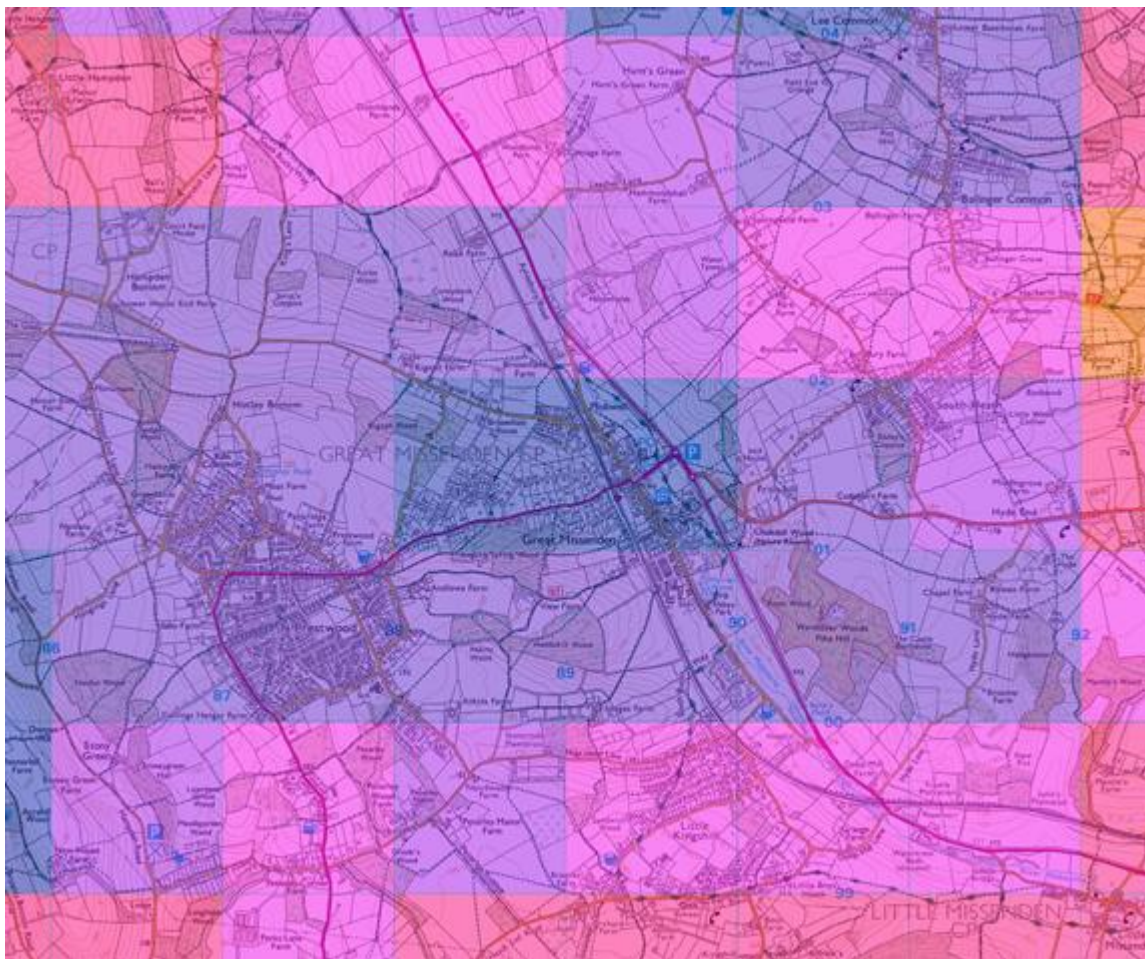


# Buckinghamshire County Council

## Flood Investigation Report

### Great Missenden, Sunday 27<sup>th</sup> May 2018



## Revision Schedule

### Buckinghamshire County Council

16<sup>th</sup> October 2019

Final

Rev	Date	Details	Author	Checked and Approved by
1.0	05/03/2019	Draft	Alex Back	
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## Executive summary

Buckinghamshire County Council (BCC) as the Lead Local Flood Authority (LLFA) has a responsibility to record and report flood incidents in accordance with Section 19 of the Flood and Water Management Act (2010):

(1) On becoming aware of a flood in its areas, a lead local flood authority must, to the extent that it considers it necessary or appropriate, investigate-

(a) Which Risk Management Authorities (RMAs) have relevant flood risk management functions, and

(b) Whether each of those risk management authorities has exercised, or is proposing to exercise, those functions in response to the flood.

(2) Where an authority carries out an investigation under subsection (1) it must-

(a) Publish the results of its investigation, and

(b) Notify any relevant risk management authorities.

British Standard BS 85600:2017 has established criteria for Section 19 post-event flood assessments which can be found in appendix B.

It was deemed necessary to complete an investigation into the flood incident in Great Missenden on Sunday 27<sup>th</sup> May 2018 because it meets the following threshold: One or more commercial property flooded internally.

In the early hours of Sunday 27<sup>th</sup> May 2018 an intense localized thunderstorm hit the village of Great Missenden flooding four commercial and two residential properties internally as a result of the surface water flooding. The report findings show the storm rainfall magnitude was very high with the rainfall recorded by the Met Office rainfall radar gave a return period of 1 in 85 years. This intensity of rainfall is much greater than the design capacity of the highway drainage. As a result of the intense rainfall, the highways drainage was overwhelmed and surface water flowed into the impacted properties. None of the impacted commercial properties had any means of defence against the flood water. As it was a bank holiday weekend the staff/owners of the commercial properties did not realise that their properties had flooded until Tuesday morning. The report concludes that this flood was unavoidable in these circumstances but there are recommendations for the statutory bodies and the property owners to explore making improvements respectively to drainage and property level protection measures which will reduce the impacts of future flood events.

## **1. Introduction**

### **1.1 Scope/purpose of report**

This report summaries the extent, flood mechanism and impact of the flooding in Great Missenden on Sunday 27<sup>th</sup> May 2018. It is not intended to identify which individual properties flooded, nor to provide an exhaustive hydraulic analysis of the event. The recommendations are there to help the RMAs learn lessons from the event and to move forward with management of the flood risk in the future.

A list of recommendations is included in the report which is intended to ensure that the flood management, warning and response to events are improved going forward. All the RMAs will be involved in taking forward these recommendations.

### **1.2 Location characteristics**

#### **1.2.1 Site Location**

Great Missenden is located centrally in the county of Buckinghamshire in Chiltern District Council area. It is located in the Misbourne Valley near the top of the catchment as shown in Figure 1. Figure 2 shows a more detailed map of Great Missenden.

