2020 Flood Events:

Flood and Water Management Act

Section 19 - Investigation

Main Street and Bond End, Yoxall

This report has been prepared by Staffordshire County Council as Lead Local Flood Authority for Staffordshire County, under Section 19 of the Flood and Water Management Act 2010, with the assistance of Severn Trent Water and the Environment Agency.

This report is based on the information available at the time of preparation. Consequently, there is potential for further information to become available, which may lead to future alterations to the conclusions drawn in this report for which Staffordshire County Council cannot be held responsible.

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Executive Summary

When made aware of flooding, Staffordshire County Council (SCC), in its role as Lead Local Flood Authority (LLFA), has a duty to investigate the flood to determine the causes of the flooding and appropriate actions that may be undertaken by the relevant Risk Management Authorities (RMAs).

Several storms occurred across the Midlands region in 2020 that impacted many areas. These storms occurred as a result of European windstorms that became a series of extratropical cyclones bringing intense, short duration rainfall periods. In February 2020, a long duration, low-to-moderate intensity event, named Storm Dennis, led to severe weather warnings across much of Wales and the Midlands. causing widespread flooding nationwide. The event led to a severe weather warning over much of Wales and the Midlands. As a result, a significant number of flooding incidents were recorded across Staffordshire, and reported to SCC, including Main Street and Bond End, Yoxall, as well as nationwide.

SCC, in partnership with the Environment Agency, Severn Trent Water and appropriate Borough, District and Parish councils, have undertaken flood investigations in the areas where internal property flooding was reported, to determine the most likely cause of flooding (surface water flooding, flooding from rivers, flooding from sewer infrastructure, and/or flooding from highway drainage).

This report focuses on flooding associated with Storm Dennis that internally affected properties on Main Street and Bond End, Yoxall, on the 16th of February 2020. The investigation undertaken has been summarised, outlining the extent of flooding and flow routes reported, the most likely cause of the flooding, and the relevant actions that have been completed or are proposed to be completed in the future.

Introduction

Several storms occurred in the Midlands in 2020 that resulting in associated flooding to properties and highways in several locations across Staffordshire. As a result, SCC has undertaken investigations in the areas where flooding has occurred to determine the most likely cause of flooding (surface water flooding, flooding from rivers, flooding from sewer infrastructure, and flooding from highway drainage), in accordance with the 2010 Flood and Water Management Act.

This report focuses on the event that occurred in the Yoxall area on February 16th 2020 as a result of Storm Dennis. This report aims to provide an investigation into the identified extent, flow routes, and potential causes of the flooding in Yoxall, and to identify the next steps, if any, that need to be taken by the relevant RMAs.

Although this report specifically focuses on flooding in Yoxall, Storm Dennis flood related incidents resulted in more than 130 applications for grant support from residential and business properties across East Staffordshire. Many areas also experienced incidents in which five or more properties were internally flooded, reaching the criteria for a Section 19 investigation.

Lead Local Flood Authority

Following Royal Assent of the Flood and Water Management Act in 2010 (FWMA), Staffordshire County Council (SCC) became the Lead Local Flood Authority (LLFA) for Staffordshire. As such, SCC is responsible for the management of surface water food risk, groundwater flood risk and the flood risk from ordinary watercourses[1].

As LLFA, SCC is required to work in partnership with other agencies and authorities to manage flood risk. These agencies and authorities include, but not exclusively:

- Environment Agency, who hold responsibility for Main Rivers;
- Severn Trent Water, who hold responsibility for the public sewer network;
- Emergency service providers; and,
- Other public agencies and bodies.

Section 19 Requirements

The FWMA also places a duty on Lead Local Flood Authorities to investigate incidents of flooding. This is set out in Section 19 of the act and the investigations are therefore typically termed '*Section 19 Reports*.' The Act states:

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

a) Which risk management authorities 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.

[1] An ordinary watercourse is defined as any watercourse not designated as 'Main River,' i.e. watercourse that are not managed by the Environment Agency.

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.

It should be noted that not all flooding will require a formal investigation and report.
SCC has, set out in its *Local Flood Risk Management Strategy*[2], the process which will be used to determine to what extent it considers is 'necessary or appropriate' to investigate and what constitutes a significant flood event.

Stage 1 is an initial assessment, sufficient to ascertain with some confidence the extent of the flooding consequences. The second stage is to carry out a detailed investigation of the sites where it has been deemed necessary and appropriate. Reporting and publishing is the third, and final, stage. These stages may be described as: -

- Stage 1: Initial assessment
- Stage 2: Section 19 Investigation
- Stage 3: Section 19 Report and publish

It follows that there will be requirements for coordination and cooperation between RMAs at each stage and, where required, following the outcome of a Section 19 Investigation. This will be undertaken via day-to-day officer communication, and through the LLFA's governance process for flood risk management.

Flood Investigation Methodology

SCC will undertake/coordinate a Flood Investigation in accordance with Section 19 of the Flood and Water Management Act (2010) when one or more of the following thresholds are exceeded.

Consequence Staffordshire Flood Investigation Thresholds:

- Five or more residential properties are reported to have been internally flooded during a single flood event in one location;
- Two or more business properties are reported to have been internally flooded during a single flood event in one location, or;
- One or more items of critical infrastructure are reported to have been adversely affected during a single flood event in one location

SCC may investigate flooding outside these categories, but only when all outstanding issues with a higher priority have been considered. These guidelines set numerical thresholds, however, in recognition of the fact that all floods will be different; a certain amount of discretion will be required in order to implement this policy effectively. This policy only relates to how flood investigations will be prioritised and does not guarantee that any flood risk mitigation works will be installed at the locations where investigations are undertaken.

This report has been based on the number of reported incidents of flooding; however, it is likely that the actual number of incidents of flooding was higher than that reported.

This data is the best currently available and is being verified and quality checked for accuracy.

[2] https://www.staffordshire.gov.uk/environment/Flood-Risk-Management/Local-Flood-Risk-Management-Strategy.aspx

Investigation into Flooded areas

Step 1: During the Flood Event

SCC received a high number of calls during the event, which reported flooding of properties, gardens, and highways

During the flood event, the LLFA coordinated with multiple Risk Management Authorities (RMAs) to ensure that flooding was managed effectively and the risk to people and properties was mitigated as far as reasonably practicable.

Step 2: Initial Investigations

Using call records, flooding investigation questionnaires and site visits, the LLFA identified the locations where flooding occurred.

Responses were received, providing personal accounts of the flood event including the estimated time, duration, extent, and depth with any other information which was felt pertinent.

Following receipt of the Flood Survey responses, the LLFA identified areas where at least one property experienced internal flooding.

Step 3: Detailed Investigation and Analysis

The LLFA conducted detailed investigation and individual location analysis of each of the areas where a minimum of one property experienced internal flooding. It should be noted that SCC have defined internal property flooding as:

'Flooding that occurs in a habitable room within a single property, excluding garages, porches and underfloor ingress of water.'

These investigations typically included a review of existing infrastructure and topography, identification of predominant flow paths, site visits and local knowledge gathering.

Through a detailed analysis, the LLFA have identified the types of flooding that occurred at each location during the events of February 2020.

As a general rule, the LLFA does not undertake investigation of external flooding to garages, gardens, and highways due to limited resources and funding. Indeed, gardens often act as flood storage areas and highways can be designed to convey flood waters reducing the extent/level of internal property flooding.

Step 4: Recommended Actions

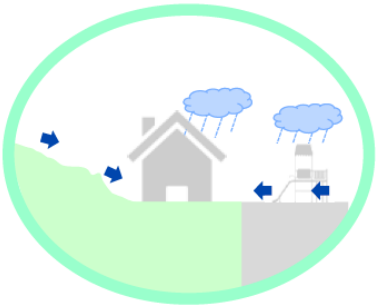
Following the analysis of the affected area, the LLFA have worked in collaboration with other RMAs to identify opportunities and options to mitigate the potential that a similar rainfall event will result in similar outcomes. These have been summarised as 'Recommended Actions' and a lead RMA has been identified to undertake these actions.

Types of Flooding

The following section explores the various types of flooding that may have been experienced during the event in February 2020.

Surface Water Flooding

Surface water is rainwater which is on the surface of the ground and has not soaked into the ground or entered a watercourse, drainage system or sewer. During a storm event, rainfall will land on the ground and depending on the characteristics of the ground it will behave in different ways.



