Chalgrove Brook at Chalgrove and Stadhampton". There are no Environment Agency Flood Warning Areas covering this area. The coverage of the Flood Alert Area is shown in Figure 5-1.

**Figure 5-1: Flood Alert Areas**



### 5.2.2 Channel maintenance

There are several ditches and small watercourses within the village. These are maintained by riparian landowners. The watercourse at Church Lane appears to be well-maintained. It is reported that blockages of road ditches have been cleared by landowners where necessary in the past.

The River Thames at Ickford, Worminghall and Lappingford/Peppershill Brooks are not included in the Environment Agency's annual maintenance programme. Historically the Environment Agency maintained these watercourses. Watercourses are now prioritised using a risk-based approach, and the Environment Agency withdrew from the maintenance 15 to 20 years ago due to low numbers of properties at risk of internal flooding. The responsibility for maintenance sits with the riparian landowners.

The Environment Agency does not have the resources to carry out inspections of the watercourses that are not included on its annual maintenance programme. If members of the public report issues (e.g. a fallen tree causing a blockage), these will be assessed on the level of risk and the Environment Agency may either take appropriate action or write to riparian owners reminding them of their responsibilities.

### 5.2.3 Sewer flood risk reduction measures

Manhole covers along Worminghall Road, Church Road and Sheldon Road have heavy duty 'clover leaf' covers or low leak covers, designed to prevent surface water entering the system from the road. Any remaining less robust manhole covers were replaced by Thames Water in February and March 2021 following the events in October 2020 and January 2021.

Thames Water have an ongoing investigation into the causes of sewer flooding in Ickford. They have installed three monitors on the foul sewer: at Bridge Road junction; Church

Road (the far west end); and Wормinghall Road. The monitors have recorded high levels, and further 'lift and look inspections' have been completed, progressing to additional CCTV to identify clear water sources in the network along Bridge Road and Bulls Lane to Sheldon Road (see also Section 10.2).

#### **5.2.4 Property flood resilience (PFR)**

At least one property on Church Road has installed PFR including bunds, pumps and barriers.

## 6 Hydrological analysis of the 2-4 October 2020 event

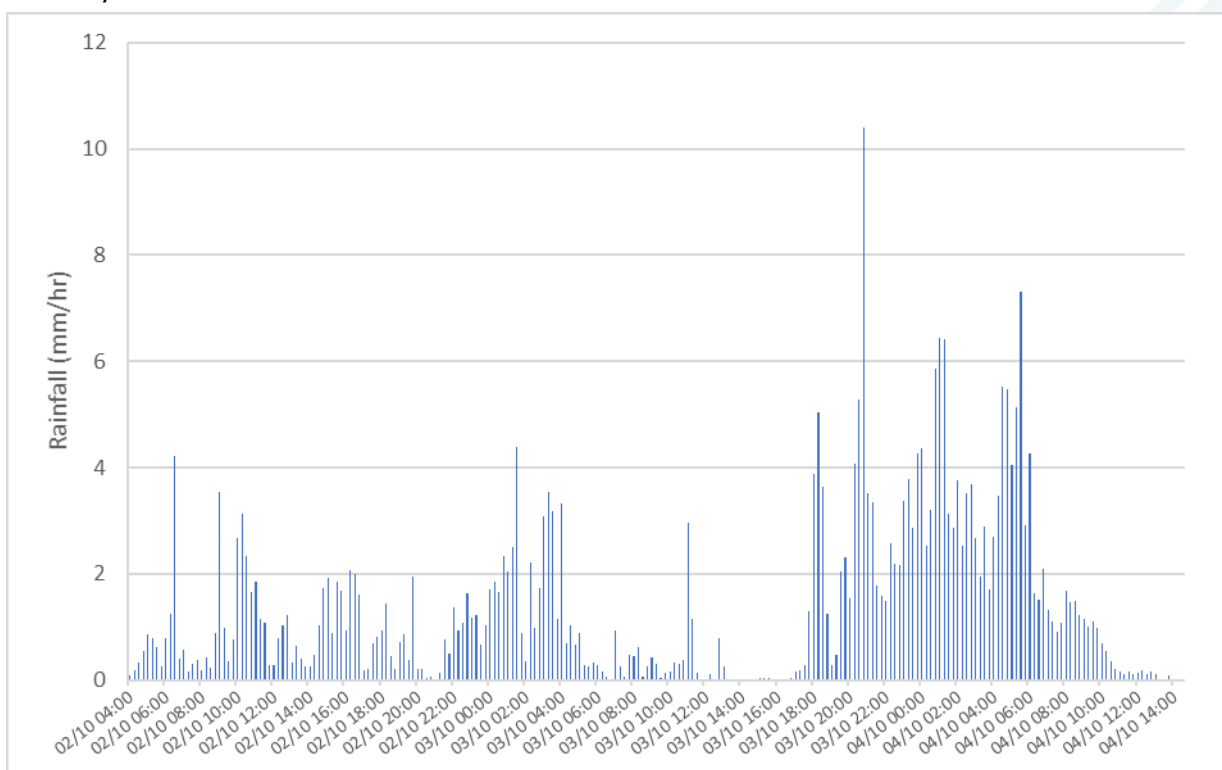
### 6.1 Conditions at the time

In the first three weeks of September 2020 only 2mm of rain was recorded at the Wheatley R22 raingauge (4.7km south-west of Ickford). Soil moisture deficit data (provided by the Environment Agency from daily soil moisture deficit gauge 'Thame Catchment') which gives an indication of the soil dryness in the Thame catchment, shows that the catchment dryness was increasing through September. During the 10 days prior to the event, from 22 September, there were a few rain events totalling about 30mm, causing a slight increase in soil wetness. However, soil remained relatively dry up until 1<sup>st</sup> October 2020, the day before the event.

### 6.2 The event

The storm event began at about 04:15 on 2<sup>nd</sup> October 2020 and ended at about 14:15 on 4<sup>th</sup> October. During this period, radar data indicates that, over the Ickford area, 81mm of rainfall fell over 58 hours, which is approximately a 1.3% annual chance rainfall event. This compares well with the Wheatley R22 raingauge which shows that about 90mm fell over 58 hours (1% annual chance). Estimates of the probability of extreme rainfall are based on existing rainfall records. The chance of flooding may change in the future with the effects of climate change.

The long-term monthly average for September to December is approximately 60mm meaning that, during the event, about a month and half's worth of rain fell in two and a half days.