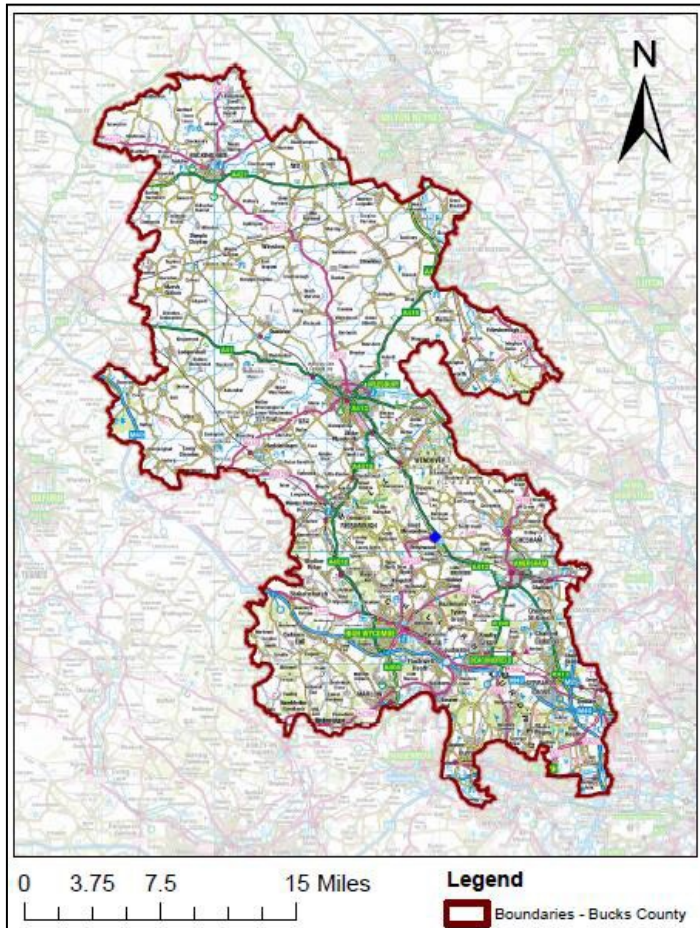


Figure 1: Location Map of Great Missenden in Buckinghamshire

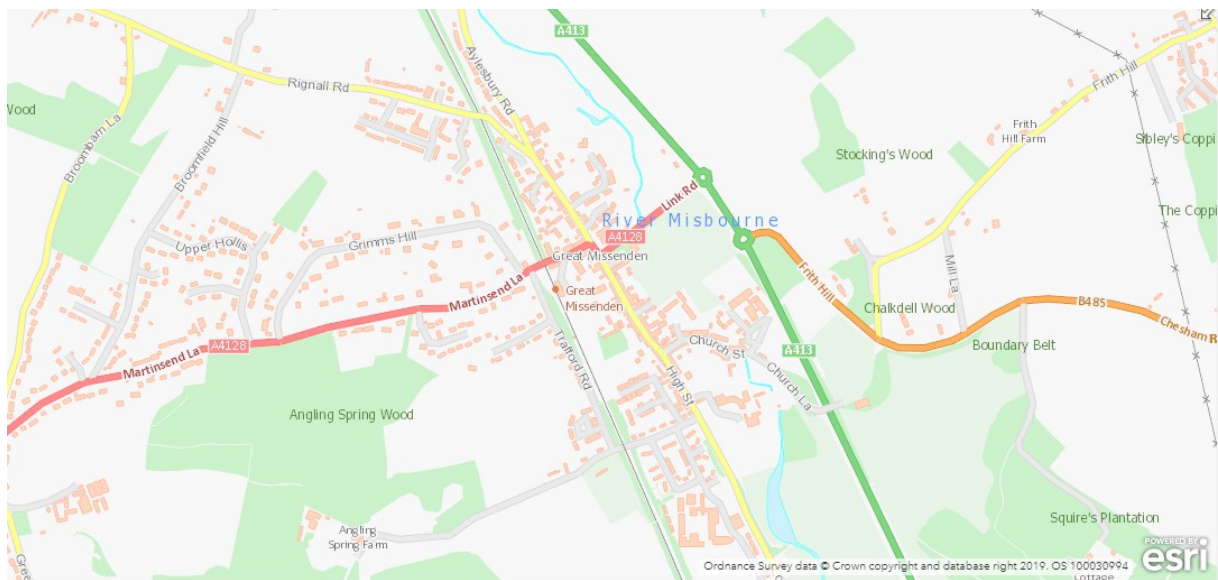
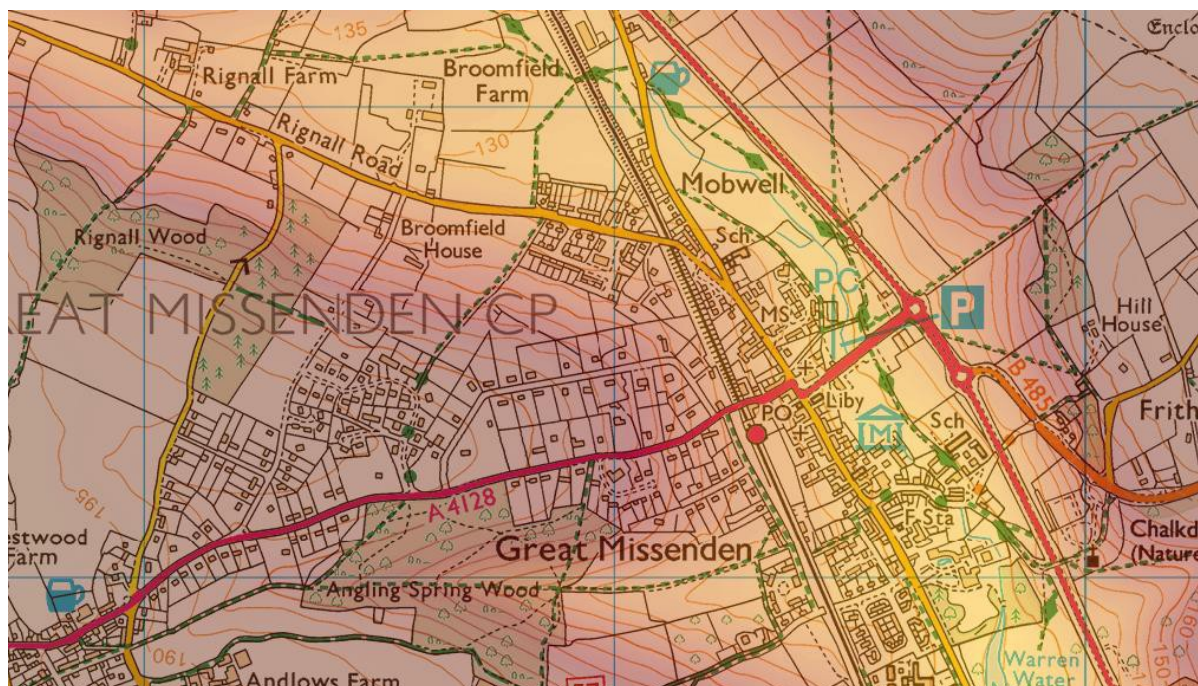


Figure 2: Map of Great Missenden



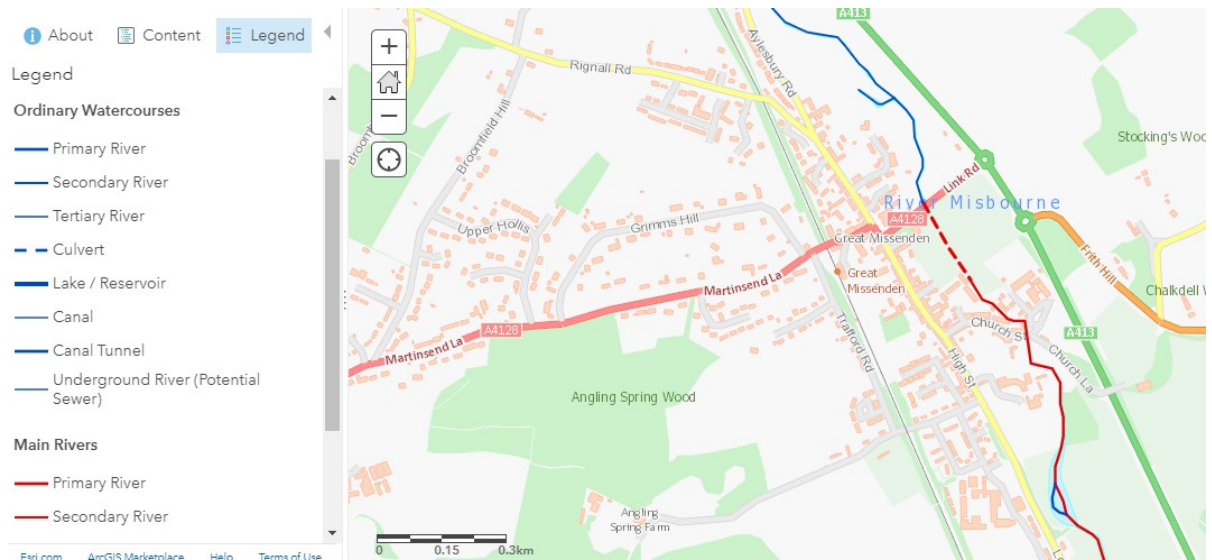
**Figure 3: Map of Great Missenden, showing topography**

Figure 3 also highlights the topography showing the slopes in the locality. These slopes show the bottom of the valley which is also shown in the flood maps as being the greater depth flood areas.

### **1.2.2 River network**

The River Misbourne is a main river that flows through Great Missenden. The river is a chalk stream that flows for 17 miles (27 km) from its source, at Mobwell Pond just north of Great Missenden, to its confluence with the River Colne, which itself is a tributary of the River Thames. Apart from a small section through Great Missenden, the River Misbourne is classed as a main river and comes under the responsibility of the Environment Agency (EA). Figure 4 shows the location of the main river and the ordinary watercourses.





**Figure 4: Main river (red) and ordinary watercourses (blue) in Great Missenden**

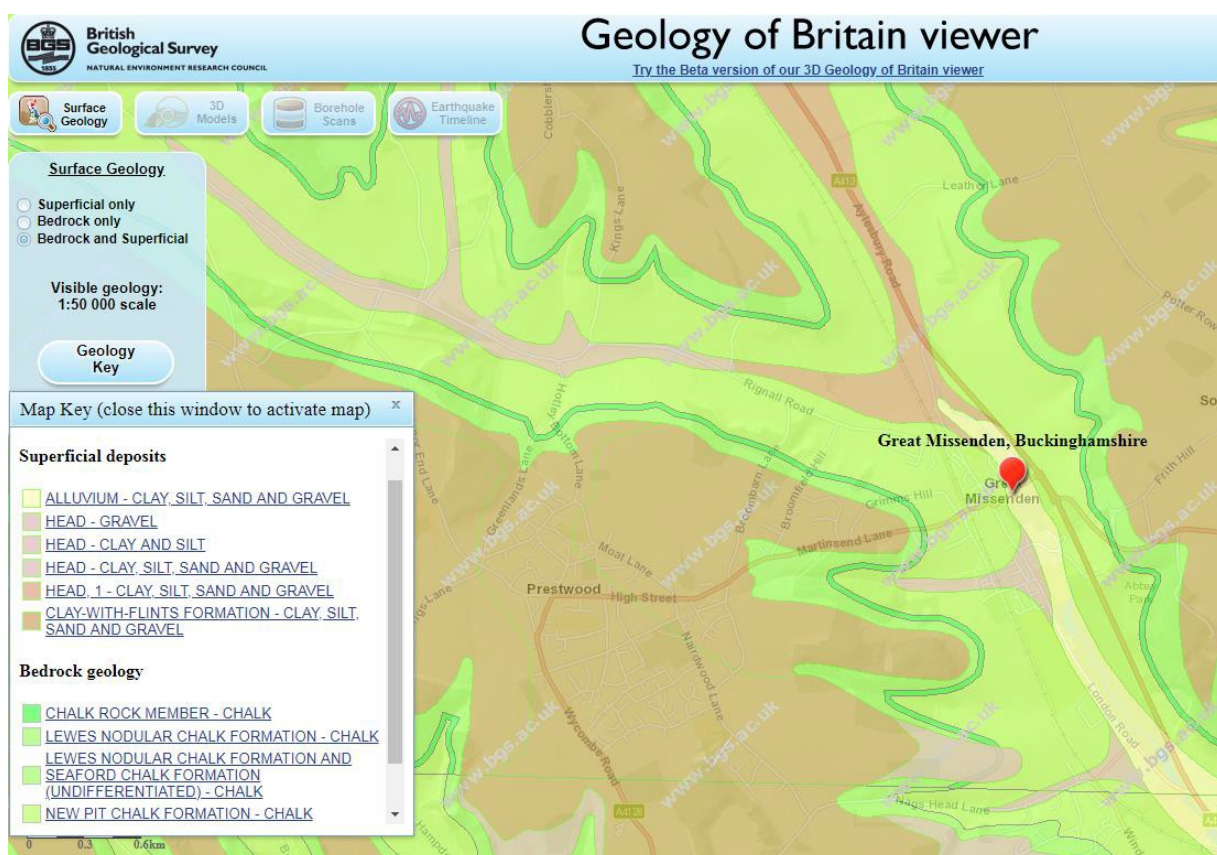
The EA is the Risk Management Authority (RMA) for main rivers. The EA has permissive powers to work on main rivers and the sea to manage flood risk. BCC, as LLFA for Buckinghamshire, is the RMA for ordinary watercourses and as such BCC have permissive powers on ordinary watercourses.

## 2. Background

### 2.1 Catchment characteristics

#### 2.1.1 Geology, soils, land use

The valley of the River Misbourne at Great Missenden and is situated on alluvium (clay, silt, sand and gravel) along the line of the Misbourne, with no superficial deposits in Great Missenden outside of the alluvium areas. The solid geology is chalk and the River Misbourne is characteristic of a chalk stream, where flash chalk and groundwater flooding is rare unless groundwater levels are elevated (as shown in Figure 5).