Permeable surfaces, sometimes colloquially known as *'soft surfaces'*, allow water to soak (infiltrate) into the ground. These are typically in the form of gardens, parks, fields, and green spaces,

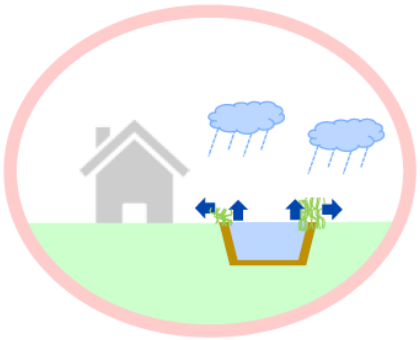
Impermeable surfaces, sometimes colloquially known as *'hard surfaces'*, do not allow any rainfall to soak into the ground and this rainfall will become (surface water) runoff. Runoff is usually very quick too. These are typically in the form of highways and roads, roofs, car parks and public squares.

Surface water flooding occurs under a number of circumstances, most commonly occurring when:

- There has been a prolonged period of rainfall and the permeable surface becomes saturated therefore no more water can infiltrate into the ground;
- The rainfall intensity is very high, and the rain is falling faster than it can infiltrate into the ground;
- There has been a prolonged warm dry period, the permeable surface may be baked hard and effectively turn the permeable surface into hard impermeable surface;
- It rains on impermeable surfaces, and there is no formal means of managing the rainfall;
- There is heavy rainfall on impermeable surfaces and surface water cannot enter the drainage system provided to manage rainfall as the system is at capacity.

During most storm events, the rainfall rate is low enough to allow surface water to soak into the ground or drain into formal drainage systems (e.g. gully pots). However, during an extreme event, where the intensity of the rainfall is high or there is an excessive volume of water, it is unable to soak into the ground or enter formal drainage systems and as such it will flow across a surface in an uncontrolled manner.

River Flooding



River flooding occurs when the amount of water in a river channel exceeds its capacity. This causes the water level in the river channel to rise above the riverbanks, where water flows from the channel into the surrounding area.

In terms of flood risk management there are two classifications of rivers/watercourses:

Main River; and ***Ordinary Watercourse***.

The Environment Agency holds responsibility for the management of flood risk on Main Rivers. All other watercourses, which are not specified as Main Rivers are termed Ordinary Watercourses. Flood risk management of these watercourses is the responsibility of the LLFA. However, in both cases, the riparian owner, that is anyone who owns land or property next to, or over, a watercourse, is responsible for maintenance of watercourse through their land.

River flooding occurs under several circumstances, most commonly occurring when:

There has been a prolonged period of rainfall and the river levels have risen due to surface water runoff and inflow from sewer infrastructure;

There has been a prolonged period of rainfall whereby permeable surface become saturated and the rate of surface water runoff increases thereby reaching the river faster;

There is heavy rainfall on impermeable surfaces and the provided drainage system conveys water to the river quickly;

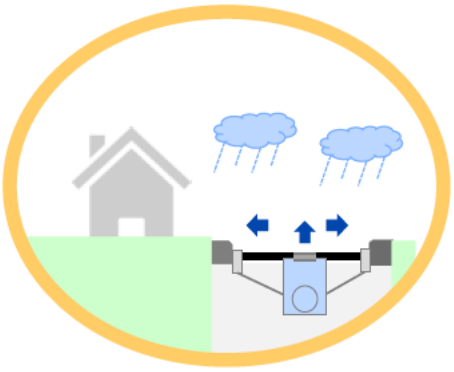
There are high flows within the river which become restricted by structures (e.g. bridges and culverts) which results in water levels upstream rising and spilling from the banks;

Sediment and debris building up in the river channel and reduces the capacity of the river channel causing flows to spill from the banks.

During most storm events, rivers are capable of conveying flows within their channels however, during an extreme event where the volume of water may be significant, flows may exceed the channel capacity and spill from the river in an uncontrolled manner.

Flooding from Sewer Infrastructure

Where rainfall falls on an impermeable surface, it will typically be served by a formal drainage system, most commonly this is a sewer.



There are different types of sewer, including:

Surface Water Sewers, that carry rainfall and surface water away from properties to watercourses.

Foul Water Sewer, that carry wastewater away from properties to be treated; and,

Combined Sewer, that drain both wastewater from properties along with runoff from highways, roofs, car parks and other sources. These systems were typically constructed up to the 1950s and hence are still found in historic areas of cities.

Flooding from sewer infrastructure occurs under a number of circumstances, most commonly when:

There is a blockage, or the sewer itself collapses, which restricts or prevents flow within the sewer network. This causes water to back-up through the network and find its way to the surface, typically through a manhole or associated drainage structure.

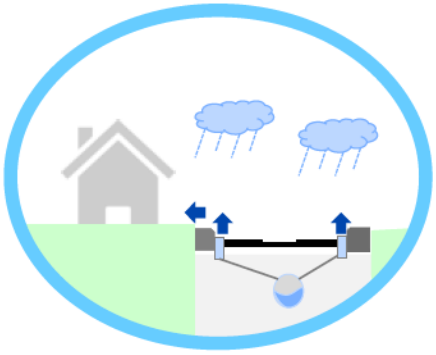
There is a period of heavy and/or prolonged rainfall, which results in significant flows that exceed the capacity of the sewer network. This prevents water from entering the sewer network and may result in surface flooding.

Severn Trent Water, as the sewerage company, is responsible for the operation and maintenance of the public sewers within the Staffordshire area.

Surface water and foul water sewers are currently designed in accordance with Sewers for Adoption (8th Edition, published 2018). This guidance states that sewers should have to capacity to deal with all runoff from a storm with a 3.33% or greater probability of occurring in any given year and not cause any above ground flooding. This guidance is relatively recent having been brought into effect in approximately the last 15 years. In addition, improvements in computer aided design and calculations also ensure designs are in agreement with the existing standards.

Therefore, at the time of construction of much of the sewer network across Staffordshire, the design standards may have been to accommodate a smaller storm event. The designs will likely have been done by hand and may have used “rules of thumb” to determine the required sizes. As a result, the drainage network is complex with some sewers able to accommodate storms well above current design standards and other sewers much lower. Thus, when a large storm event occurs, the existing drainage network (combined or surface water sewers) may be significantly overwhelmed.

Flooding from Highway Drainage



Highway drainage consists of gullies, drainage channels and other features which collect and drain rainfall away from the highway. These features are typically located on one, or both, side(s) of the highway where they connect to an underground highway drainage system which ultimately connects to the public sewer infrastructure.

Where rainfall falls onto the highway, this will enter the highway drainage system or flow within the highway channel until a point where it enters the system or ponds on the surface.

In new development, it is common practice to use highways to contain and convey heavy rainfall events away from properties, however historically this practice has not happened.

Across Staffordshire, properties can be seen at or below the level of the adjacent road. This means that should a carriageway not be able to contain the water flowing within it, flow will overtop the kerbs on the highway and spill over adjacent land into properties.
Flooding from highway infrastructure occurs under several circumstances, most commonly occurring when:

There is a blockage or build-up of surface debris in the vicinity of a gully, typically trash, leaves and twigs, which prevents, or restricts, the highway runoff from entering the gullies and subsequent highway infrastructure.

There is a period of heavy and/or prolonged rainfall, whereby the volume of rainfall falling onto the highway overwhelms the highway drainage features and is unable to be captured. The resulting flows are then conveyed or contained within the highway, until such times as the water level overtops the kerbs and flows overland into properties.

The sewer, culvert, or watercourse to which the highway drainage is connected is at full capacity and therefore the highway run-off has no-where to drain to.

Staffordshire County Council, in their role as the local highway authority, is responsible for the highway drainage and gullies across East Staffordshire Borough Council. This work includes maintenance of the highway drainage including roadside gully pots.

Flood Risk Mapping

Flooding is traditionally very difficult to predict, and while there are many local factors that influence flooding, there are a number of publicly available, national information tools which can enhance our understanding of the potential flood risks within a local area, more specifically risk of flooding from surface water and from rivers.

Surface Water Flood risk

In 2013, the Environment Agency, working with LLFAs, produced the Risk of Flooding from Surface Water map. This is the third national surface water map produced by the Environment Agency under their Strategic Overview role and is the first publicly available surface water flood risk map.

Storms are usually given with an annual probability or the chance of occurring in any given year. Typically, smaller storms have a higher probability of occurring in any given year and larger storms have a lower probability of occurring. However, the probability only describes the chance a storm will occur and not when. This means that if a large, low probability storm occurs, it can happen again soon after or can happen a long time after.