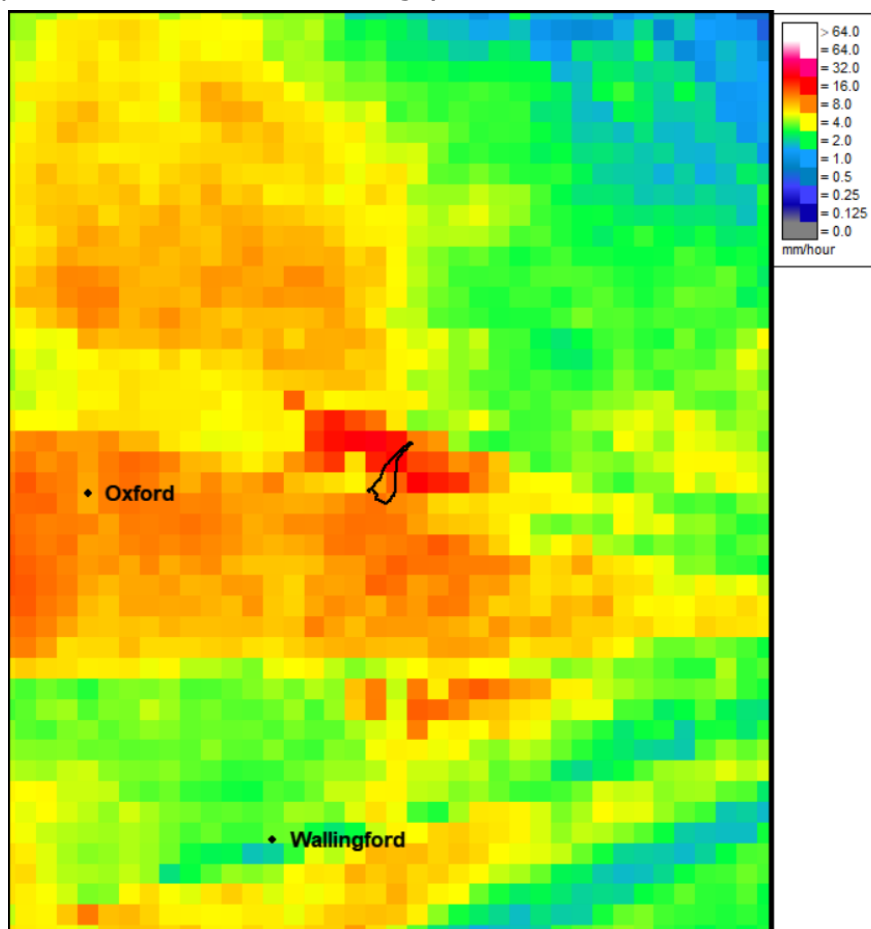
**Figure 6-1: Recorded rainfall at the Wheatley R22 gauge**

As can be seen in the graph above, the rain fell in two waves. The first, a less intense and longer period, from 04:00am on 2<sup>nd</sup> October until 13:00 on 3<sup>rd</sup> October, in which 32mm of



rain fell over 32 hours (2-year return period). During the second wave, from 16:45 on 3<sup>rd</sup> October until 14:30 on 4<sup>th</sup> October, 50mm of rain fell over 22 hours (8-year return period). HYRAD observed radar rainfall data from the Met Office shows that for the first wave of the event the storm passed in a westerly direction across the catchment. After about 17:00, as the weather system turned, the storm remained generally stationary.

The image below shows the HYRAD observed radar rainfall for the Ickford area (black boundary line in the centre of the image). Colours show rainfall rate at the time shown.



**Figure 6-2: Hyrad (radar) rainfall for the Ickford area at 20:45 3/10/2020 (time of most intense rainfall)**

**Table 6-1: Rainfall totals in the Ickford area on 2-4<sup>th</sup> October 2020**

Source of rainfall data	Distance from Ickford	58-hour total on 2-4 October 2020	Grid reference
Wheatley R22 raingauge	4.7km	90mm	460880, 205100
Ickford (HYRAD)	-	81mm	464949, 207422

### 6.3 Rainfall return period estimation

The return period of the rainfall falling across the Ickford catchment is estimated to have a 1.3% chance of occurring in any one year (return period of 75 years).



## 7 Incident response

A timeline of the incident response is given in Table 7-1.

**Table 7-1: Timeline of incident response**

Date	Time	Activity/event	Agency
04/10/2020	04:00	Groundwater enters property	N/A
04/10/2020	Unknown	Sandbags received at flooded property	Transport for Buckinghamshire
04/10/2020	20:00	Water recedes inside property	N/A
Unknown	Unknown	Thames Water tanker pumping water from the foul sewer system at the Church Road/Worminghall Road/Sheldon Road junction for an extended period.	Thames Water

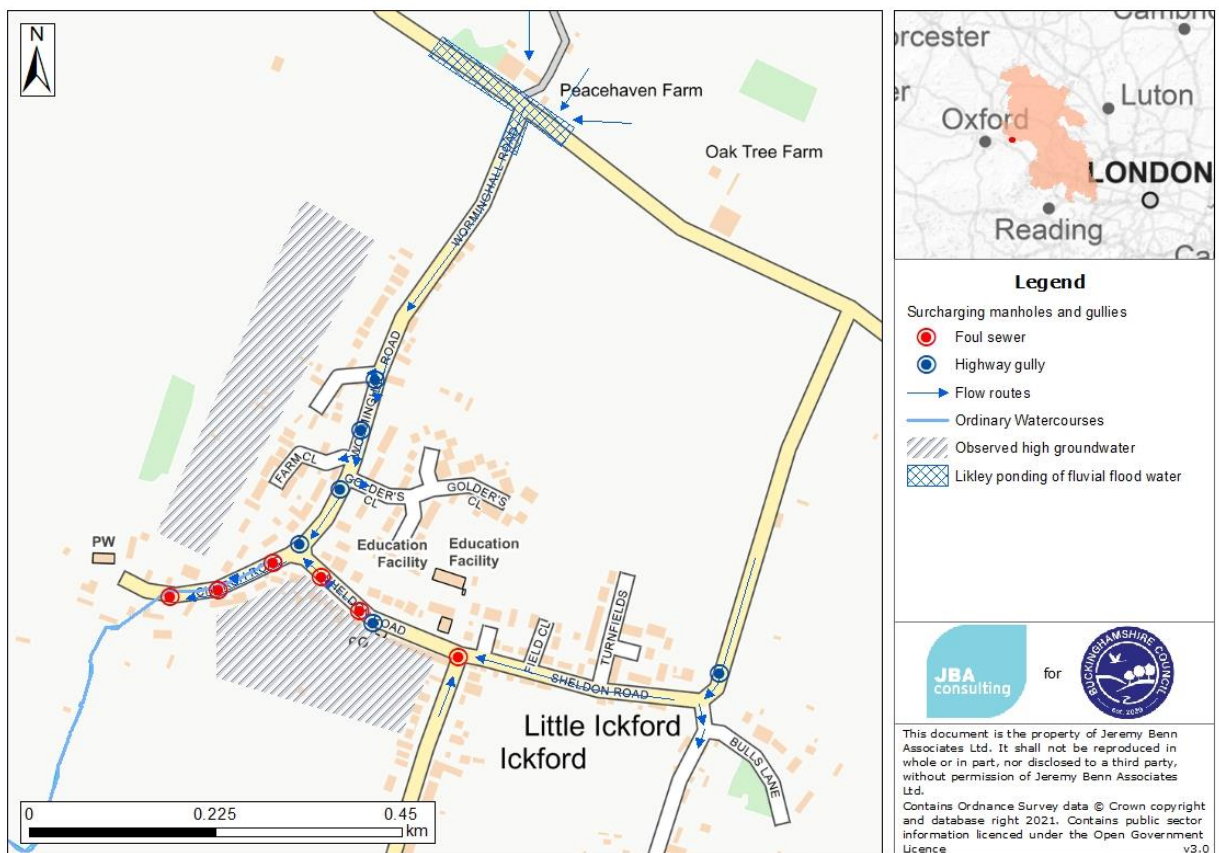
## 8 Source-pathway-receptor analysis

The Source-Pathway-Receptor model is a concept that can provide an understanding of all aspects of flood hazard. It breaks a flood incident down into three elements:

- Source - the origin of flood water
- Pathway - a route or means by which a receptor can be affected by flooding
- Receptor - something that can be adversely affected by flooding (e.g. people, property, infrastructure)

We analysed all of the information available to determine the main sources of the flood water, the pathways it took and the main receptors. These are summarised in Figure 8-1 and described in the following sections.