**Figure 5: Geology map of Great Missenden and surroundings**

#### 2.1.2 Surface Water risk

Surface water flooding is flooding that is a direct result of rainfall flow over and pooling on the land surface. Great Missenden is susceptible to this type of flooding because it is in a valley and so water naturally collects here. Surface water flooding routes and maps are shown in Figures 6 and 7 with the publicly available *Flood Risk from Surface Water* flood mapping, for a flood event with a 1 in 100 (1%) (Figure 6) and 1 in 1000 (0.1%) (Figure 7) chance of occurring in any given year.

Surface water flooding occurs when extreme or prolonged rainfall cannot infiltrate into saturated ground, or flow into the rivers and/or highways drainage due to high volumes of water. The Flood Risk mapping is viewable at: <https://flood-warning-information.service.gov.uk/long-term-flood-risk/map>. It has not been possible to reproduce this mapping at a closer scale for the purposes of this report, but different scenarios of depth, velocity and extent can be viewed at various scales via the above link.

Figures 6 and 7 show the 100 and 1000 year surface water flood maps with the depths shown in varying shades of blue the darker being the deeper predicted flood. In the centre of Great Missenden the maps show a surface water flow route that cross the main road and flows from the south west to the north east. The maps also highlight all the commercial properties at risk from surface water flooding should it occur in Great Missenden.

In Great Missenden there are 12 properties (both residential and commercial) at risk from a 30 year SW flood, 30 from a 100 year SW flood and 137 from a 1000 year SW flood.

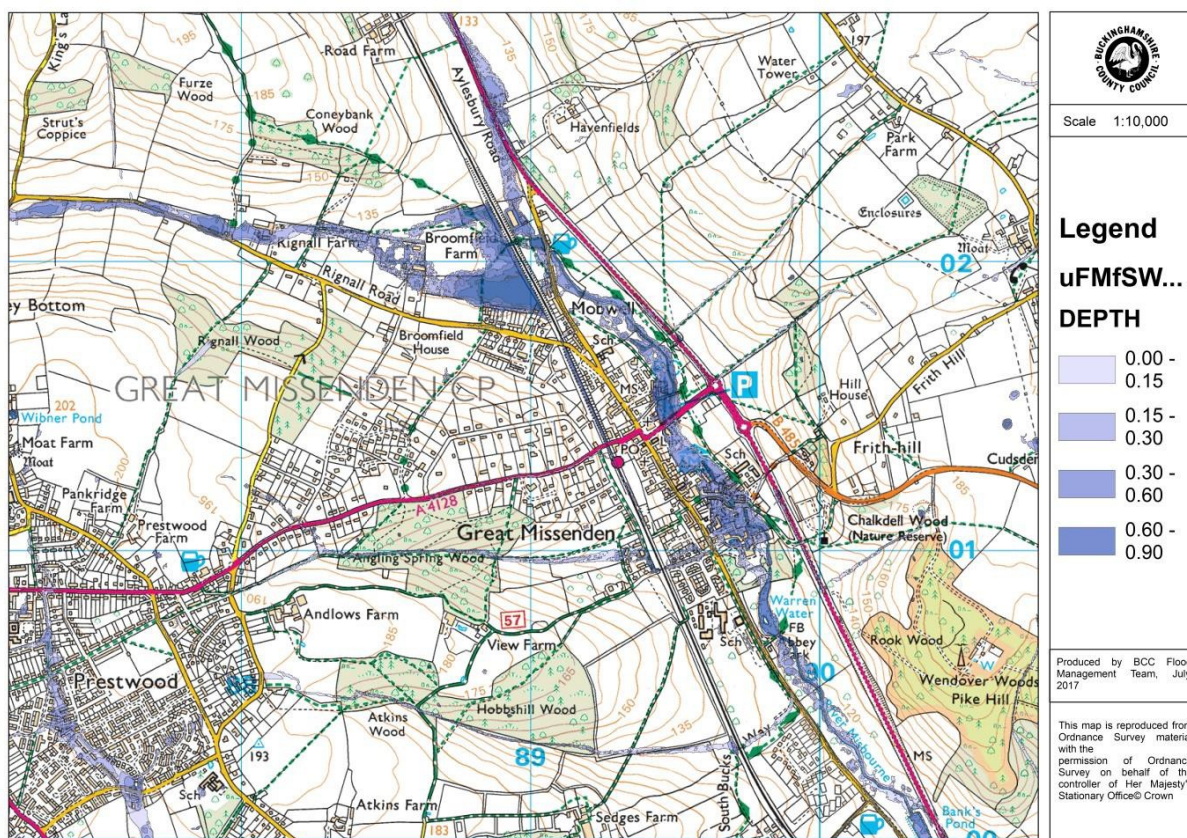
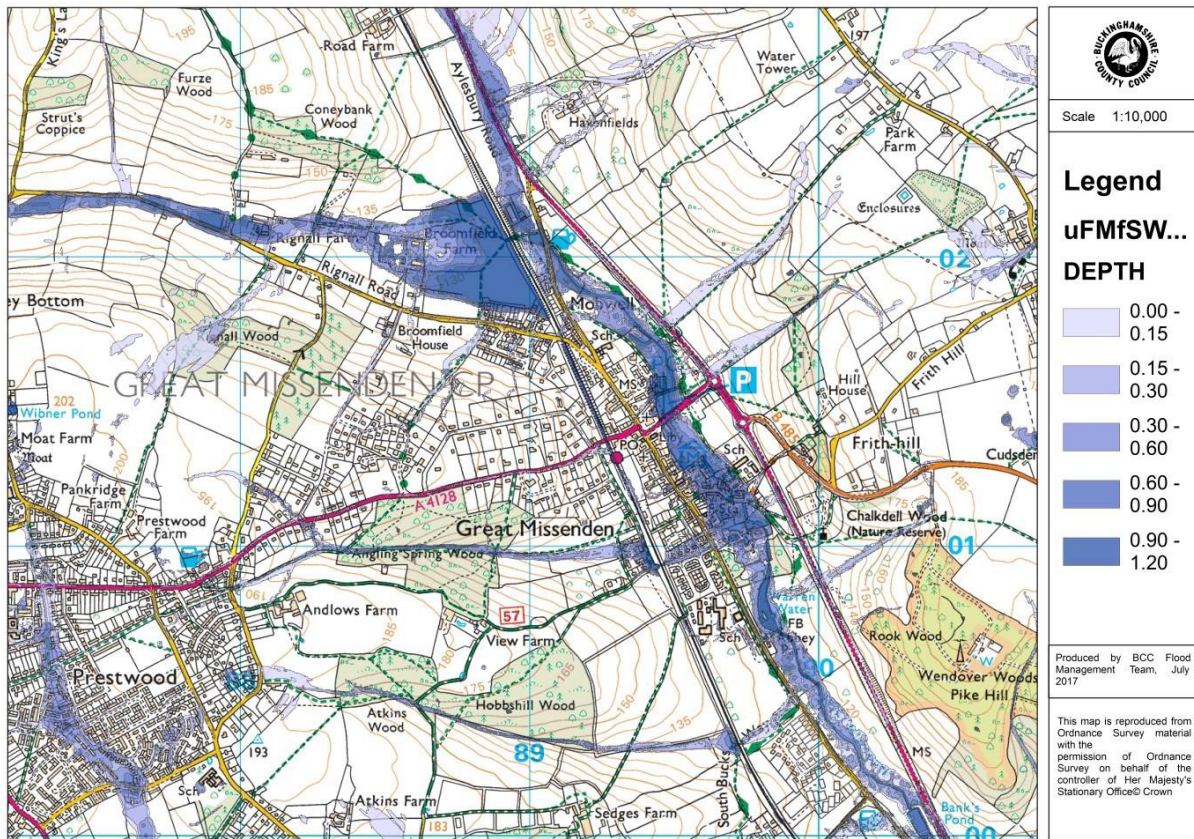
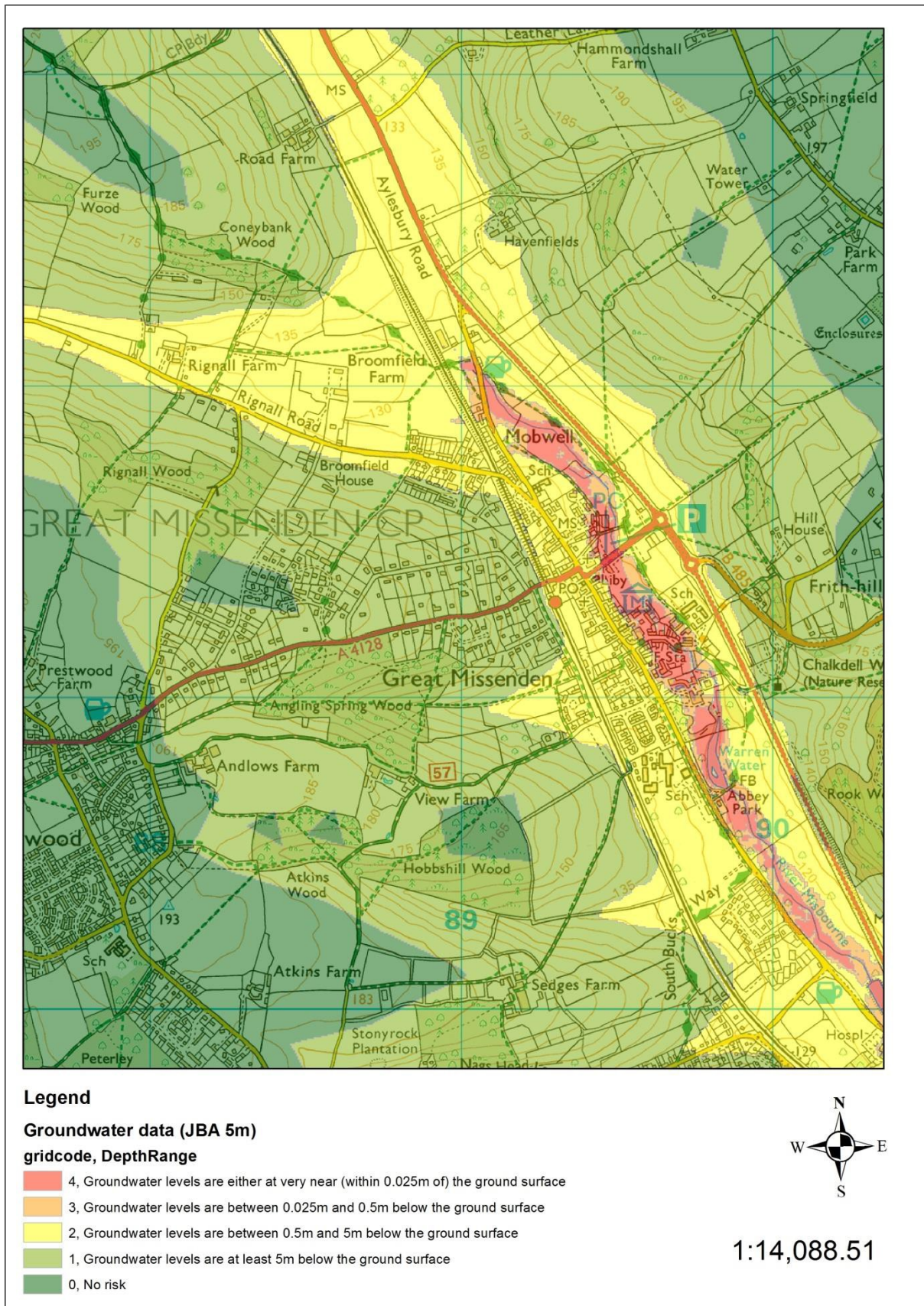


Figure 6: 1:100 year Surface Water Flood Depth Map for Great Missenden



**Figure 7: 1:1000 year Surface Water Flood Depth map for Great Missenden**

In addition Great Missenden is at risk from groundwater (GW) flooding due to the chalk geology and aquifer. Figure 8 shows the groundwater flood risk for Great Missenden which highlights that valley bottom of the River Misbourne as the highest risk (area marked in red on Figure 8) which is to be expected as the river is fed by the chalk aquifer.