This mapping assesses surface water flood risk as a result of the chance of rainfall occurring in any given year, and is categorised into the following three scenarios:

High Risk: Flooding occurring as a result of rainfall with a greater than 1 in 30 chance in any given year or 3.3% chance that the storm will occur in a single year

Medium Risk: Flooding occurring as a result of rainfall between 1 in 100 and 1 in 30 chance in any given year or between 1% and 3.3% chance that the storm will occur in a single year

Low Risk: Flooding occurring as a result of rainfall between 1 in 1000 and 1 in 100 chance in any given year or between 0.1% and 1% chance that the storm will occur in a single year

Very Low Risk: Flooding occurring as a result of rainfall with less than 1 in 1000 chance in any given year or less than 0.1% chance that the storm will occur in a single year.

It should be noted that this mapping has been produced at national scale with a number of assumptions and therefore there are some limitations at a local scale and is not appropriate for identifying individual property level flood risk. This mapping is publicly available for use and is available online at:
https://flood-warning-information.service.gov.uk/long-term-flood-risk/postcode

Figure 1: Example of Environment Agency updated Flood Map for Surface Water Flooding

River Flood Risk

With regards to river flooding the Environment Agency publish the Flood Risk from Rivers or the Sea map. This shows the flood risk from Environment Agency Main Rivers and from the sea, taking into account any flood defences that may be present.

Storms are usually given with an annual probability or the chance of occurring in any given year. Typically, smaller storms have a higher probability of occurring in any given year and larger storms have a lower probability of occurring. However, the probability only describes the chance a storm will occur and not when. This means that if a large, low probability storm occurs, it can happen again soon after or can happen a long time after.

This mapping assesses flood risk from rivers or the sea as a result of the chance of rainfall occurring in any given year, and is categorised into the following four scenarios:

High Risk: Flooding occurring as a result of rainfall with a greater than 1 in 30 chance in any given year or 3.3% chance that the storm will occur in a single year

Medium Risk: Flooding occurring as a result of rainfall between 1 in 100 and 1 in 30 chance in any given year or between 1% and 3.3% chance that the storm will occur in a single year

Low Risk: Flooding occurring as a result of rainfall between 1 in 1000 and 1 in 100 chance in any given year or between 0.1% and 1% chance that the storm will occur in a single year

Very Low Risk: Flooding occurring as a result of rainfall with less than 1 in 1000 chance in any given year or less than 0.1% chance that the storm will occur in a single year.

This modelling is publicly available as the Environment Agency's Flood Risk from Rivers or the Sea map and is available online at:
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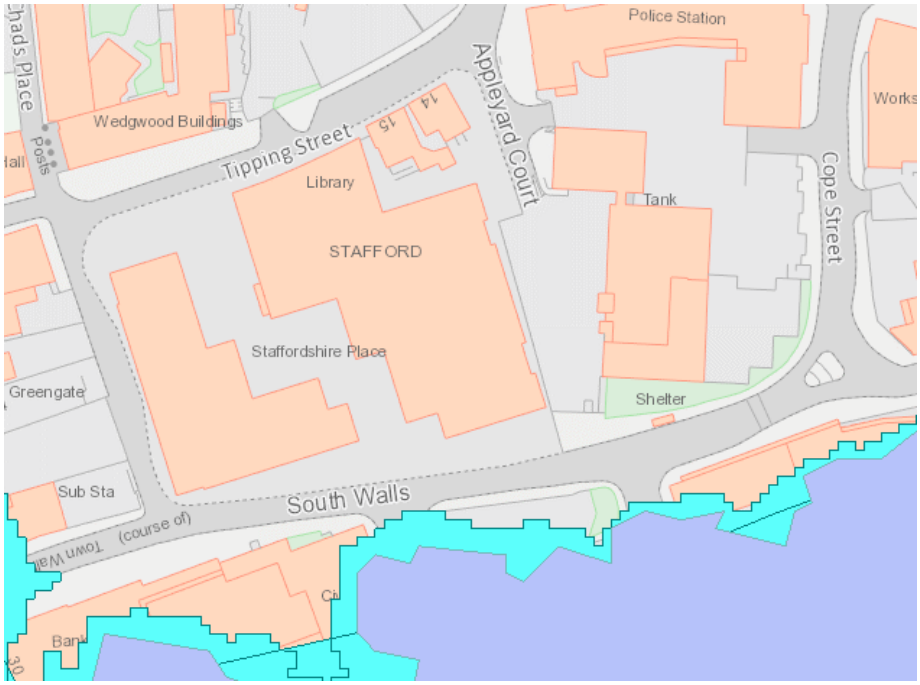

Figure 2: Example of Environment Agency River Flood Zones mapping

Analysis of Flooding Location

The following sections describe the flooding event that occurred at Main Street and Bond End, Yoxall, on 16th February 2020. The event has been assessed through the review of anecdotal evidence from local residents and through consultation with the relevant RMAs.

Event Background

Several storms occurred in winter 2019-2020 across the UK and the Midlands. The combined impacts of Storm Ciara and Storm Dennis resulted in exceptionally high rainfall totals across the UK, with associated flooding in several areas.

Storm Dennis (15th-16th February 2020) was the fourth named storm in the 2019/20 season, which arrived one week after Storm Ciara and brought with it heavy and persistent rainfall[3]. In the twelve and six month periods prior to Storm Dennis, Staffordshire had exceptionally high rainfall compared to the average (**Figure 4**). Rainfall in December and January was unremarkable. However, rainfall totals in February were exceptional, with February the wettest month in a series from 1862; the England figure was 258% of the long-term average (1981-2010). Crucially, soil moisture deficit from December 2019 through to February 2020 was generally practically zero/remained close to zero in Central England[3] (**Figure 5**). This means in the time running up to Storm Dennis there was generally little to no capacity within soils to drain or infiltrate rainfall. River flows in large rivers were also exceptionally high through February.

On 14th February, Storm Dennis developed off the west coast of Ireland, moving east, and arriving in England early afternoon. By mid-afternoon the front swept into Staffordshire and by late Friday night/early hours of Saturday morning this front had passed east out of Staffordshire. On Saturday 15th February a large front of rainfall developed in the morning and approached Staffordshire quickly, sustaining through to mid-day and continuing to remain over Staffordshire until early afternoon on Sunday 16th February. **Figure 6** shows radar-images of the rainfall across the UK. Through the rest of Sunday, the sustained/persistent rainfall moved over the rest of Europe, leaving scattered rainfall showers over Staffordshire through to Monday. For a more detailed account of Storm Dennis please refer to The Met Office[4] and Centre for Ecology and Hydrology[5].

[3] Met Office – Winter 2019/2020 https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/summaries/uk_monthly_climate_summary_winter_2020.pdf

[4] Met Office – Storm Dennis https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2020/2020_03_storm_dennis.pdf

[5] Centre for Ecology and Hydrology – Briefing note: Severity of the February 2020 floods – preliminary analysis https://nrfa.ceh.ac.uk/sites/default/files/Briefing_Note_V6.pdf

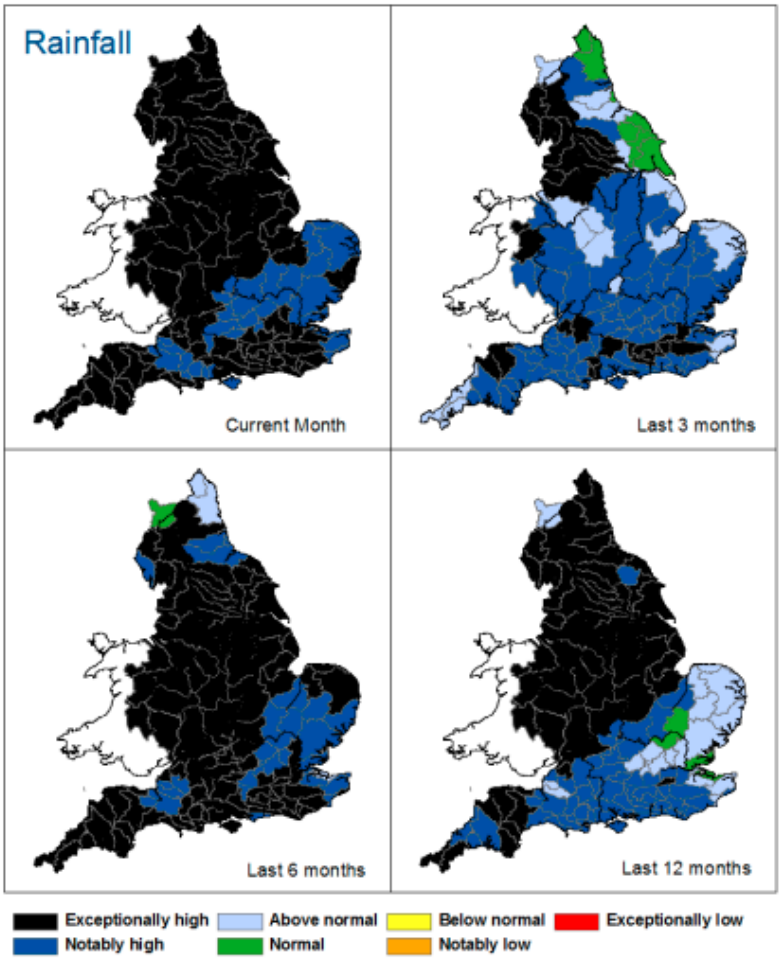

Figure 3: Total Rainfall Across England up to February 29th 2020 (Source: Environment Agency[6])