**Figure 8-1: Map of sources, pathways and receptors**



*Note: A large proportion of Ickford is at high groundwater risk (see Figure 4-3). Generalised areas have been drawn where high groundwater levels were reportedly observed during the October event. The borders do not denote the extent of groundwater flooding or the overall boundary of high groundwater levels within Ickford.*

*Note: The exact extent of fluvial flooding on the floodplains and at the junction of Ickford Road and Worminghall Road from Worminghall and Peppershill Brooks is not known.*

### 8.1 Source

#### 8.1.1 Extreme rainfall

The intense rainfall experienced in Ickford caused a large volume of water to fall directly onto the ground surface in the village and onto the surrounding fields. A total of 81mm of

rain fell over 58 hours at Ickford. This rainfall event had a 1.3% chance of occurring in any one year (return period of 75 years).

### 8.1.2 Watercourses (Main River and Ordinary watercourse)

Water levels in the River Thame, Lappingford/Worminghall Brook and Peppershill Brook, which surround the village, were all very high during the event. The river levels rose in response to rainfall falling on the river catchment upstream.

The River Thame at Ickford (including the catchments of the brooks) has an area of 478km<sup>2</sup>. The Lappingford/Worminghall Brook has a catchment of 17.7 km<sup>2</sup>, and the Peppershill Brook has a catchment area of 9.8km<sup>2</sup>.

The level gauge at Thame Bridge, just upstream of Ickford, recorded a peak water level of 62.803mAOD at 06:15 on 5<sup>th</sup> October 2020. This is the highest peak since February 2014, when 62.905mAOD was recorded.

### 8.1.3 Groundwater

High groundwater levels in the superficial floodplain deposits were a direct source of flooding in Ickford. Groundwater levels are strongly linked to levels within the River Thame, which had risen in response to the rainfall. Groundwater ponding has been observed in the fields, particularly to the west of Worminghall Road (Figure 8-2) and south of Sheldon Road.

Groundwater to the south of Sheldon Road is thought to be one of the main sources of flooding for the one property confirmed to have flooded internally in this event. There is also an unconfirmed report that groundwater came up through the floor of a property on Worminghall Road.



**Figure 8-2: Groundwater ponding in the field to the west of Worminghall Road**

Photo credit: Ickford residents

## 8.2 Pathways

### 8.2.1 Exceedance of channel capacity

All the main rivers (as shown in Figure 3-1) surrounding the village exceeded their bank level during the flood event and spilled out into the floodplain. For the most part, this

flooding was contained on agricultural land, rather than affecting properties. There are several pathways by which river water affected the village, as follows.

Water backed up from the River Thame in the ordinary watercourse along Church Road due to the relatively flat gradient and because it was no longer freely able to discharge into the Thame. The channel capacity was exceeded and water overtopped onto Church Road (Figure 8-3).



**Figure 8-3: Capacity of Church Road ditch exceeded, looking south down Church Road from junction (taken January 2021)**

Photo credit: Ickford residents

Floodwater from the main rivers of the Lappingford/Worminghall and Pepperhill Brooks flowed across the fields towards Peacehaven, at the Worminghall Road and Ickford Road junction (Figure 8-4). From here, some of this water flowed down Worminghall Road towards the village. This flood route is not shown in the Environment Agency's Risk of Flooding from Rivers and the Sea, as the flood map data is not detailed for the area.



**Figure 8-4: Flooding at the junction of Wормinghall Road and Ickford Road (taken in January 2020 but also occurred in October 2020)**

Photo credit: Ickford residents

### **8.2.2 Surface water flow**

Impermeable surfaces such as roads became direct pathways for surface water flow to run off e.g. Wормinghall Road, Church Road and Sheldon Road. This is known as surface water flooding, which is also referred to as pluvial flooding. Surface water flooding occurs more rapidly than fluvial flooding in Ickford.

During the flood event surface water flowed down Wормinghall Road and ponded along Wормinghall Road, on Golders Close, around the Church Lane junction and along Sheldon Road (Figure 8-5, Figure 8-6, Figure 8-7). It also flowed down the road towards Little Ickford. It is noted that in the October 2020 event the lower part of Wормinghall Road reportedly flooded before river floodwater reached the junction at the northern end of the road, and residents indicated that this has also been the pattern of flooding in previous events.

### **8.2.3 Highway drainage**

In some locations, the highway drainage system (see section 3.3) became overwhelmed by the volume of water, exacerbated where highway gullies become blocked by leaves and debris. This led to flooding of Wормinghall Road, Sheldon Road and Church Road. Water depths on Wормinghall Road were reported to be around 20cm deep, which is above kerb level.

The surface water drainage network could not freely discharge to the ditch at Church Road due to the high water levels, causing surface water to back up through the system and surcharge out of gullies and manholes. Locations where the drainage system was reported to be surcharging are located on Figure 8-1.



**Figure 8-5: Worminghall Road, looking north towards the Rising Sun and Deanfield site (taken October 2020)**

Photo credit: Ickford residents



**Figure 8-6: Worminghall with Golders Close on the right (taken January 2020)**



Photo credit: Ickford residents



**Figure 8-7: Sheldon Road looking towards Church Road junction (taken January 2021)**

Photo credit: Ickford residents

#### **8.2.4 Foul sewer system**

The Thames Water foul sewer network within Ickford, follows the roads to convey sewage via gravity to the Church Road pumping station. In both the October 2020 event and previous events (Figure 8-8) sewage was observed 'bubbling' out of manholes and combining with surface water along both Church Road and Sheldon Road. Thames Water had a tanker in place at the Church Road junction to remove water from the foul system for an extended period in October 2020, and this has been a regular occurrence during previous events.

Flooding of the foul sewer network occurs when additional sources of water are entering the foul sewer system. Thames Water have an ongoing investigation into the sources of the water entering the system but it is believed to be mainly caused by infiltration from groundwater when river levels are high.

As there is no separate surface water sewer system in most of the village, there are likely to be misconnections of surface water drainage into the foul system, which can contribute additional surface water into the foul network during a rainfall event. This has been observed by a resident of a property near the Church Road junction when a private manhole was lifted during heavy rain.

It is also likely that unwanted flows are entering the network via private pipework, whether that be via groundwater ingress or fluvial/pluvial flooding through private manholes and gullies.



**Figure 8-8: Flood water and sewage emerging from manhole on Sheldon Road outside the school (taken October 2020)**

Photo credit: Ickford residents

## **8.3 Receptors**

### **8.3.1 People**

The questionnaire suggested that for those affected directly by the flooding it had a “devastating” impact on mental health and quality of life for a long period of time.

Access and egress to the village was significantly disrupted (see section 8.3.3). This meant vulnerable residents, and those without access to 4x4 vehicles were unable to leave the village for several days during the event.