**Figure 8: Groundwater Flood Map for Great Missenden (JBA 5m Groundwater flood data, 2019)**

© JBA Consulting. 2018. Some of the responses contained in this mapping are based on data and information provided by the Natural Environment Research Council (NERC) or its component body the British Geological Survey (BGS). Your use of any information contained in this mapping is at your own risk. Neither JBA, NERC or BGS give any warranty, condition or representation as to the quality, accuracy or completeness of such information and all liability (including for negligence) arising from its use is excluded to the fullest extent permitted by law. Your use of the mapping constitutes your agreement to bring no claim against JBA, NERC or BGS in connection with it.

## **2.2 History of flooding**

Buckinghamshire County Council has records of highway flooding during the winter of 2013/14 in the vicinity of the Museum on the High Street and Rignall Road. These are the only records of flooding in these areas of Great Missenden since Buckinghamshire County Council took on the role of LLFA in 2010. There were also four incidents of flooding included in the SFRA for Chiltern District Council within Great Missenden. As part of this investigation it has come to light, from the owners of the residential properties on Rignall Road, that they have been flooded frequently in the past starting back in the winter of 2013/14 and continuing to date every time it rains heavily they have issues with the road flooding and also on a few occasions internal property flooding.

## **3. Investigation – what happened?**

### **3.1 Weather conditions at the time (Hydrometric data)**

Prior to the flood incident the soil moisture deficit and rainfall totals were below average so the catchment and soils were drier than average (EA Water Situation Report May 2018). As the catchment was drier than normal some of the initial rainfall will have been absorbed by the soil. The groundwater levels in the catchment were average for the time of year but not above average (EA Water Situation Report May 2018) which shows that groundwater will not have been a contributing factor to this flood event.

A thunderstorm occurred over Great Missenden on Sunday 27<sup>th</sup> May 2018 during which the Met Office recorded over 1000 lightning strikes over Great Missenden. The storm was at its most intense during the early hours of Sunday 27<sup>th</sup> May 2018.

The closest rain gauge is located at Prestwood Reservoir and Figure 9, shows the daily rainfall totals for the period for 23<sup>rd</sup> to 27<sup>th</sup> May 2018 at this rain gauge with the highest daily total of just under 35mm on 27<sup>th</sup> May 2018.

The Met Office rainfall radar data show the accumulated total rainfall for the event (Figure 10) for the entire country with Great Missenden highlighted for context. The 3 day Met office rainfall radar total shown in Figure 10 shows a 3 day total of 94 to 153mm total over the centre of Great Missenden which is considerably higher than the three day total at Prestwood gauge (which was 42.6mm). Comparing Figures 9 and Figure 10 shows that the rainfall was more intense over the centre of Great

Missenden than it was in Prestwood. The return period for the radar rainfall event equates to a 1 in 85 year return period rainfall event.

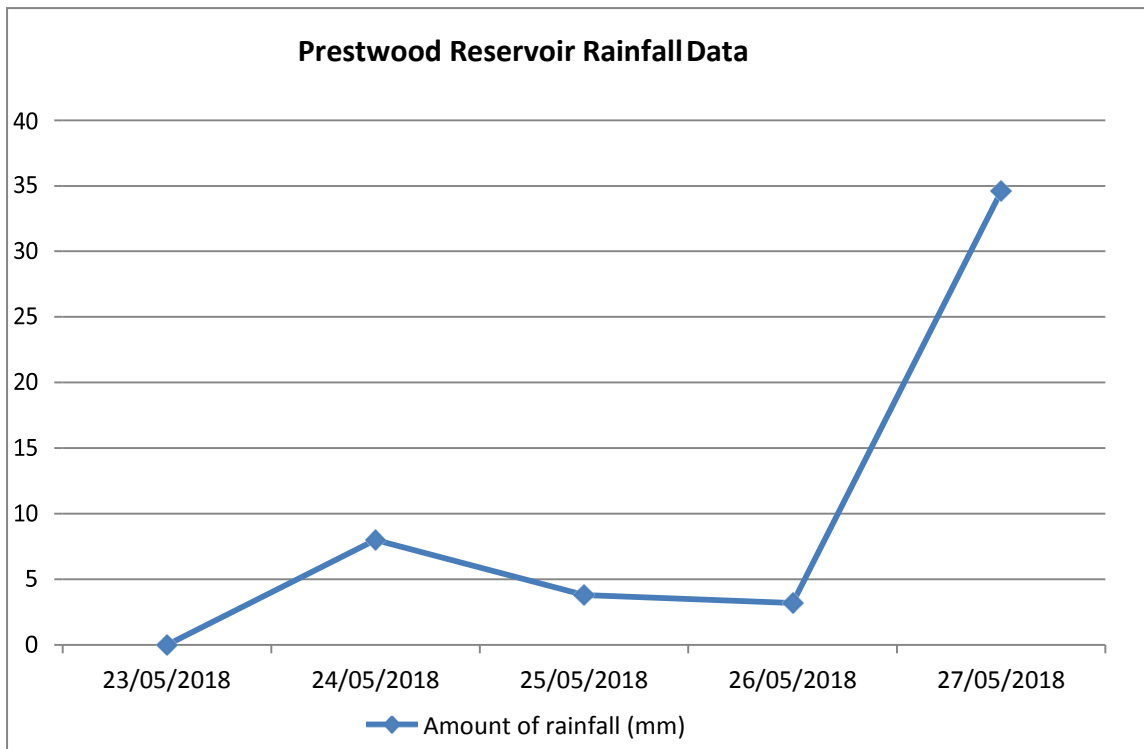


Figure 9: Daily rainfall totals from EA rain gauge at Prestwood Reservoir

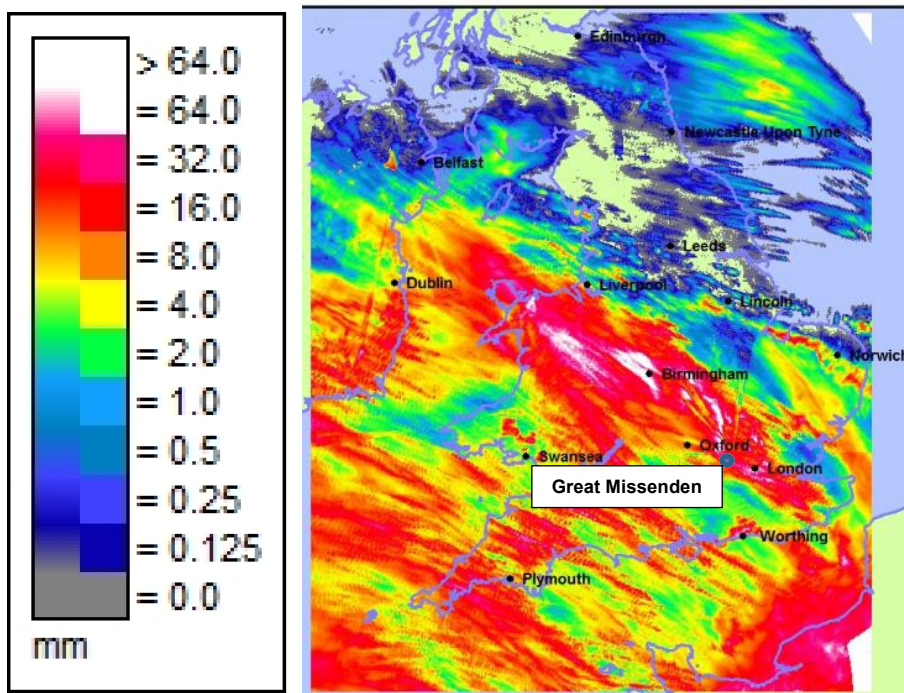
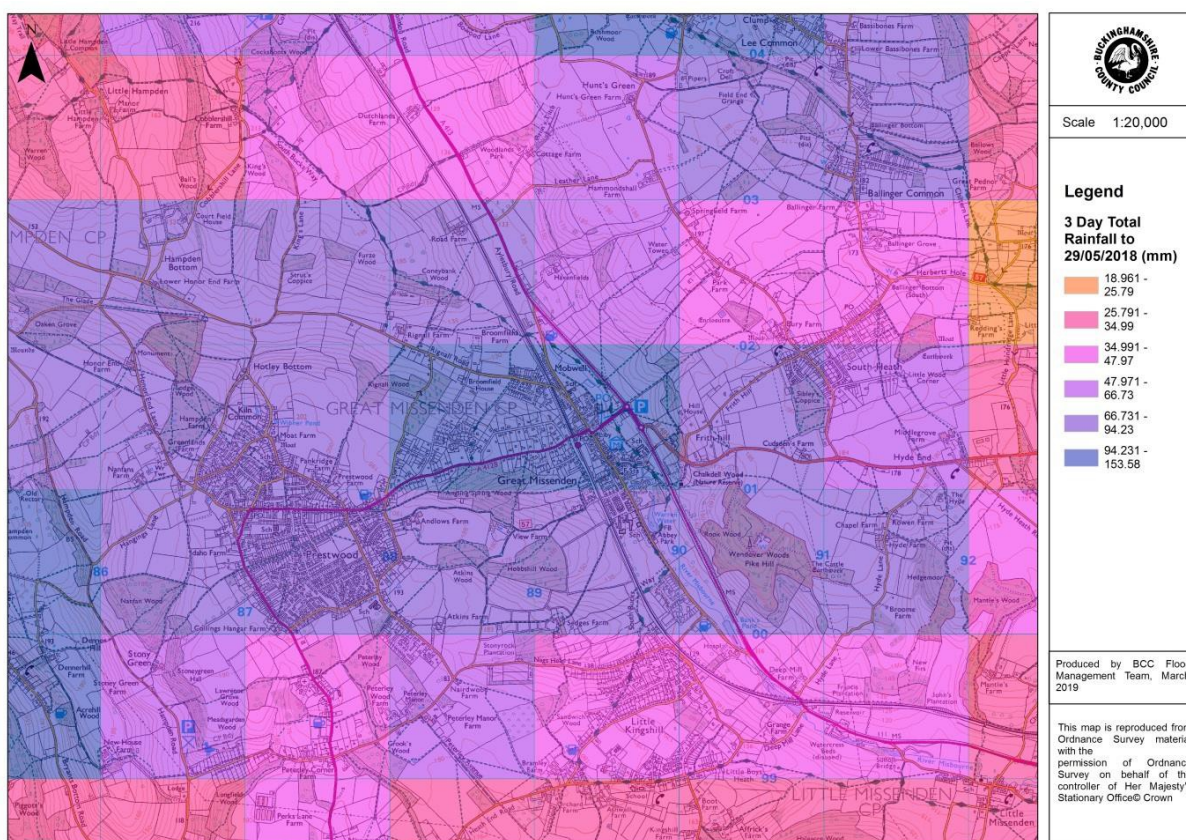