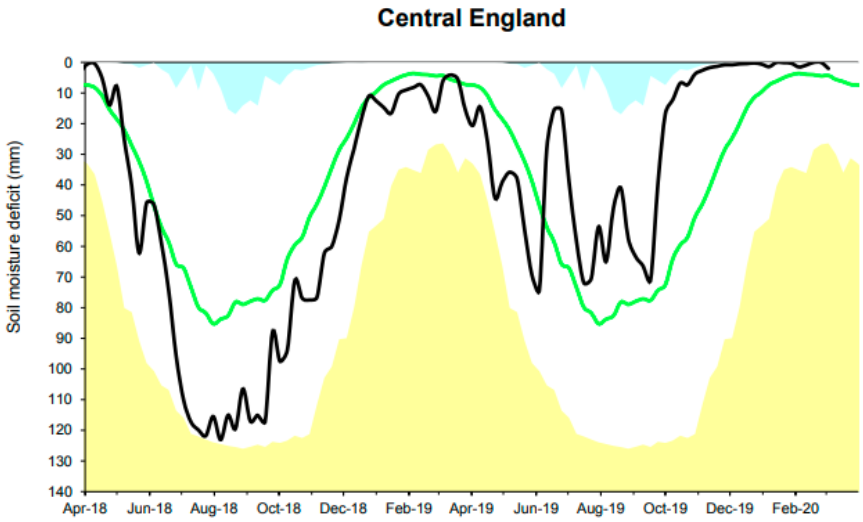

Figure 4: Central England Soil Moisture Deficit (Source: Environment Agency[6])

[6] Environment Agency – Monthly water situation report: England
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/871949/Water_situation_February_2020.pdf

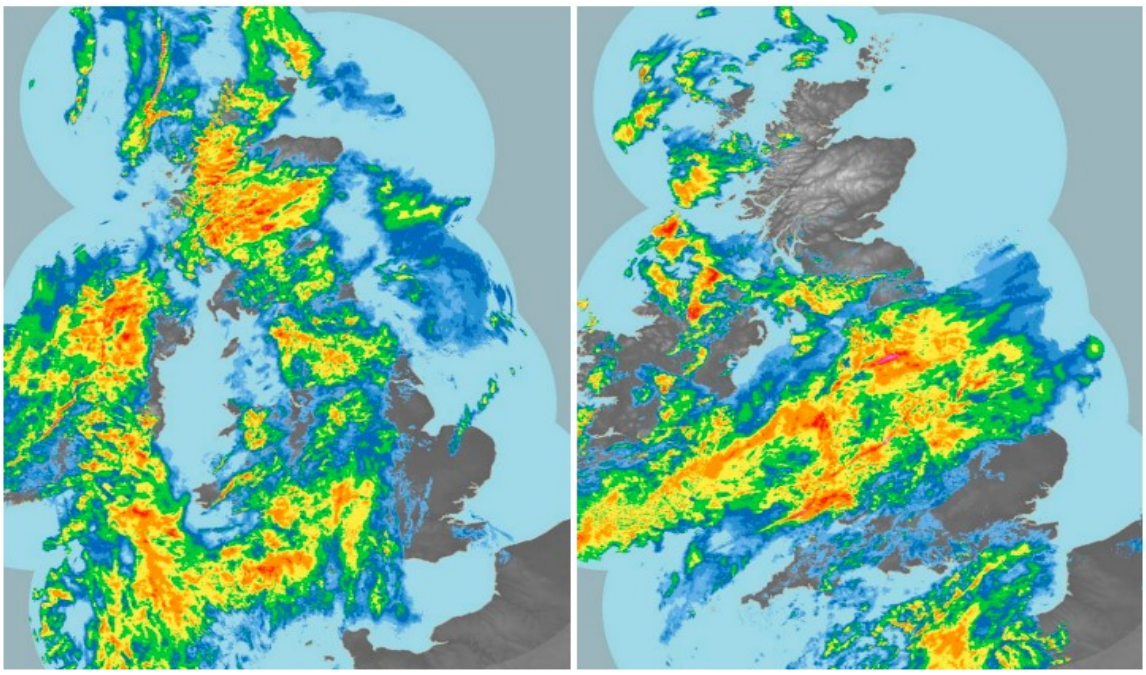

Figure 5: Rain-radar images at 12 UTC 15th and 00 UTC 16th February 2020 show the heavy and persistent rainfall from storm Dennis with the fronts sweeping across the UK (Source: The Met Office[4])

Location Background

Yoxall is a small village and civil parish in East Staffordshire, situated south-west of Burton-on-Trent and north of Lichfield (**Figure 7**). The village is located on the banks of the River Swarbourn. Main Street runs through the heart of the village and there is a collection of residential properties on the road as well as several convenience stores and a public house. At the heart of the village is Town Hill Bridge which is an early 19th Century brick bridge with three segmental arches. At the bridge there is a roundabout where Main Street diverges and becomes Bond End which continues the A515 south through the village and the B5016 heads east towards the small village of Woodhouses.

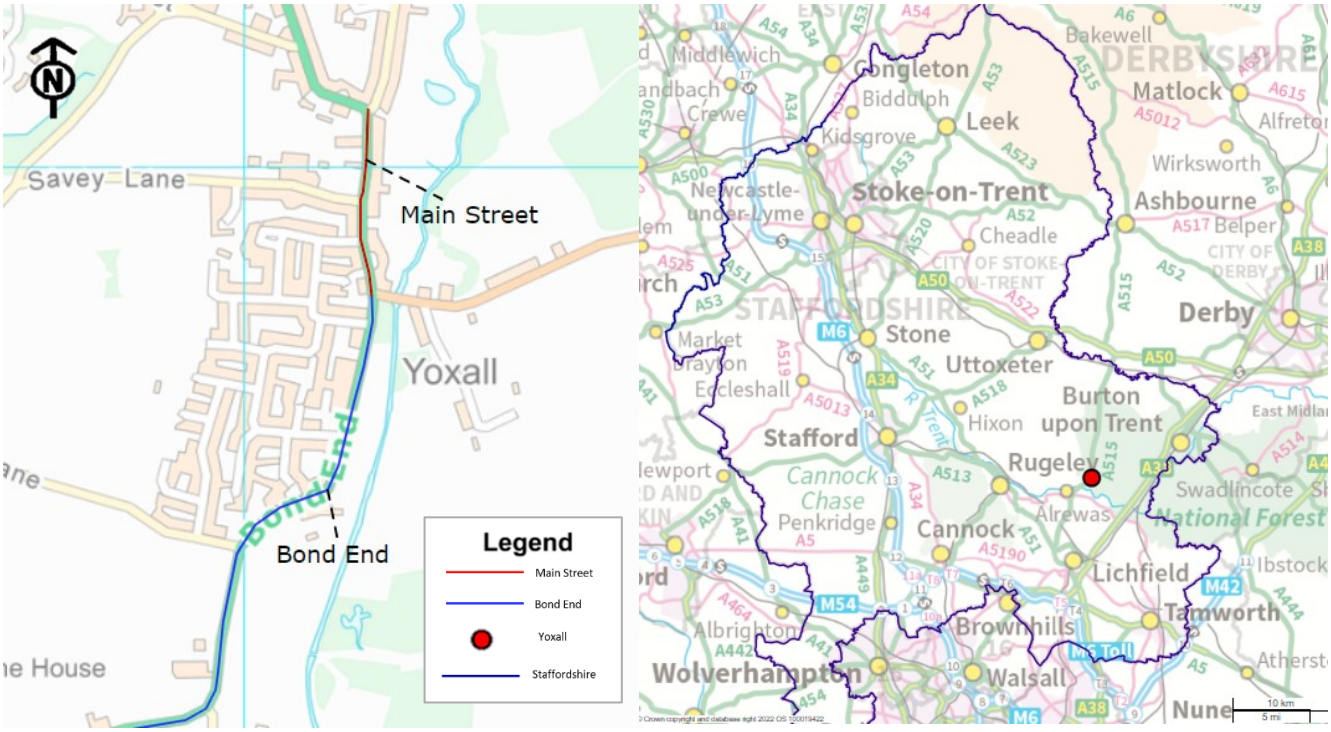

Figure 6: Location of Main Street and Bond End in Yoxall, East Staffordshire

Local Watercourses:

The River Swarbourn is 16km in length (9.9 miles) and flows predominantly in a southerly direction from its source just north of Newborough to its confluence with the River Trent. The stretch of watercourse that runs through Yoxall is designated as a main river and is thus the responsibility of the Environment Agency. As a result of Yoxall's close proximity to the River Swarbourn, the majority of the village is located within Flood Zone 3 meaning there is a 1 in 100 or greater annual probability of river flooding (>1%).

The catchment is largely rural, with moderately permeable soils and underlying geology. The Swarbourn and its tributaries (**Figure 8**), which include the Eland Brook, Mare brook and Lin Brook, drain a catchment area of 48km^2 (19 square miles). The river channel is predominantly natural, however there are several small weirs that control low flow water levels, primarily for fishing. The most notable structures are the Town Hill Bridge and weir at Town Hill Road that influence the flood levels in Yoxall. The Bond End Footbridge downstream of these structures also significantly impacts flood levels in Yoxall.

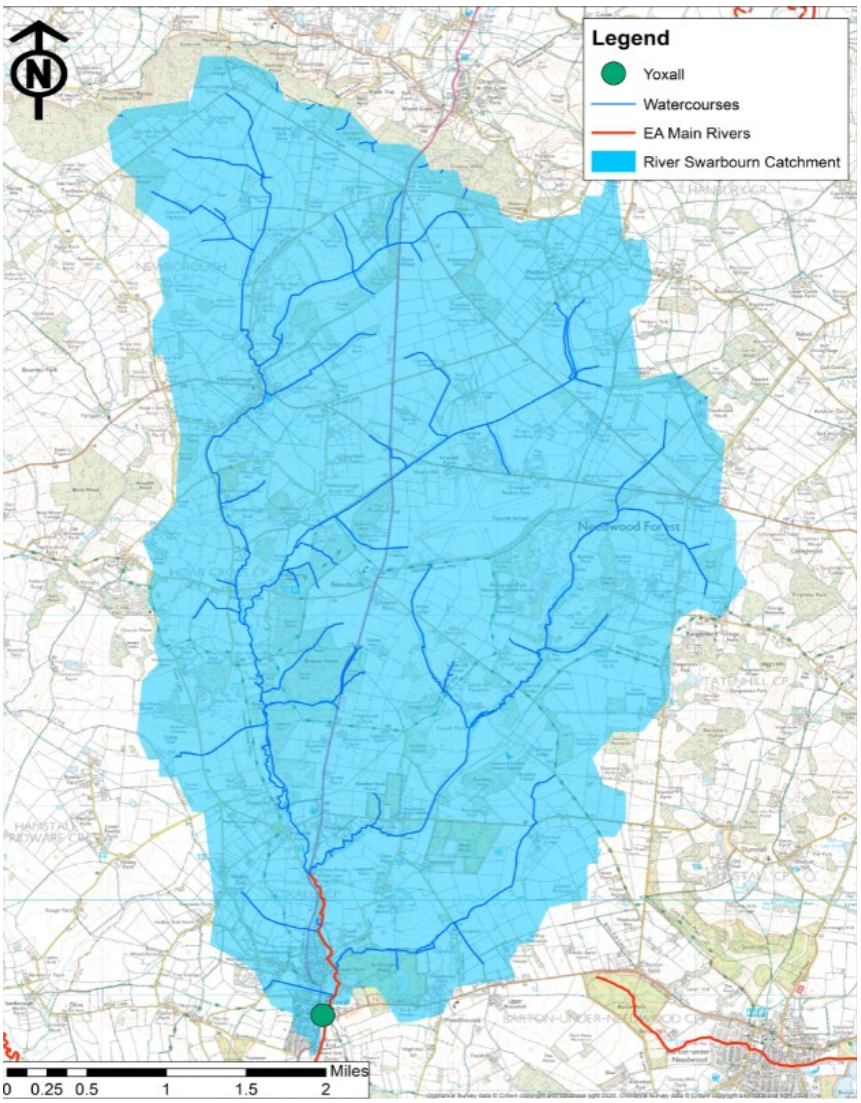

Figure 7: River Swarbourn Catchment in East Staffordshire that discharges through Yoxall (green dot)

Environment Agency Flood Maps:

From a flooding perspective, large parts of Yoxall are deemed to be at risk from flooding according to the Environment Agency Flood Mapping. **Figure 9** below displays the Environment Agency Risk of Flooding from Rivers and Sea (RoFRS; flood zone mapping) and Risk of Flooding from Surface Water maps for Yoxall. Large areas of Yoxall are at risk of surface water flooding (**Figure 9, A**) and fall within the 1 in 30-year Risk of Flooding from Surface Water (RoFSW) outline around the River Swarbourn (3.3% yearly AEP) along Main Street and Bond End, as well as highways into the residential area such as Savey Lane and Ferrers Road. Further highways and residential areas are within the 1 in 100-year (1% yearly AEP) and 1 in 1000-year (0.1% yearly AEP) RoFSW outlines. The flood zone map (**Figure 9, B**) shows parts of Yoxall, along Bond End and Main Street in Flood Zone 3 (FZ3, projected flood risk than 1% Annual Exceedance Probability AEP yearly) from the River Swarbourn, with areas of Flood Zone 2 (FZ2, flood risk between 1% and 0.1% AEP yearly) extending further west from Main Street and extending further east and west around Bond End.