The presence of a tanker operating to remove foul sewage for a long period at the Church Road junction caused inconvenience and noise for nearby residents.

### **8.3.2 Property**

One property was confirmed to have flooded internally and the owner faced significant unexpected costs associated with repairing and replacing damaged parts of their property, with a drying out period of nine months.

It is suspected that there may have been several more properties which may have flooded internally but these were not reported on the online questionnaire, so it was not possible to confirm this. There were several reports of garden flooding due to surface water.

### **8.3.3 Infrastructure**

Access and egress to the village was heavily impacted with roads in and out of the village towards Worminghall, Shabbington and Draycot cut off by floodwater for several days in some locations. Flooding is known to have occurred to roads at Bridge Street, Church Road, Golders Close, Ickford Road, Little Ickford, Sheldon Road, and Worminghall Road.

The Thames Water pumping station located along Church Road was overwhelmed during the event and the existing foul sewer system surcharged and spilled onto Sheldon Road and Church Road.

It was reported that, at least one property along Church Road was unable to flush downstairs toilets during the October event.

### **8.3.4 Services**

No services are known to have been impacted during the event. The school on Sheldon Road was able to continue operating as normal despite the road being flooded.

## 9 Planning review

JBA Consulting carried out an independent review of the flood risk assessment and surface water drainage proposals for recent developments in Ickford.

The sites assessed were:

- 42 Worminghall Road
- Land off Turnfields

We liaised with the Buckinghamshire Sustainable Drainage Team to discuss any concerns around the sites in question.

The reviews focus on whether the developments have been designed within current planning guidelines and good practice around flood risk and surface water drainage, and whether they are likely to increase flood risk on site or elsewhere. No site inspections were undertaken.

A summary of the applications can be found in Sections 9.1 and 9.2.

### 9.1 42 Worminghall Road

An application was made for demolition of an existing dwelling and outbuildings to allow residential development of up to 66 dwellings. The application was originally submitted on 26<sup>th</sup> August 2017 and went to Planning Inspectorate appeal on non-determination grounds, before being granted conditional approval on 29<sup>th</sup> August 2019. The construction is now substantially complete.

The site is located within Flood Zone 1 and is therefore classified as at very low risk of fluvial flooding (less than a 0.1% chance of flooding in any given year). Worminghall Road is shown as at low risk on the Risk of Flooding from Surface Water map, and the site itself is shown as at very low risk.

Concerns were raised to the Local Planning Authority (LPA) by both the LLFA and residents about a number of issues. These included safe access and egress from the site, as the village is at risk of being surrounded by fluvial flood water, it should be noted that safe access and egress is a matter for the LPA to consider as it is outside the remit of the LLFA. High groundwater was also raised as an issue, with residents reporting that the site was known to become waterlogged in winter (Figure 9-1). There were also concerns that flooding in the village from the foul sewer network would be made worse.



**Figure 9-1: Waterlogging on the 42 Worminghall Road development site (taken December 2020).**

Photo credit: Ickford residents

Surface water runoff generated by the site will be managed via permeable paving, an attenuation basin and a geocellular tank. Infiltration is not viable at the site due to the high groundwater levels and therefore the permeable paving will provide storage and water treatment.

Following comments from the LLFA the final design proposal was to line permeable paving and the attenuation basin to prevent groundwater ingress affecting the capacity of storage. Finished floor levels appear to be generally around a metre above ground level, which should prevent any groundwater ingress into the residential properties. The development itself will not increase groundwater risk elsewhere in the village.

Calculations of the drainage network show no flooding predicted in the 1 in 30-year rainfall event, which is in line with the Non-Statutory Technical Standards for Sustainable Drainage Systems (Defra, 2015). Exceedance of the system is predicted to occur in the 1 in 100-year + 40% climate change event, with flows being conveyed via the site road network, into the rural land to the north of the site.

The reviewer is satisfied that the flood risk and drainage strategy for the site was prepared in line with flood risk planning legislation and guidance at the time of the application and that the LLFA's comments improved the design with relation to groundwater as far as possible within its remit.

## 9.2 Land off Turnfields

An application was made for residential development of up to 30 dwellings. The application was originally submitted on 3<sup>rd</sup> July 2017, with permission granted on 19<sup>th</sup> September 2019, with the reserved matters application being approved on 28<sup>th</sup> June 2022.

The site is located within Flood Zone 1, with less than a 0.1% chance of flooding in any given year. It is also predicted to be at very low risk of surface water flooding.

The original drainage strategy relied on discharge of the site via infiltration. However, due to high groundwater levels and low infiltration rates encountered on the site, discharge to highway drainage, via a pumped connection, on Turnfields was the next feasible option. To ensure the existing drainage network had capacity to receive flows from the development, the LLFA required a 50% betterment on greenfield rates for the site. This goes beyond current best practice of meeting greenfield rates and represents an improvement on the pre-development runoff rates from the site, up to the 1 in 100-year + 40% climate change rainfall event.

At reserved matters stage the drainage proposals have been updated to include an attenuation tank rather than a pond to remove the need for a pumped connection to the highway drainage on Turnfields.

It is evident that the applicant and LLFA worked together to agree a drainage solution which is feasible within the site constraints and is designed to not increase flood risk to the site or elsewhere.

## 10 Discussion, appraisal and recommendations

### 10.1 Introduction

In this section, we discuss in more detail some of the aspects of flood risk management in Ickford, what worked well and not so well, and we consider potential options to mitigate flood risk and reduce damages caused by flooding.

This includes consideration of measures such as improvements to data collection and evidence; flood warning and incident management; community, property and infrastructure flood resilience; maintenance and minor works; asset maintenance and refurbishment and flood risk management capital scheme options.

We undertook a high-level option appraisal focussing on benefit, practical and viability considerations. We carried out a multi-criteria analysis to compare each option which included consideration of:

- Contribution towards reducing flood risk to property
- Contribution towards reducing flood impacts on people/communities
- Contribution to improving the availability of data, evidence and modelling to support option development or flood incident response
- Deliverability (including construction complexity, access, designations, services, space, land ownership, available materials and expert equipment or advice required)
- Community / resident acceptability
- Contribution towards biodiversity and water quality betterment
- Contribution towards amenity benefits
- Contribution to carbon reduction
- Maintenance requirements

Relative costs and timescales are provided for information only and are not included in the scoring.

The scoring criteria and full results are described in more detail in Appendix B. Recommendations have been listed in order of priority according to the multi-criteria analysis score.

It is important to note that whilst JBA and Buckinghamshire Council have liaised with partner organisations regarding this assessment, this is a high-level, preliminary assessment undertaken by and on behalf of Buckinghamshire Council. Therefore, it is for the relevant responsible body or persons to assess these recommendations in terms of their legal obligation, resource implications, priorities and the costs and benefits of undertaking such options.

Buckinghamshire Council will monitor progress on all these recommendations through the Buckinghamshire Strategic Flood Committee, but does not have powers to enforce their delivery by others.

### 10.2 Sewer monitoring and investigations

Clearly there is a need for greater understanding of the sources of surface and groundwater entering the foul sewer system, which are causing it to become overloaded. Thames Water had initiated investigations before the 2020 flood, by installing three sewer level monitors in the system: at Bridge Road junction; Church Road (the far west end); and Worminghall Road. Unfortunately, they were not working during the event, but Thames Water advises they are now working correctly.