Figure 10: Met Office Rainfall Radar Data 3 day total to 29th May 2018 (Met Office)

Figure 10 shows the 3 day total rainfalls as measured by the radar just divided into more bands with different colours to highlight in more detail the intensity of the rainfall that fell in this area.



**Figure 11: Rainfall Radar Data 3 day total to 29th May 2018 (Met Office)**

The most accurate of the rainfall data is the local rainfall radar data from the Met Office as shown in Figure 11. These give a rainfall total of 105.3mm and 97.3mm for the two radar squares over Great Missenden. This also equates to a 1 in 85 year rainfall events.

The explanation for the discrepancies in the daily rainfall totals (Figure 9) and the Met office rainfall radar data (Figures 10 and 11) is given below.

The Prestwood rain gauge totals did not necessarily pick up the rainfall totals that fell over Great Missenden. The gauge at Prestwood is not geographically close enough to Great Missenden, nor does it measure rainfall more frequently than a daily total so it was not able to measure the high intensity rainfall that fell in Great Missenden during this thunderstorm. The Met Office data (Figures 10 and 11) are consistent in terms of rainfall totals and return period. This data is likely to be more accurate for this event and are consistent with the local knowledge that this was a localised rainfall event over Great Missenden.



### **3.2 Flooding incident and extent**

The flooding impacted four commercial properties around and including the Roald Dahl Museum in the centre of Great Missenden and two residential properties on Rignall Road on north western edge of the village. Figures 12, 13 and 14 show the flood extents in the three separate geographic areas that were impacted by the surface water flooding. The flow routes are unknown as the flooding occurred in the middle of the night with no witness in the village centre. The surface water flood map does suggest a couple of potential flow routes but these cannot be verified by this event. The 1000 year surface water flood map Figure 7 shows a flow route from the south west to the north east as it crosses over the High Street and flows towards the Museum and into its courtyard. The flow route for the water flowing around and into two residential properties on Rignall Road is known as it has occurred in the past as noted in the historic flooding section.

At the Rignall road properties, the water flowed off the highway into the front gardens and driveways and then in through the front doors of the properties as shown in Figure 14. During the rainfall event the water came round behind the second property along the lane and in through the patio doors at the rear of the property as shown in Figure 15. The flooding of these two properties occurred during the early hours of the morning on Sunday 27<sup>th</sup> May. The photos on Appendix F show that the depth of the flooding varied between 30 and 40cm approximately to the exterior of the property. The highways drainage in this location flows into a soak away which has had problems in the past, according to the residents, due to debris that flows into it from the unmade road. This might have been significant during this event although this will need to be investigated by Transport for Buckinghamshire.

The flooding at Missenden Abbey also occurred during the early hours of the morning on Sunday 27<sup>th</sup> May although the staff did not discover it until the Tuesday when they returned to work after the bank holiday. The surface water entered the main reception/lobby area through the side door and flooding approximately half of the floor area in this room to a depth of approximately 5cm. The water flowed down the drive way and around the left of the building and into the side door.

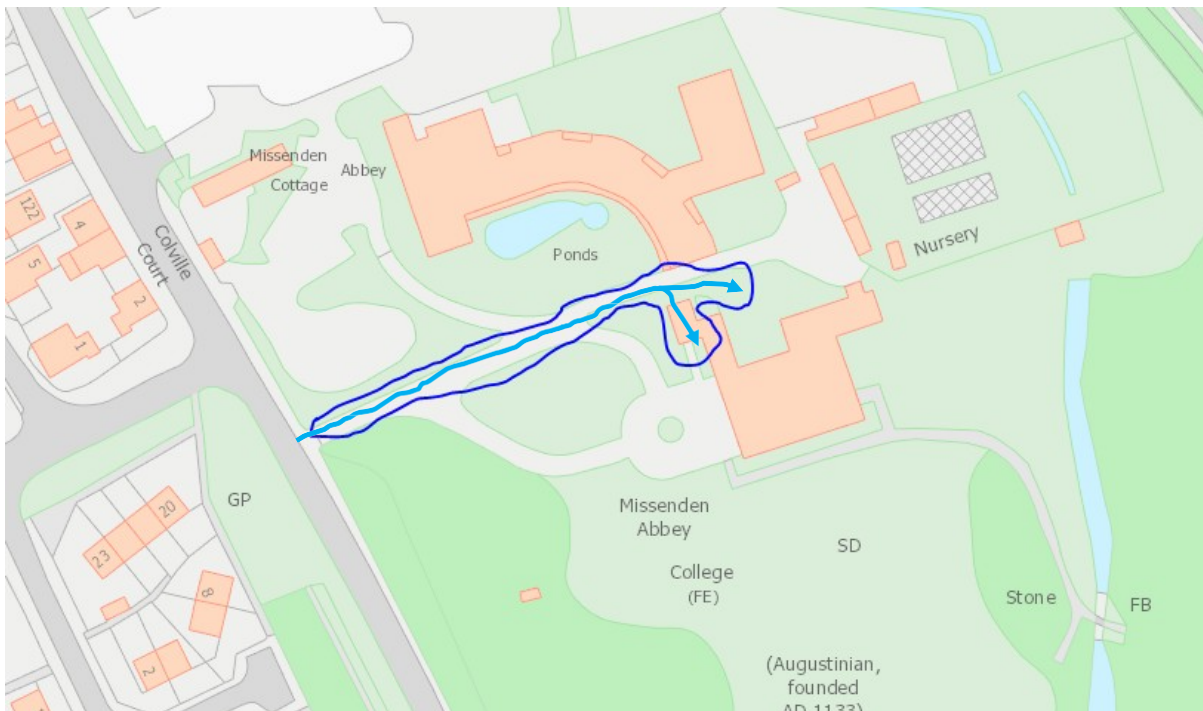
For all the flood locations covered by this report the water was clean in nature, no sewer flooding occurred although there was a lot of silt and small stones mixed in with the water and this can be seen in the photos shown in Appendix F.

The impacts of the flooding to the museum were significant the toilets, galleries, kitchen, courtyard seating area, staff kitchen and staff room were all flooding. The store room and the DIY shop was flooded so was the staff room and stock room at the bridal shop and the reception area at Missenden Abbey was also flooded. (See photographs included in Appendix F)

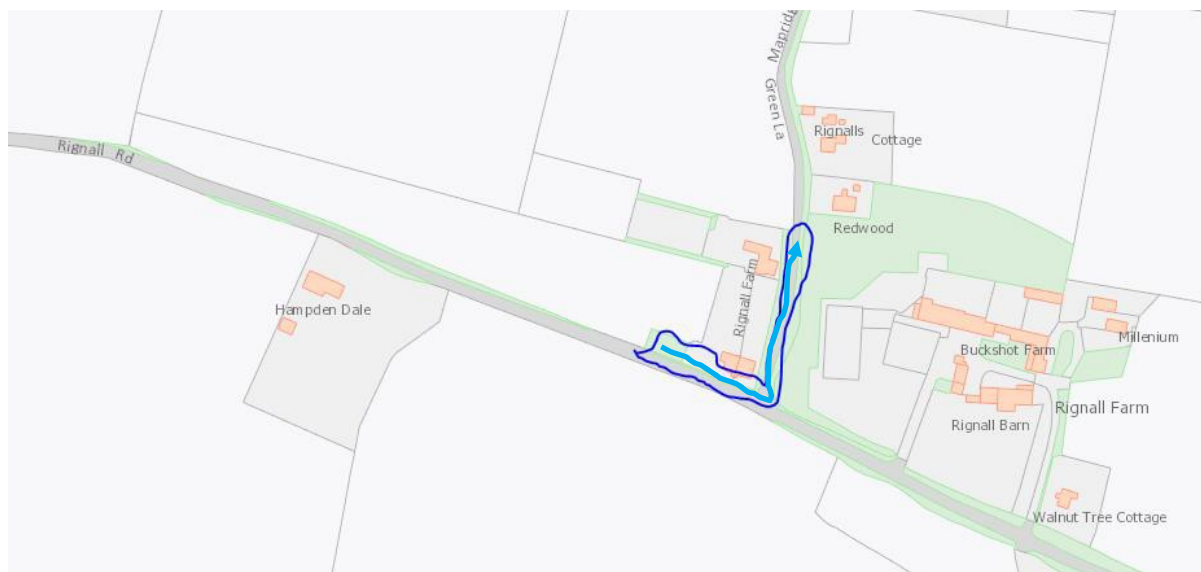
The rest of the flood damage, internal flooding to the hall way and kitchen and rear of the neighbouring property, was not discovered until the following day in the daylight once the storm had passed by. (See photographs included in Appendix F)



**Figure 12: Extent of Flooding along High Street Great Missenden around the museum (flow route shown)**



**Figure 13: Extent of flooding off London Road Great Missenden at Missenden Abbey (flow direction shown)**



**Figure 14: Extent of flooding on Rignall Road (flow direction shown)**

### **3.3 Asset and drainage conditions at the time**

The highway drainage assets in this area are all owned by Buckinghamshire County Council and operated and maintained by Transport for Buckinghamshire. At the time of the flood the assets (gullies and pipes) on the High Street appeared to be operating effectively whereas those in the section of Rignall Road were not. The gullies outside the effected properties on Rignall Road (Figure 15) were working effectively and conveying water away. There is anecdotal evidence from the residents that the soakaway into which they the water from the gullies appeared to be not functioning properly, it has over flowed on several occasions during heavy rainfall events.