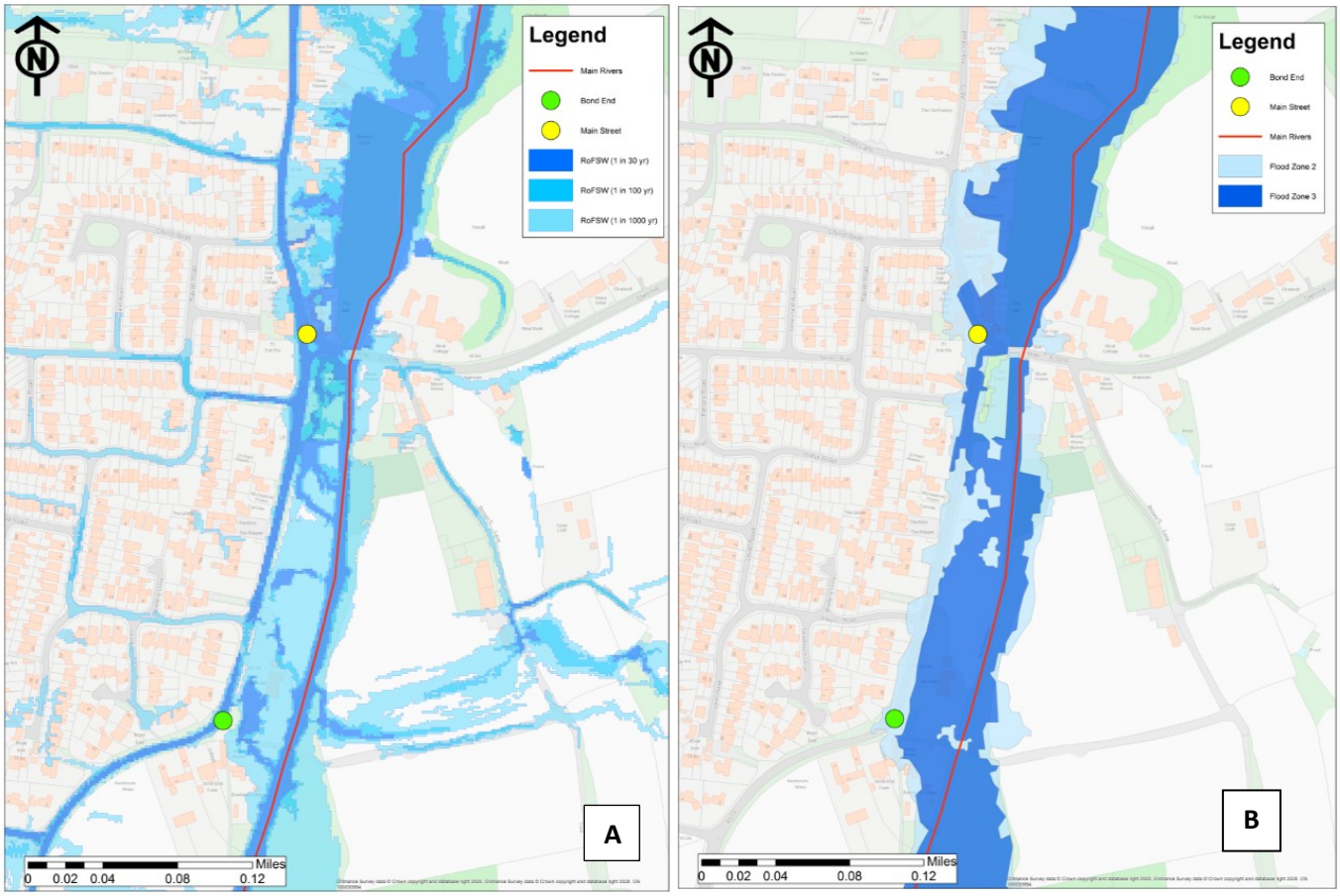

Figure 8: Environment Agency Risk of Flooding from Surface Water (RoFSW) extents (A) and Risk of Flooding from River and Sea (RoFRS) Flood Zones (B) along Main Street and Bond End, and the surrounding area, Yoxall

Public Sewer Network:

Main Street, Yoxall is predominantly served by a gravity fed foul sewer network which is owned and maintained by Severn Trent Water. Two gravity fed foul sewer networks run parallel through Yoxall, with one heading south down Main Street and the other running south underneath the floodplain of the River Swarbourn. The sewers then join and merge into a bigger 450mm gravity fed foul sewer which continues south running down the right bank of the Swarbourn where it meets a pumping station. The pumping station lies on a track adjacent to the A515, further down this track lies the Yoxall Sewage Works where ultimately the sewer network in Yoxall finishes up.

In winter 2019, Severn Trent Water completed a £1.8 million scheme to upgrade the existing sewerage system around Yoxall. The scheme provided new sewer pipes and two new sewage pumping stations for the area.

Highway Drainage Network:

The local highway drainage network comprises of traditional highway gullies and connections. A series of highway gullies connect into clay pipes and then run-down Main Street. The highway drains discharge into the River Swarbourn just downstream of the Town Hill Bridge, at an outfall which is also fed by a Severn Trent Water public gravity sewer for surface water. Staffordshire County Council highways department are responsible for the maintenance of this network of highway gullies and connections.

Historical Flooding in Yoxall

Yoxall has experienced notable flood events from the River Swarbourn in July 1922, 1953, August 1987, and November 2000. The 1987 and 2000 events caused extensive flooding to the centre of Yoxall that caused damage to properties and disrupted key local transport routes.

Information from residents identified one key concern relating to local flooding as blockages to the 3 arches of the Town Hill Bridge. It has been documented that during the 2000 flood one of the arches of the Town Hill Bridge became blocked with a fallen tree and this led to water backing up against the structure. The weir located near Town Hill Bridge reduces the flow of water and is also documented as having a negative effect on flooding in Yoxall and a factor during the 2000 flood incident by impeding river flows and increasing flood risks. Downstream of the bridge, the Bond End footbridge acts as another barrier to the smooth flow of water. Past the footbridge, the river becomes less well defined and meanders throughout the farmland that slows the flow.

Anecdotal evidence also suggests surface water flooding resulting from surcharging of the local drainage system may have had a notable impact on the extent of flooding observed. This was due to overland flow being unable to re-join the river due to the flow path being obstructed.

Subsequently to the flooding event in 2000, there are reports that Main Street experienced flooding in June 2007 and summer 2012. During the 2012 flood event, a commercial property at the junction between Main Street and the B5016 experienced flooding. However, there were no reports of internal property flooding during this event. Analysis of flood event data as part of the 2008 Hydraulic Modelling report for the River Swarbourn, commissioned by the Environment Agency and undertaken by Capital Symonds, estimates that both the August 1987 and November 2000 flood events were likely between a 1 in 20-year (5% Annual Exceedance Probability; AEP) and 1 in 50-year (2% AEP) return period flood event, whereas the June 2007 flood event is estimated between a 1 in 10-year (10% AEP) and 1 in 5-year (20% AEP) return period.

February 2020 - Flood Event Description

On the 16th of February, multiple properties in Yoxall reported that they had experienced internal flooding. Anecdotal accounts from residents describe flood waters entering properties in the early hours of Sunday February 16th, that corresponds with the peak River Swarbourn level on Sunday February 16th at 04:00hrs. Information suggests the flooding occurred from a variety of sources (**Table 1**) including surface water flooding and flooding from drainage, but predominantly from a river flooding exceedance event from the River Swarbourn.

Table 1: Identified types of flooding in Yoxall on February 16th 2020

Identified Flooding Types		
Surface Water	**River Flooding**	**Highway Drainage**
		

Records passed to us from the Environment Agency as well as East Staffordshire Borough Council (ESBC) indicate that 8 residential properties and 1 commercial property experienced internal flooding. Flooding of gardens, garages, summer houses and driveways were also reported. Flooding of the main roads through the village also resulted in these being unpassable until floodwater had receded that left some residents unable to leave their homes.

Figure 10 demonstrates the main flow routes observed during the 2020 events. Flood water from the River Swarbourn had risen onto the floodplain to the west of the channel in the early hours of 16th February 2020 ultimately leading to several properties on Main Street becoming internally flooded. Water had begun to back up against the Town Hill Bridge, that acted as a significant constriction mechanism to the River Swarbourn channel, in the late hours of February 15th and began to spill out from the channel into the gardens on Main Street in the early hours of February 16th. As heavy rainfall continued, flood water continued to inundate gardens and ultimately led to several properties on Main Street experiencing internal ground floor flooding.

Reports also suggest that a combination of surface water and river flood water had started to pool at the roundabout by the Town Hill Bridge, at the junction between the A515 and the B5016, and this flood water subsequently flooded the commercial property. This continued to flow down Main Street, where it was eventually discharged back into the River Swarbourn at the Severn Trent Water outfall approximately 150m downstream of the Town Hill Bridge.