A CCTV survey was carried out in Spring 2022 by Thames Water along Bridge Road and Bulls Lane to Sheldon Road to help them to understand network performance under various conditions and to identify the sources of unwanted flows into the foul sewer. The survey indicated multiple sources of flow entering the foul system, including surface water inundation, groundwater infiltration and surface water misconnections into the foul sewer. All of these are likely to be contributing in some way to the surcharging of the foul system in Ickford.

A study conducted on behalf of Thames Water, before the 2020 flood event, confirmed a link between Ickford Pumping Station’s pump rate and local flood risk. Thames Water is not currently aware the operating pump rate for the pumping station due to a defective asset. However, it does have plans to fix this. It is essential that Thames Water understand the operating pump rate for Ickford Pumping Station when considering any flood alleviation measures.

Thames Water has recently undertaken an Impermeable Area Survey (IAS) for Ickford. Such surveys use techniques such as dye tracing, sound testing and CCTV testing to determine where the rainwater falling on roofs and private hard standing areas (e.g. patios) ultimately drains to. The results of the IAS confirmed that there are indeed some surface water misconnections from these areas into the foul network, but suggest that the majority of these areas actually drain to the highway network or soakaways.

Thames Water is currently considering a more detailed survey of both the foul and highway drainage in partnership with Buckinghamshire Highways in order to identify the locations of all the drainage assets, possible cross connections into both drainage systems, as well as to survey the general condition of the network. Also included in the scope of this survey is an infiltration assessment of some privately owned lateral sewers in Ickford, as this is a currently unknown element which could be a significant factor in the flooding history.

It is recommended that all these investigations are completed as soon as possible and that the conclusions and planned actions are shared with the LLFA and stakeholders.

Ickford Village has been identified as a successful example of partnership working in the Thames Water Drainage and Wastewater Management Plan<sup>10</sup>, which supports these continuing investigations.

It is also important to urge residents affected by sewer flooding to report this to Thames Water (details on how to do this are on the Thames Water website<sup>11</sup>). This will not impact on insurance premiums but will ensure Thames Water know the scale of the problem in order to prioritise it appropriately.

**Table 10-1: Recommendations for sewer monitoring and investigations**

Option	Organisation(s) responsible	Multi-criteria analysis score	Recommendation	Timescale
Complete sewer monitoring and CCTV investigations to identify groundwater	Thames Water	10	Recommended	Survey substantially complete

10 Thames Water Catchment Strategic Plan (Central Bedfordshire, Buckinghamshire, Slough and Luton) <https://www.thameswater.co.uk/media-library/home/about-us/regulation/drainage-and-wastewater/central-bedfordshire-catchment-strategic-plan.pdf>

11 Thames Water What to do during sewer flooding <https://www.thameswater.co.uk/help/emergencies/sewer-flooding/what-to-do-during-sewer-flooding>

ingress and undertake remediation works if required				
Undertake impermeable area survey	Thames Water	10	Recommended	Complete
Report every incident of sewer flooding to Thames Water	Residents	N/A	Recommended	Ongoing

### 10.3 Disconnecting surface water drainage

#### 10.3.1 Disconnecting roof water drainage

Disconnecting existing rainwater downpipes and redirecting surface water runoff into SuDS planters, rain gardens, above ground water butts or underground rainwater harvesting tanks, could relieve pressure on the foul sewer and ordinary watercourses in small frequent events, and provide sustainability benefits as a result of water re-use.

Water butts are available in a variety of shapes and designs and can be used to re-use water for gardening. Rainwater harvesting tanks are typically larger and stored underground with a pumped supply for water re-use within a property e.g. flushing toilets. As their capacity is dependent on the re-use of water, both systems should be designed with an overflow to discharge excess water.

As outlined in the Thames Water Drainage and Wastewater Management Plan<sup>10</sup>, Thames Water intends to work with the community to “promote community reuse....and sustainable water management, including water butts and recycling of roof drainage”. A partnership scheme cannot be guaranteed, though recent conversations between Thames Water and Buckinghamshire Council have resulted in an agreement to continue with investigations. Any solutions will need to understand where disconnected water can be discharged to and will require funding.

Disconnection of roof water drainage by householders, e.g. as part of renovations should be encouraged as a way to increase community resilience. There may also be opportunities to disconnect downpipes into raingardens on public-owned building such as the school, which may provide educational benefits.

#### 10.3.2 Disconnecting highway drainage

Retrofitting sustainable drainage features such as raingardens to capture and store water is a way of slowing down highway runoff before it reaches the watercourses in lower magnitude rainfall events. This could help to reduce to reduce nuisance surface water flooding, where surface water runoff can overwhelm the existing gullies. It would also reduce the peak of highway runoff reaching the already at-capacity watercourse e.g. along Church Road. There are opportunities and space for fitting such features, particularly on roads such as Worminghall Road, and they can also deliver biodiversity and water quality benefits and help to reduce traffic speeds.

However, this option would not prevent fluvial flooding or sewer flooding, and raingardens would be overwhelmed in larger events where river water reaches Worminghall Road. It would also be less effective in Sheldon Road and Church Road where the foul sewer is likely to surcharge.

#### 10.3.3 Reducing ingress of surface water to sewers

Property owners should wherever possible take measures to ensure that fluvial and surface water inundation does not ingress into the sewers via private manholes and gullies at their property. This can be helped by not lifting manholes to drain gardens, sandbagging around



manholes to prevent ingress through covers, covering and sandbagging around any open gullies or drains that may connect to the foul system.

**Table 10-2: Recommendations for disconnecting surface water drainage**

Option	Organisation(s) responsible	Multi-criteria analysis score	Recommendation	Timescale
Take opportunities to disconnect or slow down roof water drainage on private properties and the school	Property owners	5	Recommended as opportunities arise	1-3 years
Work with the community to promote disconnection of surface water from the sewer	Thames Water	5	Recommended	1-5 years
Investigate opportunities to retrofit highway raingardens e.g. Worminghall Road	Buckinghamshire Highways	6	Further investigation needed	1-5 years
Reducing ingress of fluvial or surface water into sewers	Residents	N/A	Recommended	Ongoing

#### 10.4 Community flood resilience

A community approach to resilience can significantly increase residents’ ability to prepare, respond, and recover from floods in the future, and so reducing the impact of flooding on the community.

There is already an active residents’ flood group in Ickford. Using experience of what worked well during the event, residents (with support from Ickford Parish Council and Buckinghamshire Council, if required) could formalise this existing group to become a Flood Action Group with the aim of increasing the community’s resilience to flooding. Buckinghamshire Council<sup>12</sup> and the National Flood Forum<sup>13</sup> have resources to assist communities with planning and preparing for flooding.

It is recommended that a community Flood Plan<sup>14</sup> be developed to inform residents how to prepare for, respond to and recover from flooding. This may include plans for helping residents with transport in and out of the village using 4-wheel drive vehicles, as one of the main issues is access and egress for vulnerable residents during a flood event.