The gullies along the High Street in Great Missenden were operating as designed, for the 1 in 5 year design storm event, they were not full of silt after the event and the event is likely to have exceeded the design capacity. There are no gullies between the opticians and the museum section of the High Street as shown in Figure 16.

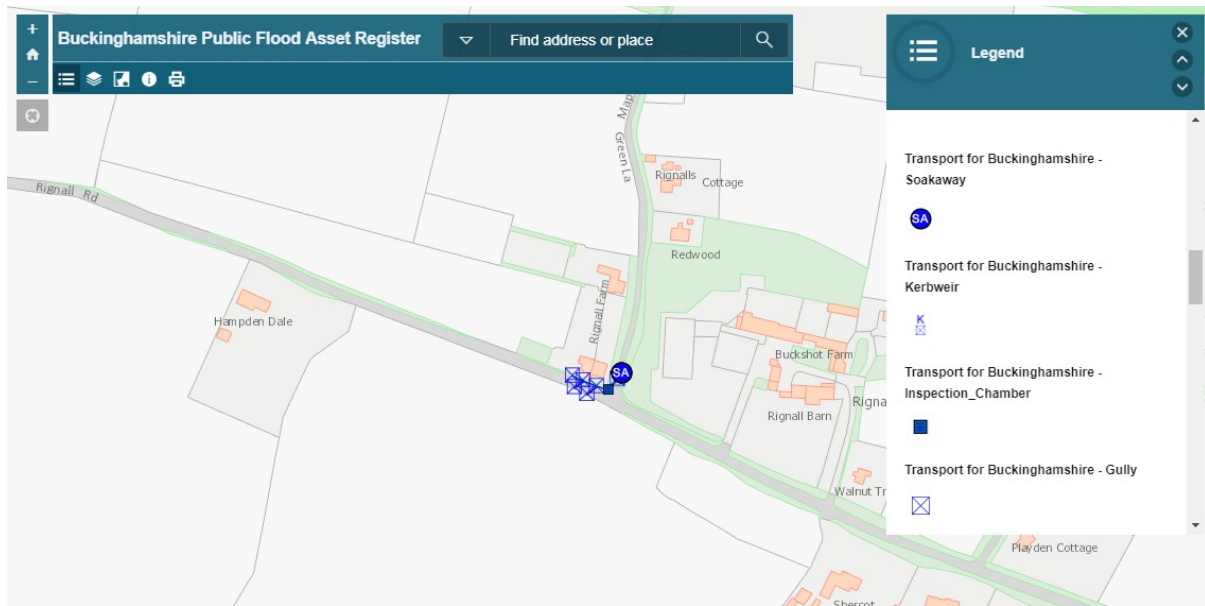


Figure 15: TfB Highway drainage Assets Map Rignall Road

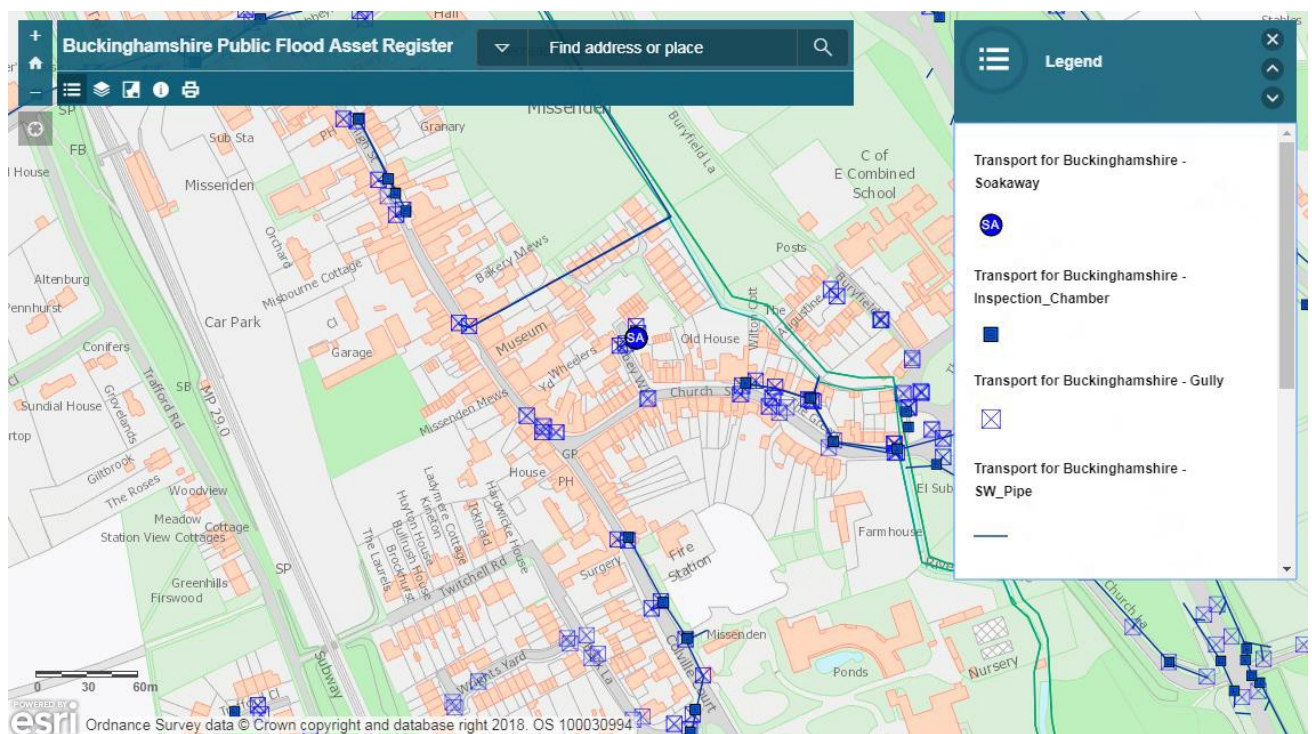


Figure 16: TfB Highway drainage assets for central Great Missenden

### 3.4 Likely causes of flooding

The surface water flooding was caused by an intense short duration thunderstorm that passed over Great Missenden in the middle of the night, early hours of the morning on Sunday 27<sup>th</sup> May 2018. The met office rainfall radar data shows between 94 and 153mm of rain fell in Great Missenden in the 3 days from 27<sup>th</sup> to 29<sup>th</sup>

May 2018. The 1 in 85 year storm was so intense that it overwhelmed the highway drainage and as a consequence flooded several commercial properties and two residential properties. Most highway drainage systems are designed to take a 5 or 10 year storm event and so it is understandable that a storm event of this magnitude would overwhelm the drainage system.

### **3.5 Flood incident response**

#### **3.5.1 Commercial properties**

There was no incident response as the event took place in the middle of the night on Sunday 27<sup>th</sup> May 2018. The commercial properties were unoccupied and the flood impacts and devastation was discovered when the first employees arrived to work on Tuesday morning (29/05/2018), two days later, as the Monday (28/05/2018) was a Bank Holiday.

#### **3.5.2 Residential properties (Rignall Road)**

The homeowners were woken, in the early hours of the morning, by the heavy rainfall thunder and lightning and went downstairs to see what was happening. The residents discovered that the road, front gardens and driveway were flooded and that some water had started to come under the front doors of both properties. The residents deployed sandbags outside the front doors and mopped up the water that had already entered the properties.

The Bucks and Milton Keynes Fire and Rescue Service responded to this flood event as part of an emergency response to a number of emergency calls within Great Missenden.

## **4. Summary of impacts and findings**

### **4.1 Summary**

In the early hours of Sunday 27<sup>th</sup> May 2018 an intense localized thunderstorm hit the village and outskirts of Great Missenden. Flooding occurred at three locations: Rignall Road, High Street Great Missenden around the museum and Missenden Abbey off London Road. Four commercial and two residential properties were flooded from the surface water flooding resulting from the heavy rainfall.

### **4.2 Findings from investigation**

The intensity of the rainfall created some surface water runoff along well known flood routes especially along Rignall Road where the flooding was consistent with previous flood events. The highways drainage in this location flows into a soak away which has had problems in the past, according to the residents, due to debris that flows into it from the unmade road. The capacity of the soakaway was not sufficient to take the surface water runoff at Rignall Road and the cottages in the surface water flow path became flooded to a depth of around 200mm internally.

The thunder storm that caused the flooding on 27<sup>th</sup> May was likely to have been a greater magnitude than the designed highway drainage capacity. As the highways drainage was not able to convey the flood water, the water flowed down the road to and around and into the impacted properties. The impacted residential and commercial properties had no means of defence against the flood water. As it was a bank holiday weekend the staff did not realise that their properties had flooded until Tuesday morning although this did not affect the impact of the event.

## **5. Rights and responsibilities (authorities and landowners)**

There are different responsibilities for flood management depending on the type of flooding. Organisations responsible for flooding are known as Risk Management Authorities (RMAs) and their responsibilities are detailed below. Riparian landowners also have responsibilities for watercourses across their land and these are also detailed below. These are summaries of the details included in the Buckinghamshire County Councils Local Flood Risk Management Strategy (published 2017). The organisations details are all listed in Appendix D and extra information on flooding is shown in Appendix C and flood warnings are explained in Appendix E.

### **5.1 Lead Local Flood Authority**

The Lead Local Flood Authority in this area is Buckinghamshire County Council. Buckinghamshire County Council has a role as a RMA in coordinating management of local flood risk from surface water, ground water and ordinary watercourses in the county.

### **5.2 Chiltern District Council**

Chiltern District Council have responsibilities to inspect and maintain watercourses on District Council land, respond to requests for assistance during flood events and have the power, if instructed by Buckinghamshire County Council, to carry out flood risk management work which will benefit management of surface runoff, groundwater and ordinary water courses.