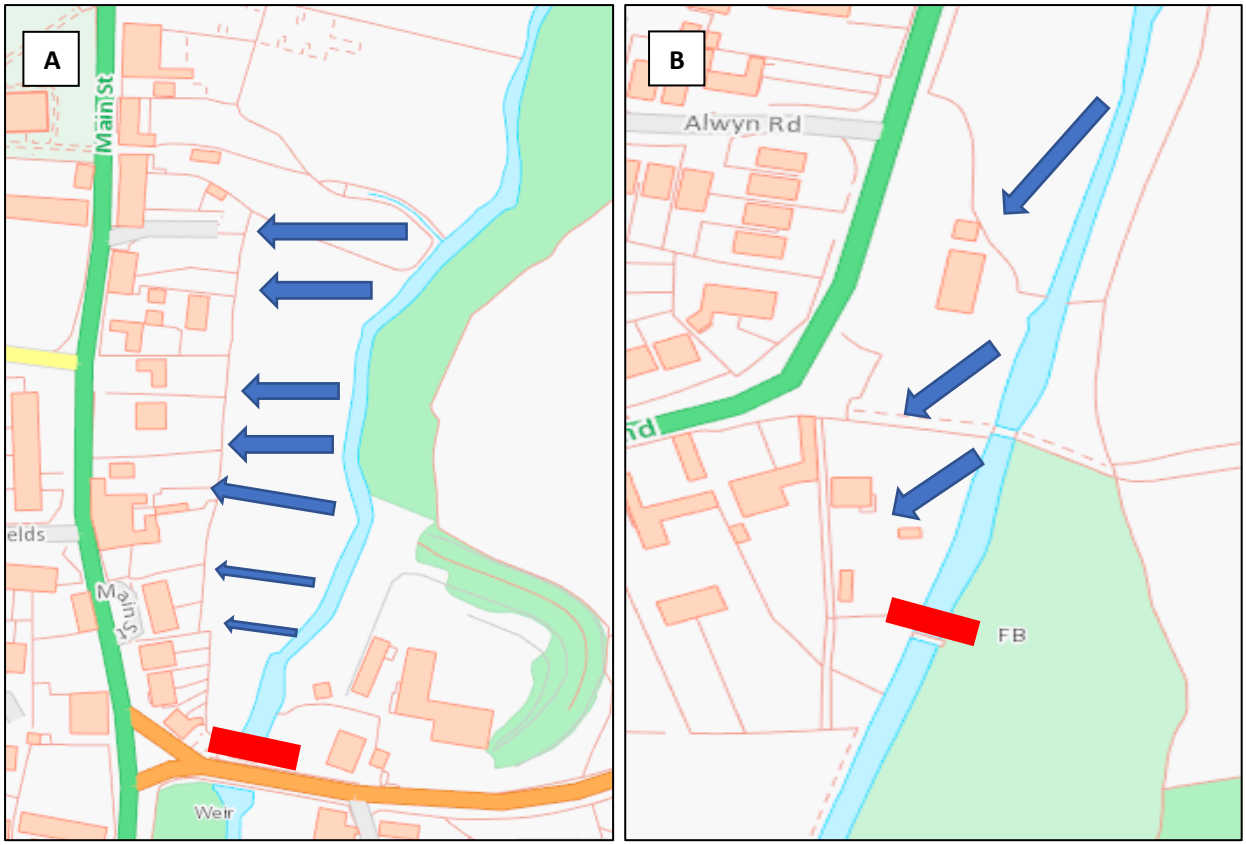

Figure 9: A) Flow routes (blue arrows) of floodwater into properties on Main Street with the Town Hill Bridge shown in Red that constricted and backed up flow and B) flow route (blue arrows) of flood water into properties on Bond End Street with Bond End Footbridge shown in red that further constricted flow

The floodwaters that were discharged back into the River Swarbourn created further problems downstream. River levels remained extremely high and continued to rise downstream as surface water and floodwaters found their way back into the River Swarbourn. Like the Town Hill Bridge, the Bond End Footbridge acted as another significant constriction in the channel that water backed up against. This resulted in water overtopping the channel and inundating several properties at Bond End internally during the early hours of February 16th, 2020.

Property owners in Yoxall describe flood depths within their dwellings as ranging from 5 to 24 inches (approximately between 12cm and 60cm). This internal inundation also led to many reports of properties experiencing damp issues and mould growth within the dwelling after the event. These impacts were also accompanied by internal property damage to carpets, flooring, furniture, and irreplaceable personal items.

Flood Incident Response:

Yoxall is covered by the River Swarbourn Flood Alert and has two Flood Warning Areas which cover Main Street and Bond End. The Flood Warning for the River Swarbourn at Yoxall was in force during the February 2020 flood event. It was issued at 03:35 on 16/02/20 and was removed at 10:50 on 16/02/20.

During the flood event, calls were received by Staffordshire County Council and East Staffordshire Borough Council by residents that were internally flooded and worried about their flood risk.

In the days following the event, the Environment Agency conducted a site visit in Yoxall and collected reports of flooded properties. The Environment Agency also noted that sandbags appeared to be placed outside several properties on Main Street. However, due to the number of flooding incidents across the East Midlands, and several in East Staffordshire, the Environment Agency noted that there was not enough time to speak to, and collect full reports from, residents in Yoxall. This meant that the extent of flooding in Yoxall was not realised until after the event when East Staffordshire Borough Council started collecting information from residents to process Flooded Property Claims to help fund repairs for flood damages.

In total, East Staffordshire Borough Council received more than 130 applications for grant support from residential and business properties across East Staffordshire. By the end of the scheme, the DEFRA Property Flood Resilience grant scheme and ESBC will have provided grants to approximately 86 properties that equals an approximate value of £370,840 across the Borough.

Investigation

Following the flood event, Staffordshire County Council (SCC) as LLFA has worked in conjunction with the relevant RMAs to obtain data to help understand what happened in Yoxall on February 16th 2020.

The flooding in Yoxall has been identified as river flooding, surface water flooding and flooding from highway drainage becoming overwhelmed. However, the main driver of this flooding event was floodwaters rising from the River Swarbourn. Weeks of sustained rainfall prior to the event had swelled the River Swarbourn to the extent that it topped its banks, and therefore surcharging of the local drainage system was not thought to be a major contributing factor during the event.

Rainfall Event:

On the 15th and 16th of February, Storm Dennis generated a severe weather warning over much of the Midlands. The Storm Dennis event has been characterised as a long duration, low to moderate intensity rainfall event that spread over a large catchment and is typical with winter rainfall storm events. **Figure 11** below shows the recorded 15-minute rainfall for Yoxall from February 15th to 18th.

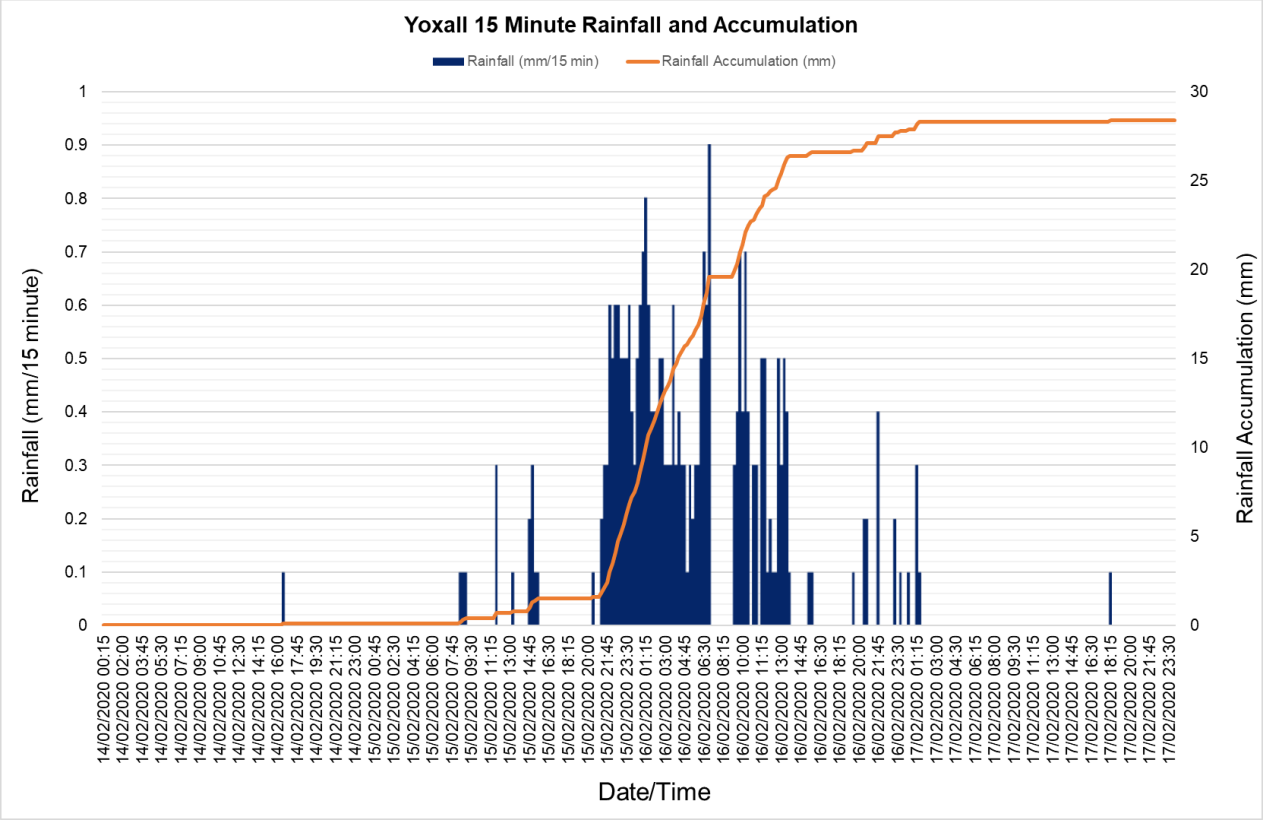

Figure 10: Recorded 15-minute rainfall (mm) totals for Yoxall between the 15th and 18th of February 2020. Source: HydroMaster software

A total of 28.3mm was recorded during this period, with 24.8mm recorded during a 17-hour period between 21:15hrs on February 15th and 14:15hrs on February 16th. The 24-hour storm duration return period has been identified as just below a 1-year event by Hydromaster software. Although this presents the event as unexceptional, the average rainfall for February (1981-2010 baseline) for the area, recorded by the closest Staffordshire Met Office climate station in Denstone, is 62.1mm. Therefore, more than 50% of the monthly rainfall fell in the Yoxall area within two days making it significant to the area.