The Flood Action Group could also create a ‘flood preparedness’ information pack for existing and future residents in the area. The pack may contain advice on taking out

12 Working with your community: <https://www.buckscc.gov.uk/services/environment/flooding/how-to-deal-with-a-flood/working-with-your-community/>

13 National Flood Forum: <https://nationalfloodforum.org.uk/working-together/communities/what-is-a-flood-action-group/>

14 Community flood plan template - GOV.UK ([www.gov.uk](http://www.gov.uk))

contents' insurance on belongings, property resistance and resilience measures and a checklist of what to do in the event of a flood. This may help to give reassurance to residents on what can be done in the event of another flood and minimise future loss of belongings and damage to properties.

The Flood Action Group can help share information and provide support during an event. Emergency flood packs may also be created to use during a flood and once established, the group could apply for community group funding to purchase communal flood protections measures (such as sandbags, inflatable barriers etc) that can be deployed to areas at risk during an event.

As evidence and data on past internal property flooding is essential for the development of capital schemes, it is recommended that in the future residents report internal property flooding to the relevant risk management authorities: the LLFA (for surface water, groundwater or flooding); the Environment Agency for flooding from the River Thames or Worminghall / Lappingford / Peppershill Brooks; and Thames Water for flooding from the sewer system.

**Table 10-3: Recommendations for community flood resilience**

Recommendation	Organisation(s) responsible	Multi-criteria analysis score	Recommendation	Timescale
Set up a Flood Action Group and create a community Flood Action Plan to formalise and develop any existing arrangements.	Community, supported by Ickford Parish Council and Buckinghamshire Council (LLFA)	10	Recommended	1 year
Prepare a 'flood preparedness' information pack for existing and future residents.	Community, supported by Ickford Parish Council and Buckinghamshire Council (LLFA)	10	Recommended	1 year
Report internal property flooding from Main Rivers to Environment Agency	Residents	N/A	Recommended	Ongoing
Report internal property flooding from surface water or groundwater to Buckinghamshire Council	Residents	N/A	Recommended	Ongoing
Report sewer flooding to Thames Water	Residents	N/A	Recommended	Ongoing

## 10.5 Property Flood Resilience (PFR)

Property Flood Resilience (PFR) can provide effective products and measures, at an individual property level to reduce the impact of future floods, by either aiming to limit water entry in the first place (resistance) or by adapting the internal fabric of the property to limit damage (resilience) if flooding does occur. Resistance measures can include flood doors, flood barriers, automatic airbricks and non-return valves. Resilience measures include raising electrics, using porous plaster, and fitting solid floors or tiled floor coverings instead of carpets.

Although resistance measures are not able to entirely prevent flood water ingress, they aim to limit damage and ensure properties are adapted to cope with the impacts of floods and recover quickly from these disruptive events.

PFR is usually either taken forward as a community-wide scheme by a lead organisation such as Buckinghamshire Council, or can be installed privately by individual property owners. Given that only one property is confirmed to have flooded internally, a community wide Property Flood Resilience scheme at Ickford is unlikely to be able to secure funding from central government.

Individual property owners can at risk of flooding may wish to consider installing PFR products and make making their properties more resilient on a private basis<sup>15</sup>. Before any products are fitted, an independent PFR survey should be commissioned conducted to identify the points of ingress and recommend appropriate measures<sup>16</sup>. Kitemarked PFR products should be supplied and installed by an approved supplier, to ensure the efficacy and reliability of the PFR measures.

**Table 10-4: Recommendations for Property Flood resilience (PFR)**

Recommendation	Organisation(s) responsible	Multi-criteria analysis score	Recommendation	Timescale
Investigate opportunities for installing PFR at relevant at-risk properties	Property owners	10	Recommended	1-5 years

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15 The Homeowners' Guide to Flood Resilience'

([https://www.knowyourfloodrisk.co.uk/sites/default/files/FloodGuide\\_ForHomeowners.pdf](https://www.knowyourfloodrisk.co.uk/sites/default/files/FloodGuide_ForHomeowners.pdf)) aims to inform homeowners about how to reduce flood risk to their homes and the variety of PFR methods available. It also includes contact details for surveyors/providers of Kitemarked flood protection equipment.

The National Flood Forum provide a webpage and guidance leaflet for homeowners on the steps towards installing their own PFR measures, and a tool to provide indicative costs of measures at: <https://nationalfloodforum.org.uk/about-flooding/reducing-your-risk/protecting-your-property/>

16 The Blue Pages, a directory for flood risk reduction services provided by the National Flood Forum, list a number of companies who may be able to undertake such individual flood risk surveys: <https://bluepages.org.uk/listing-category/surveys-building/>.

### 10.6 Watercourse condition and maintenance

Watercourse maintenance of the River Thames, Worminghall and Peppershill Brooks (all Main River) has been highlighted as an issue of concern by residents. However, it should be noted that in a very extreme event, when large volumes of water fill the floodplain, the capacity of the channel becomes less of an influence on water level, and this is not thought to have been a major factor in the flooding in October 2020.

It is important that watercourses are maintained to make sure they do not increase flood risk elsewhere, and planning for regular watercourse maintenance by riparian owners should be encouraged. The Environment Agency can help to advise riparian owners of their responsibilities for maintaining their main river watercourses.

**Table 10-5: Recommendations for watercourse maintenance**

Recommendation	Organisation(s) responsible	Multi-criteria analysis score	Recommendation	Timescale
Watercourse maintenance plan and riparian awareness (to include activities required, frequency etc)	Riparian owners, with support from Parish Council and Environment Agency	6	Recommended	1 year

### 10.7 Natural Flood Management

Natural flood management aims to reduce flood severity and delay flood peaks using a range of techniques to slow down or store flood water. Installation of features such as leaky dams and large woody debris on flow paths could reduce the risk from overland flow pathways. There are also changes that can be made to land management that can help to reduce field runoff - for example, measures such as winter crops, ploughing along slopes, maintaining soil health, growing hedgerows and water storage.

The upper catchments of the Lappingford/Worminghall Brook and the Peppershill Brook are very rural and opportunities to install NFM could be possible. However, the catchments are also quite large, meaning NFM would have to be very extensive to make any difference. Added to this, the main influence on the fluvial flooding in the lower reaches around Ickford is the very flat floodplain and the water levels in the River Thames. NFM in the upper catchments would not improve the problems with surface water and sewer flooding in the village. It is therefore unlikely that a NFM scheme could have a meaningful impact on the severity of flooding around Ickford, and so this is not recommended.

**Table 10-6: Recommendations for natural flood management**

Recommendation	Organisation(s) responsible	Multi-criteria analysis score	Recommendation	Timescale
Natural flood management in upper Lappingford/Worminghall Brook and Peppershill Brook	Community and landowners	3	Not recommended	N/A

## 10.8 Planning and development control

The National Planning Policy Framework (NPPF) and associated guidance, and the consultee roles of the Environment Agency and LLFA on flood risk and surface water drainage (see section 5) are intended to minimise the impact of new development on flood risk. When properly designed, development does not automatically increase flood risk, and in some cases can reduce existing flood risks by limiting flows from the site. For example, waterlogged sites can be improved by installing positive drainage with formally designed attenuation storage.

The independent review of planning applications at 42 Worminghall Road and Land off Turnfields undertaken as part of this S19 investigation (see Section 9), has identified several limitations in the NPPF and its application within the development control process.