### **5.3 Environment Agency**

The Environment Agency is one of the RMAs as defined by the Flood and Water Management Act 2010. Protecting the river environment and managing flood risk is part of their job. The EA is the RMA for flooding from main rivers.

### **5.4 Highways Authority – Transport for Buckinghamshire**

Any flooding from highways is managed by the Highways Authority which is BCC and the highways function is managed by TfB.

### **5.5 Water Utility Company – Thames Water**

Thames Water is responsible for flooding from foul sewers and surface water sewers which they own. Whilst undertaking this they must manage flood risk from sewers.

### **5.6 Landowners and riparian owners**

Landowners and riparian owners must maintain any culvert, or the bed and banks of any adjacent watercourse. They should clear away any debris from the watercourse or culvert even if it did not originate from their land.

Riparian owners can find further guidance on their responsibilities as landowners in the Environment Agency document 'Living on the Edge' which can be found online at [gov.uk/government/uploads/system/uploads/attachment\\_data/file/297423/LIT\\_7114\\_c70612.pdf](http://gov.uk/government/uploads/system/uploads/attachment_data/file/297423/LIT_7114_c70612.pdf).

### **5.7 Residents**

Residents have a responsibility to take measures to protect themselves and their property when flooding is imminent.

### **5.8 Emergency Responsibilities**

The emergency responsibilities are outlined in Table 3 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 1: Roles and responsibilities in an emergency, during and after a flood event**

<b>Local (County and District) Authorities</b> <ul style="list-style-type: none"> <li>• Coordinate emergency support within their own functions</li> <li>• Deal with emergencies on 'non main rivers'</li> <li>• Coordinate emergency support from the voluntary sector</li> <li>• Liaise with central and regional government departments</li> <li>• Liaise with essential service providers</li> <li>• Open rest centres</li> <li>• Manage the local transport and traffic networks</li> <li>• Mobilise trained emergency social workers</li> <li>• Provide emergency assistance</li> <li>• Deal with environmental health issues, such as contamination and pollution</li> <li>• Coordinate the recovery process</li> <li>• Manage public health issues</li> <li>• Provide advice and management of public health</li> <li>• Provide support and advice to individuals</li> <li>• Assist with business continuity</li> </ul>	
<b>Police Force</b> <ul style="list-style-type: none"> <li>• Save life</li> <li>• Coordination and communication between emergency services and organisations providing support</li> <li>• Coordinate the preparation and dissemination</li> </ul> <b>Fire and Rescue Service</b> <ul style="list-style-type: none"> <li>• Save life rescuing people and animals</li> <li>• Carry out other specialist work, including flood rescue services</li> <li>• Where appropriate, assist people where the use of fire service personnel and equipment is relevant</li> </ul> <b>Ambulance Service</b> <ul style="list-style-type: none"> <li>• Save life</li> <li>• Provide treatment, stabilisation and care at the scene</li> </ul>	<b>Utility Providers</b> <ul style="list-style-type: none"> <li>• Attend emergencies relating to their services putting life at risk</li> <li>• Assess and manage risk of service failure</li> <li>• Assist with recovery process, that is, water utilities manage public health considerations</li> </ul> <b>Internal Drainage Board</b> <ul style="list-style-type: none"> <li>• Operate strategic assets to reduce flood risk in partnership with RMAs and public</li> </ul> <b>Town and Parish Councils</b> <ul style="list-style-type: none"> <li>• Support emergency responders</li> <li>• Increase community resilience through support of community emergency plan development</li> </ul> <b>Voluntary services</b> <ul style="list-style-type: none"> <li>• Support rest centres</li> <li>• Provide practical and emotional support to those affected</li> <li>• Support transport and communications</li> <li>• Provide administration</li> <li>• Provide telephone helpline support</li> </ul>
<b>Environment Agency</b> <ul style="list-style-type: none"> <li>• Issue Flood Warnings and ensure systems display current flooding information</li> <li>• Provide information to the public on what they can do before, during and after a flood event</li> <li>• Monitor river levels and flows</li> <li>• Work with professional Partners and stakeholders and respond to requests for flooding information and updates</li> <li>• Receive and record details of flooding and related information</li> <li>• Operate water level control structures within its jurisdiction and in line with permissive powers</li> <li>• Flood event data collection</li> <li>• Arrange and take part in flood event exercises</li> <li>• Respond to pollution incidents and advise on disposal</li> <li>• Assist with the recovery process, for example, by advising on the disposal of silt, attending flood surgeries</li> </ul>	



## 6. Recommended actions

These recommended actions have been written up to help all the risk management authorities to work together to reduce the likely impacts of future flood events. Buckinghamshire County Council as LLFA will monitor these actions and complete its own actions where resources allow in a timely manner.

Authority / Stakeholder	Recommended Actions
<b>Property owners (both commercial and residential)</b>	1) explore the possibility of installing property level protection and resilience measures to reduce flood water entering properties and also speed up the rate of recovery after a flood event.
<b>Communities and residents (e.g. town/parish councils, flood forum, community group, landowners and affected residents)</b>	1) establish observation networks in flood prone catchments; 2) appoint a community flood warden (and a deputy) to coordinate: <ul style="list-style-type: none"> <li>i) preparation of an overall plan of the catchment area that includes:               <ul style="list-style-type: none"> <li>• any historic routes of drainage from the various catchment areas of the settlement, which could be reinstated or improved;</li> <li>• riparian ownership and responsibilities for field drainage systems such as ditches, culverted watercourses and open watercourse sections; and</li> <li>• land uses within the catchment that could affect the normal flow of surface water;</li> </ul> </li> <li>ii) preparation of household emergency plans for vulnerable properties in the area; and</li> <li>iii) regular inspection of drainage and flood defences in the area of flood risk, with blockages or other issues reported to the landowner, asset owner, LLFA, and, if necessary, Environment Agency/SEPA/Natural Resource Wales;</li> </ul> 3) explore options for property level protection and implement any recommendations, e.g. additional drainage at the rear of properties, self-sealing air bricks and flood barriers; 4) explore options for alternative pedestrian and vehicular routes at times of flooding; 5) explore community-wide solutions, e.g. natural flood retention measures; and 6) explore permanent building measures, e.g. installing

	floodgates, raising electrical sockets and fitting non-return valves on pipes.
<b>The Environment Agency and Lead Local Flood Authority</b>	<p>1) work with their Emergency Planning Team and the Environment Agency to support the community in the instatement and training of a community-based flood warden; and</p> <p>2) work with their emergency planning team, the Environment Agency and other flood management authorities to support the community in the production of a community flood plan and provide advice to residents on how to explore options for property level protection; inform owners of drainage systems and watercourses within the catchment area of their legal responsibilities; and recommend appropriate maintenance regimes.</p>
<b>Transport for Buckinghamshire</b>	<p>1) Investigate upgrading the highway drainage assets outside the residential properties on Rignall Road</p> <p>2) Investigate upgrading the highway drainage around the Roald Dahl museum as to whether or not this was an issue for flooding in this area.</p> <p>3) regular highway drainage inspection and cleansing;</p> <p>4) assess the capacity of the drainage assets, identify any areas with insufficient capacity for draining runoff from the highway and, where this leads to flood risk to properties, consider improvement works;</p>
<b>Other utility companies</b>	1) examine bespoke protection options where assets were shown to be at high risk of flooding, including using resistant and resilient building repairs.
<b>Developers</b>	<p>1) work with local authorities to ensure all development is completed in accordance with approved plans and documents, and planning policy; and</p> <p>2) take care when constructing the approved development and, in particular, prior to drainage systems being built or connected, ensure that flood risk to adjacent properties/land is not increased</p>
<b>Landowners</b>	<p>1) undertake regular inspection and maintenance of their drainage systems in accordance with a defined maintenance regime;</p> <p>2) assess the capacity of their drainage systems and identify any areas with insufficient capacity for the</p>

	<p>collection, conveyance, storage and disposal of surface water, and, where this could lead to runoff to the public highway or nuisance to third party private property, consider improvement works; and</p> <p>3) agricultural landowners carry out works to their land to reduce surface water runoff, such as following principles of good soil husbandry, natural flood management and providing land drainage systems, e.g. ditches.</p>
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## 7. Next steps

The recommendations outlined in section 6 will be followed up by the Strategic Flood Management team at BCC on an annual basis we will also work in partnership with the other RMAs and local community to raise the issues and encourage them to be taken forward as projects. BCC will work closely with Transport for Buckinghamshire to pursue options for capital drainage schemes in both of the affected areas of Great Missenden subject to business case and budget availability. Any work suggested will need to be prioritised against other projects and benefit cost assessment may be needed. Any major works requiring capital investment will be considered through the Department for Environment Food and Rural Affairs (Defra) funding programme alongside local levy funding administered by the Regional Flood and Coastal Committee (RFCC), Department for Transport and other local funding schemes. The RMAs will continue to work together to engage with the communities affected and to identify all potential options for each location reduce flood risk across Great Missenden.

Meanwhile, the communities should be prepared for more similar extreme weather events in the future, such as heavy and intense downpour after a quite dry period. These kinds of event can be more common due to climate change, and their impacts can be reduced with paying attention to the weather forecast and flood warnings, and regular maintenance of the drains and watercourses.

## 8. Conclusion

This rainfall was very intense (1 in 85 year rainfall event) and the subsequent surface water overwhelmed the highways drainage and caused flooding to a number of properties. Following the event there are mitigation options that are outlined in the recommendations section. Recommendations are given for the highway authority to explore making improvements to drainage in the local area to help mitigate the impacts of this type of intense rainfall. Recommendations are made for local authorities to explore with the residents, the options for property level protection and resilience measures. Combining improved highways drainage with property flood resistance and resilience measures would all help to reduce the impact of the flooding on both the residential and commercial properties.

## 9. Appendices

### Appendix A: Glossary

Acronym	Definition
BCC	Buckinghamshire County Council
BMKFRS	Buckinghamshire and Milton Keynes Fire & Rescue Service
BGS	British Geological Survey
CDC	Chiltern District Council
CFMP/ Catchment Flood Management Plan	Catchment Flood Management Plans are produced by the Environment Agency to give an overview of the flood risk in the two primary catchments in BCC's area: Great Ouse and Thames.
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency, which has a Strategic overview role for flood and coastal erosion risk management
Flood	The temporary inundation by water of property or land not normally covered with water
Flood & Water Management Act 2010 (FWMA)	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which (partly) is to clarify the legislative framework for managing local flood risk in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a river.
Groundwater flooding	Occurs when water levels in the ground rise above the natural surface. Low lying areas underlain by permeable strata (e.g. Chalk) are particularly susceptible.
HYRAD imagery	Standard radar display system for flood warning across England, Wales, Scotland, Northern Ireland and Belgium
IDB	Internal Drainage Board. Applicable to only one area in Buckinghamshire for which the Buckingham and River Ouzel Internal Drainage Board has flood risk management responsibilities.
LLFA / Lead Local Flood Authority	Local Authority responsible for taking the lead on local flood risk management
Local Flood Risk	Flooding from sources other than Main Rivers, which principally concerns surface runoff, groundwater and ordinary watercourses. BCC has a responsibility under the Flood & Water Management Act to manage flooding from these sources.
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers.
Ordinary Watercourses	All watercourses that are not designated Main River, and which are the responsibility of local authorities or IDBs
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.

Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
Risk Management Authorities (RMA)	Organisations that have a key role in flood and coastal erosion risk management as defined by the Flood & Water Management Act 2010. These are BCC (the Lead Local Flood Authority and Highways Authority), District Councils, Environment Agency, Buckingham and River Ouzel Internal Drainage Board, Anglian Water and Thames Water
SFRA	Strategic Flood Risk Assessment. These are produced by each District to give an assessment of flood risk from all sources and its implications for land use planning.
Soil moisture deficits (SMDs)	Soil moisture deficit levels provide a measure of the capacity of the ground to store water: the higher the number, the greater the capacity
Stakeholder	A person or organisation affected by the problem or solution, or interested in the problem or solution. They can be individuals or organisations; includes the public and communities.
Strategy	Under the Flood & Water Management Act 2010, BCC have a duty to develop, maintain, apply and monitor a strategy for local flood risk management
Sustainability	In the context of this Strategy, the risk of flooding must be reduced now, but in a way which does not compromise the interconnected needs of the economy, society and environment in the future.
SuDS / Sustainable Drainage Systems	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Surface water/runoff	Rainwater (including snow and other precipitation) which is on the surface of the ground (whether or not it is moving), and has not entered a watercourse, drainage system or public sewer. The term 'surface water' is used generically to refer to water on the surface and is often associated with periods of intense rainfall.
SWMP	Surface Water Management Plan
TfB	Transport for Buckinghamshire

## **Appendix B: Summary of relevant legislation and flood risk management authorities**

### *British Standard BS 85600:2017 Section 4:*

The following are guideline thresholds for determining the need for an investigation, but can vary depending on whether the area(s) affected is rural or urban and whether there is any ambiguity as to the source of the flooding:

- 1) Flooding of significant infrastructure (hospital, school, utilities, treatment works, etc.);
- 2) Flooding of a key transport link, e.g. primary routes (A-roads and motorways), key rail links;
- 3) Internal flooding of one or more premises on more than one occasion in the past five years (excluding gardens and detached garages/out-buildings, but including integral garages); and
- 4) Internal flooding of five or more properties in close proximity during a single incident.

If any of the criteria are met then a flood investigation should be commenced, taking account of the severity and extent of flooding (to inform timescales and resources). If the criteria are not met, then this fact and the decision not to investigate should be recorded. The recorded incidents should determine the initial scope and methodology for the survey(s) (one incident might involve several different surveys), and the decision as to whether the survey will involve a desk study and/or a site visit. This should involve identifying the means of capturing the data and in what format they should be recorded and stored to ensure the information can be viewed and shared for use by any relevant parties in the future.

## **Appendix C: Links to other information on flooding**

### **National Flood Forum**

National Flood Forum website: <https://nationalfloodforum.org.uk/>

### **Gov UK Flood Warning Information Service**

Website: <https://flood-warning-information.service.gov.uk/>

Sign up to flood warnings here: <https://www.gov.uk/sign-up-for-flood-warnings>

## Appendix D: Useful contacts and links

### Lead Local Flood Authority



Flood Management Team  
Buckinghamshire County Council  
County Hall  
Walton Street  
Aylesbury  
Bucks HP20 1UY

Telephone: 084537 08090

Email: [FloodManagement@buckscc.gov.uk](mailto:FloodManagement@buckscc.gov.uk)

Website: [www.buckscc.gov.uk/flooding](http://www.buckscc.gov.uk/flooding)

### Environment Agency



**Environment  
Agency**

National Customer Contact Centre  
PO Box 544  
Rotherham  
S60 1BY

Telephone: 03708 506506

Email: [enquiries@environment-agency.gov.uk](mailto:enquiries@environment-agency.gov.uk)

Website: <http://www.gov.uk/government/organisations/environment-agency>

### District Council



**Chiltern  
District Council**

#### Chiltern District Council

King George V House  
King George V Road  
Amersham  
HP6 5AW

Telephone: 01494 729000

Email: [info@chiltern.gov.uk](mailto:info@chiltern.gov.uk)

Website: <http://www.chiltern.gov.uk/flooding>



## Highways Authority

### Transport for Buckinghamshire

Telephone: Transport and roads – 0845 2302882

Out of hours emergencies (Highways) – 01296 486630

Email: [tfb@buckscc.gov.uk](mailto:tfb@buckscc.gov.uk)

Website: <http://www.transportforbucks.net/Transport-and-roads.aspx>

## Water Utility



### Thames Water

PO Box 286

Swindon

SN38 2RA

Telephone: 0845 9200 800

Website: <http://www.thameswater.co.uk/help-and-advice/16739.htm>

## Emergency Response

### Buckinghamshire Fire and Rescue Service

Address: Buckinghamshire Fire & Rescue Service, Brigade HQ, Stocklake, Aylesbury, Bucks, HP20 1BD

Telephone: 01296 744400

Website: <https://bucksfire.gov.uk/contact-us>

### Thames Valley Police

Telephone: 101 in non-emergency, 999 in emergency

Website: <http://www.thamesvalley.police.uk/contactus-phone.htm>

### Buckinghamshire Ambulance Service

Telephone: 111 in non-emergency, 999 in emergency

Website: <http://www.southcentralambulance.nhs.uk/content/press-release/buckinghamshire/flooding-advice.ashx>

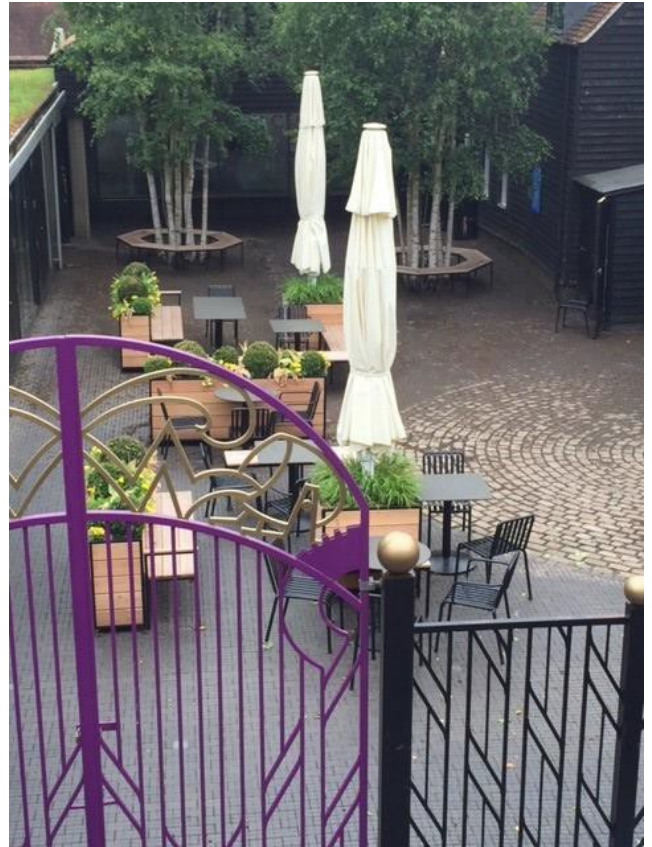
**Appendix E: Flood warnings and alerts**

Not applicable to this event as there are currently no warnings for surface water flooding available in Buckinghamshire.

**Appendix F: Photographs from flood incident investigation**



**Figure F1** Museum Courtyard



**Figure F2** Museum Courtyard Seating



**Figure F3** Museum Education Room



**Figure F4** Museum Staff kitchen



**Figure F5** Museum exhibition room



**Figure F6** Museum Exhibition room



**Figure F7** Museum exhibition room



**Figure F8** Back door flood protection at Arkwrights



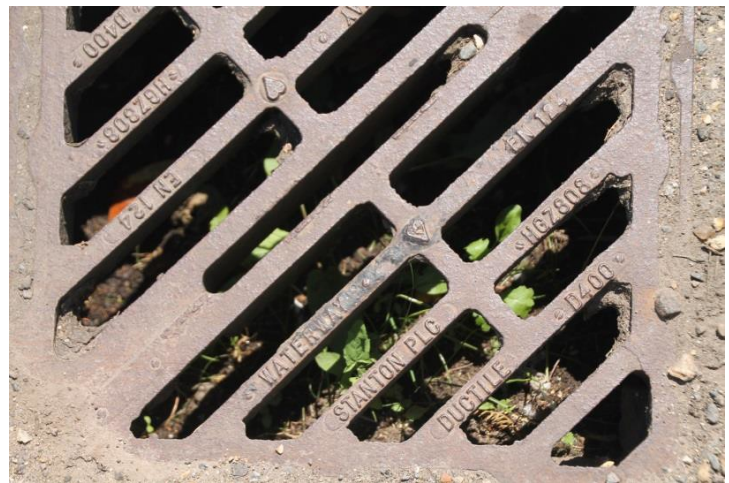
**Figure F9: Rignall Road May 2018 Flood**



**Figure F10: Rignall Road gully after June 2016 flood event silt accumulation**



**Figure F11: Rignall Road Flooded summer 2016**



**Figure F12: Silt and plant filled gully on Rignall Road summer 2016**



**Figure F13: Rignall Road flooding summer 2016**



**Figure F14: Silt in hall way Rignall Road May 2018**



**Figure F15: Flooded paddock Rignall Road May 2018**



**Figure F16: Flooded drive way Rignall Road to a depth of approximately 40 cm May 2018**



**Figure F17: Flooded duck enclosure Rignall Road May 2018**



**Figure F19: Flooded patio Rignall Road to a depth of approximately 30cm May 2018**

## **Appendix G: References**

British Standards Institute (2017) BS 85600: Post-event flood assessments — Guidance on investigating flooding incidents. London: British Standards Institute.

The Flood and Water Management Act (2010) London, TSO