For both sites, the Environment Agency was not a required consultee on the Flood Risk Assessments, as the sites themselves are located within Flood Zone 1, and therefore deemed to be at very low risk of fluvial flooding. However, this does not consider flood risk in the wider area, which in the case of Ickford involves floodwaters surrounding the village during a fluvial flood event, severely restricting access and egress for residents and the emergency services. Residents of Ickford and Buckinghamshire Council as LLFA raised concerns to the LPA on the lack of safe access and egress routes from the sites during flood events. However, as the LLFA is not the statutory consultee for fluvial flood risk matters, these comments were outweighed by other matters in the planning decision.

This lack of a requirement to ensure safe access routes from sites is a limitation in current national planning policy and therefore in development control procedures. Emergency planners are not a statutory consultee for planning. It may be possible to introduce a requirement for safe access and egress on similar sites through Local Plan policies in Buckinghamshire. However, without national policy in place to provide weight to local policy, it is likely to be open to challenge, and therefore it would be preferable for a system to be introduced at a national level.

A further issue at the two development sites in Ickford was the consideration of 'other', non-fluvial sources of flood risk, including surface water, groundwater and sewer flooding. However, when the applications were submitted, between 2017 and 2019, there was insufficient support within the NPPF to uphold an objection to the development based on groundwater or surface water flood risks alone.

The NPPF<sup>17</sup> was updated in July 2021 to include a requirement for other sources of flood risk to be considered in the Sequential Test and Exception Test, which are used to steer development towards areas at lowest flood risk. An updated Planning Practice Guidance<sup>18</sup> was also recently issued in August 2022 which strengthens this requirement. This may assist in future development sites at risk of other sources of flooding.

Wider issues of foul flooding on Church Lane due to groundwater ingress into the sewer network flooding were also raised by Ickford residents during the planning application. However, as per each of the capacity assessments undertaken by Thames Water, the existing foul water sewer network was able to facilitate an increase in foul water flows, provided surface water was not connected.

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17 National Planning Policy Framework - GOV.UK ([www.gov.uk](http://www.gov.uk))

18 Flood risk and coastal change - GOV.UK ([www.gov.uk](http://www.gov.uk))

**Table 10-7: Recommendations for planning**

Recommendation	Organisation(s) responsible	Multi-criteria analysis score	Recommendation	Timescale
Strengthen policy on other sources of flooding and access and egress through the emerging Local Plan for Buckinghamshire and Strategic Flood Risk Assessment	Local Planning Authority (with advice from LLFA, Emergency Planning and Environment Agency)	6	Recommended	1-3 years
Increase awareness of Development Control teams of the impacts of groundwater infiltration on network capacity and flooding	Thames Water	6	Recommended	<1 year

## 11 Conclusion and recommendations

### 11.1 Conclusions

The flooding that occurred in Ickford on 2<sup>nd</sup> to 4<sup>th</sup> October 2020 was caused by an extreme rainfall event which led to surface water flooding on roads in the village, river flooding in the surrounding watercourses and floodplains, and groundwater flooding in alluvial gravels in the village.

One property on Sheldon Road was flooded internally. It is suspected that other properties may have flooded internally, but it has not been possible to confirm this. Several properties are known to have experienced flooding externally. The village has experienced regular flooding to highways in the past (at least four events in the last three years) causing disruption to access and egress from the village. Numbers of properties flooded internally in these events are unknown. Buckinghamshire Council, as the Lead Local Flood Authority for Ickford, has exercised its power to undertake a Section 19 investigation.

Prior to the event, conditions in September had been generally dry before several small rainfall events occurred at the end of September. During the event, approximately 81mm of rainfall fell over 58 hours, which is approximately a 1.3% chance of occurring in any one year (return period of 75 years).

Residents indicate that the property flooded initially from rising groundwater, at approximately 04:00 on 4<sup>th</sup> October 2020 and that floodwater had receded by 20:00 the same day.

Surface water flowed down Worminghall Road and ponded along Worminghall Road, on Golders Close, around the Church Lane junction and along Sheldon Road. It also flowed down the road towards Little Ickford.

Water levels in the River Thame, and surrounding Brooks, were all very high during the event. The river levels rose in response to rainfall falling on the river catchment upstream. The level gauge at Thame Bridge, just upstream of Ickford, recorded a peak water level of 62.803mAOD at 06:15 on 5 October 2021. This is the highest peak since February 2014, when 62.905mAOD was recorded. Water backed up from the River Thame in the watercourse along Church Road. The channel capacity was exceeded and water overtopped onto Church Road.

Floodwater from the surrounding Brooks, inundated the fields adjacent to Ickford, and flooding the Worminghall Road and Ickford Road junction. From here, flood waters flowed south along Worminghall Road towards Church Road. The lower part of Worminghall Road reportedly flooded from surface water before river floodwater reached the junction at the northern end of the road.

Along Church Road, Sheldon Road and Worminghall Road, the foul and surface water sewer systems were overwhelmed, and sewage was observed 'bubbling' out of manholes and combining with surface water along Sheldon Road.

A high-level appraisal of possible flood risk management options has been undertaken (Section 10), which includes consideration of measures such as sewer investigations, property flood resilience, community resilience and disconnecting roof drainage.

Doing nothing was the least beneficial option, followed by continuing with a 'business as usual' approach to managing flood risk in Ickford. The options which scored the highest were those that could ultimately result in a more resilient community.

- Community flood resilience actions e.g. form a community Flood Action Group and prepare a residents' 'flood preparedness' information pack
- Investigate opportunities for installing Property Flood Resilience
- Carry out further investigations into groundwater ingress into the foul sewer
- Take opportunities to disconnect or slow down roof water drainage

There are also a number of recommendations for strengthening local planning policy on other sources of flooding, and access and egress.

**Table 11-1: Summary of recommended actions at Ickford**

Recommended actions	Risk Management Authority/Stakeholder
Complete sewer monitoring and CCTV investigations to identify groundwater ingress and undertake remediation works if required	Thames Water
Undertake impermeable area survey	Thames Water
Take opportunities to disconnect or slow down roof water drainage on private properties and the school	Property owners
Work with the community to promote disconnection of surface water from the sewer in the longer term	Thames Water
Investigate opportunities to retrofit highway raingardens	Buckinghamshire Highways
Reducing ingress of fluvial or surface water into sewers	Residents
Set up a Flood Action Group and create a community Flood Action Plan to formalise and develop any existing arrangements.	Community, supported by Ickford Parish Council and Buckinghamshire Council (LLFA)
Prepare a 'flood preparedness' information pack for existing and future residents.	Community, supported by Ickford Parish Council and Buckinghamshire Council (LLFA)
Report internal property flooding from Main Rivers to Environment Agency	Residents
Report internal property flooding from surface water or groundwater to Buckinghamshire Council	Residents
Report sewer flooding to Thames Water	Residents
Investigate opportunities for installing PFR at relevant at-risk properties	Property owners
Watercourse maintenance plan and riparian awareness (to include activities required, frequency etc)	Riparian owners, supported by Ickford Parish Council and Environment Agency
Strengthen policy on other sources of flooding and access and egress through the emerging Local Plan for Buckinghamshire and Strategic Flood Risk Assessment	Local Planning Authority (with advice from LLFA, Emergency Planning and Environment Agency)
Increase awareness of Development Control teams of the impacts of groundwater infiltration on network capacity and flooding	Thames Water



## Appendices

### A Multi-criteria analysis

We have considered potential options to mitigate flood risk and reduce damages caused by flooding.

This includes consideration of measures such as improvements to data collection and evidence; flood warning and incident management; community, property, and infrastructure flood resilience; maintenance and minor works; asset maintenance and refurbishment and flood risk management capital scheme options.

We undertook a high-level option appraisal focussing on benefit, practical and viability considerations. We carried out a multi-criteria analysis to compare each option which included consideration of:

- Contribution towards reducing flood risk to property
- Contribution towards reducing flood impacts on people/communities
- Contribution to improving the availability of data, evidence and modelling to support option development or flood incident response
- Deliverability (including construction complexity, access, designations, services, space, land ownership, available materials and expert equipment or advice required)
- Community / resident acceptability
- Contribution towards biodiversity and water quality betterment
- Contribution towards amenity benefits
- Contribution to carbon reduction
- Maintenance requirements
- Relative benefit-cost ratios

Options were given a relative score and recommendations made for further work to be carried out, or quick-win actions. Indicative timescales are given.

Contribute towards reducing flood risk to property	Likely change in internal flood risk to property	
	-2	Increase in flood risk to any property
	-1	N/A
	0	No perceived change
	1	Reduction in flood risk to 1 - 10 properties
	2	Reduction in flood risk to 10 - 30 properties
	3	Reduction in flood risk to 30 - 70 properties
	4	Reduction in flood risk to 70-100 properties
Contribute towards reducing flood impacts on people/communities	Likely change in flood impacts on people/communities. Encompassing community preparedness and resilience; stress, health, mental health impacts; nuisance flooding (gardens, roads etc); disruption to access and egress; vehicle damages; risk to life and evacuation costs.	
	-2	Major negative change in flood impacts on

		people/communities
	-1	Minor negative change in flood impacts on people/communities
	0	No perceived change
	1	Minimal positive change in flood impacts on people/communities (e.g. reduction in nuisance flooding)
	2	Minor positive change in flood impacts on people/communities (e.g. reduction in disruption to toilet use)
	3	Minor positive change in flood impacts on people/communities (e.g. improvements to access and egress)
	4	Medium positive change in flood impacts on people/communities (e.g. increasing community flood preparedness and ability to act)
	5	Major positive change in flood impacts on people/communities (e.g. reduction of risk to life and evacuation costs)
Contribute to improving the availability of data, evidence and modelling to support option development or flood incident response	This criteria focusses on the benefits of further data collection and evidence studies to support option development	
	0	Does not improve the availability of data, evidence and modelling
	1	
	2	Will provide additional data, evidence or modelling, helpful in development of interventions
	3	
	4	
	5	Improvement to data, evidence and modelling which is essential to the development of a capital scheme
Deliverability	Likely deliverability of the intervention considering construction complexity, access, designations, services, space, land ownership, available materials and expert equipment or advice required.	
	-2	Deliverability is at high risk of complexity/constraints
	-1	
	0	Not known/not applicable
	1	
	2	Deliverability is at low risk of complexity/constraints
Community / resident acceptability	Community buy in or perceived residents opinion.	

	-2	Community/residents are likely to have objections
	-1	Community/residents may not be receptive
	0	No known objections / constraints
	1	Community/residents are likely to be receptive but may have some constraints
	2	Community/residents are likely to be receptive and have no constraints
Contribute towards biodiversity and water quality betterment	Potential for the intervention to provide creation of habitats and river restoration, as well as improving existing water quality.	
	-2	Significant detriment
	-1	Some detriment
	0	No perceived change
	1	Some betterment
	2	Significant betterment
Contribute towards amenity benefits	Potential for the intervention to improve the amenity value of the surrounding area.	
	-2	Significant detriment
	-1	Some detriment
	0	No perceived change
	1	Some betterment
	2	Significant betterment
Contribute to carbon reduction	Potential for the intervention to contribute towards carbon reduction via sustainable construction techniques or carbon sequestration from increased planting.	
	-2	Significant net carbon increase
	-1	Some net carbon increase
	0	Not known/no effect
	1	Some net carbon reduction
	2	Significant net carbon reduction
Maintenance	High level assessment of maintenance requirements.	
	-2	N/A
	-1	High cost/frequency maintenance, requires new and specialised maintenance routines
	0	Not known/no effect
	1	Low-cost maintenance, can be compelled as part of existing maintenance routines
	2	No active maintenance required (passive maintenance designed)

Timescale	High level assessment of timescales.	
	-2	Long term strategic aim (>10yrs to progress, funding route unclear)
	-1	
	0	Likely to be able to progress in next 1 - 5 yrs e.g. through FCERM partnership funding programme
	1	
	2	Quick win (<1yr), BC able to fund directly
Benefit cost	High level assessment of benefit to cost ratio	
	-2	Strong negative BCR
	-1	
	0	Equal BCR
	1	
	2	Strong positive BCR

Reference	Opportunities	Lead RMA	1	2	3	4	5	6	7	8	9	10	11	TOTAL
			Flood risk benefit to property	Flood impact on people	Data and evidence	Deliverability	Community/ resident acceptability	Biodiversity and water quality betterment	Amenity benefits	Carbon reduction	Maintenance costs	Timescale	Cost benefit	
1	Do nothing	N/A	-2	-1	0	0	-2	0	0	0	2	0	0	-3
2	Business as usual	All	0	0	0	0	-2	0	0	0	1	0	0	-1

3	Complete sewer monitoring and CCTV investigations	Thames Water	0	0	4	2	2	0	0	0	0	2	0	10
4	Undertake impermeable area survey	Thames Water	0	0	4	2	2	0	0	0	0	2	0	10
5	Take opportunities to disconnect or slow down roof water drainage / work with the community to promote disconnection of roof drainage	Property owners / Community / Thames Water	0	1	0	1	1	1	1	0	0	0	0	5
6	Set up a Flood Action Group and create a community Flood Action Plan and flood preparedness pack	Community (supported by Ickford Parish Council and Buckinghamshire Council (LLFA))	1	3	0	1	2	0	0	0	0	2	1	10
7	Property Flood Resilience (PFR)	Property owners	1	4	0	1	2	0	0	0	0	1	1	10
8	Watercourse maintenance plan and riparian awareness (to include activities required, frequency etc)	Riparian owners (supported by Ickford Parish Council and Environment Agency)	0	1	0	2	1	0	0	0	0	2	0	6
9	Strengthen policy on other sources of flooding and access and egress through the emerging Local Plan for Buckinghamshire and Strategic Flood Risk Assessment / Increase awareness of Development Control teams of the impacts of groundwater	Local Planning Authority (with support from LLFA, Emergency Planning, Environment Agency) / Thames Water	0	2	0	1	2	0	0	0	0	1	0	6
11	Investigate opportunities to retrofit highway raingardens e.g. Worminghall Road	Transport for Buckinghamshire	0	3	0	0	2	1	1	0	1	1	-1	8
12	Develop a Groundwater Impacted System Management Plan for Ickford	Thames Water	0	0	5	0	1	0	0	0	0	0	0	6
13	Natural flood management in upper Lappingford/Worminghall Brook and Peppershill Brook	Community / landowners	0	0	0	1	1	1	0	1	0	0	-1	3

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