DEFRA Environment Agency rain gauge data for the gauges located nearest to Yoxall also show significant volumes of rainfall was recorded during the event. Byrkley Park rain gauge, approximately 5.4km north-east of Yoxall, recorded rainfall values of 11.2mm on February 15th and 29.4mm on February 16th, with peak rainfall between 21:30 on February 15th and 04:30 on February 16th (**Figure 12**). At Blithfield rain gauge, approximately 9.1km north-west of Yoxall, 38mm were recorded over the two-day period of February 15th and 16th, with peak rainfall of 32mm (of the total 38mm) recorded between 20:00hrs on February 15th and 07:00hrs on February 16th. This is calculated as a 3-year rainfall event by the FEH rainfall calculator. This data indicates that close to 40mm of rainfall fell in the area surrounding Yoxall and the Swarbourn catchment prior and during the flood incident, whilst the ground was already saturated and river levels raised from Storm Ciara the week prior.

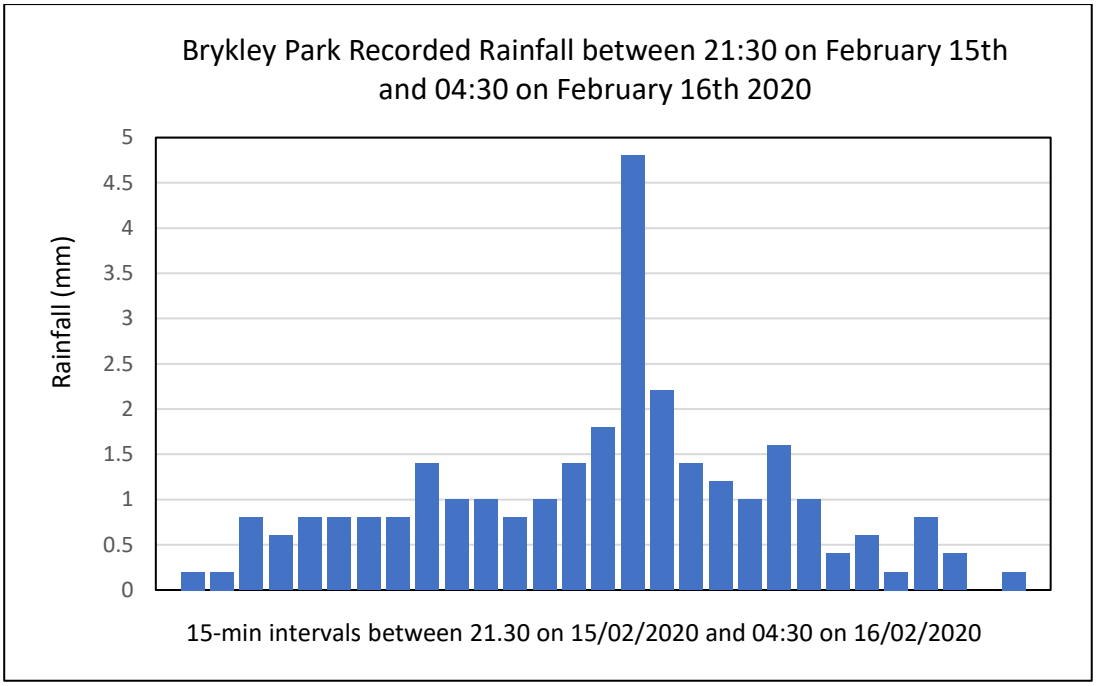

Figure 11: Rainfall (mm) between 15/02/2020 21:30 and 16/02/2020 04:30 at Byrkley Park Rain Gauge

Watercourses:

The intense periods of rainfall that occurred across Staffordshire caused many watercourses in East Staffordshire to record their highest levels since records began. This includes the highest level ever recorded for the River Swarbourn at Hoar Cross monitoring station, upstream of Yoxall, of 1.91m on February 16th 2020 at 05:00hrs (**Figure 13**).

From the 2008 River Swarbourn Hydraulic Modelling report, a developed rating curve for the River Swarbourn calculates the flow for 1.91m river level (stage) as approximately between 15 and 16m^3/s. Estimated return periods for the rating curve identify a 5% AEP event, or a 20-year return period, as 16.1m^3/s This indicates that the event was, if not very close to, a 5% AEP event. The hydraulic modelling data has a short range from 2001 to 2008, when the report was published, that suggests a limited confidence in the rating curve output. However, the modelled results for the 2007 flood incident that estimated the event as between a 20% and 10% AEP reasonably matches the anecdotal evidence from the event in relation to the soffit of the central arch of the Town Hill Bridge.

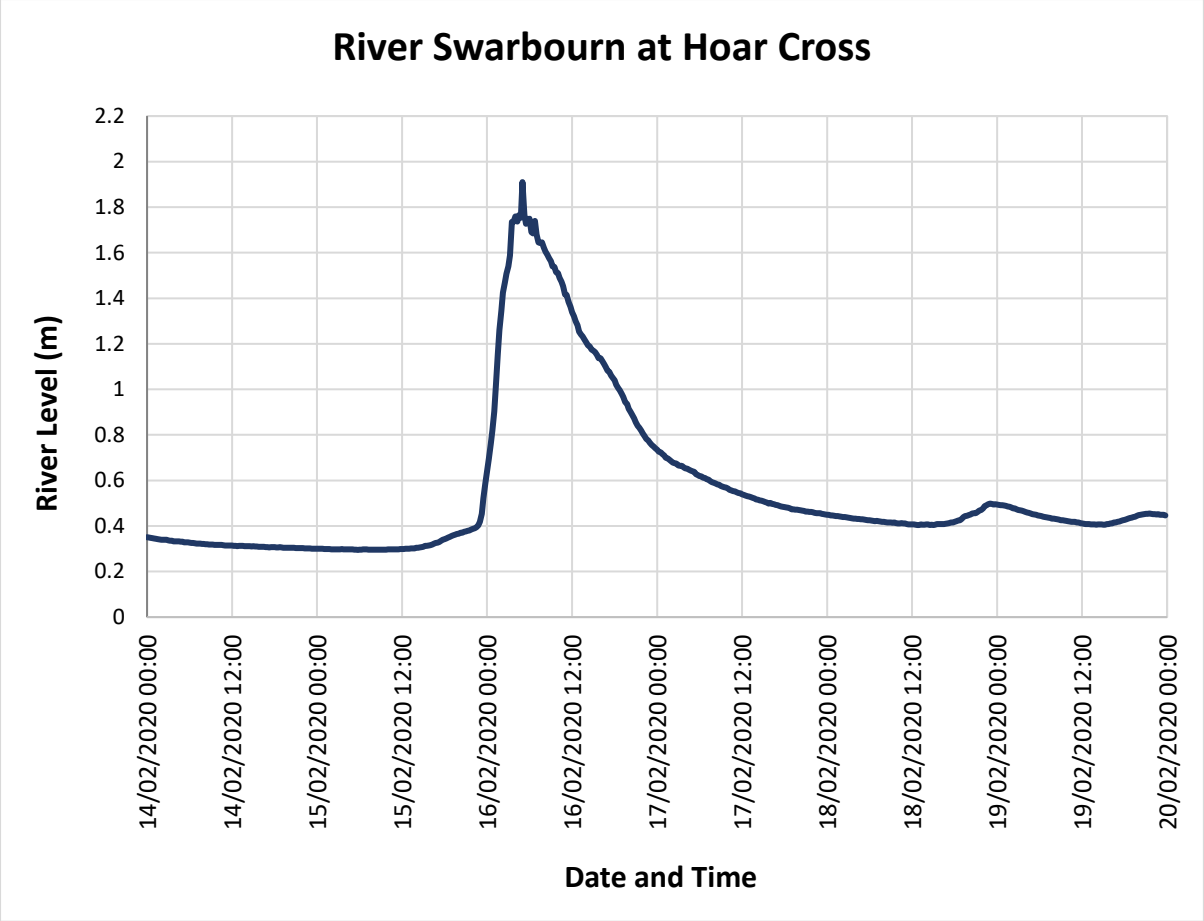

Figure 12: River Swarbourn levels recorded between February 14th and 20th 2020 at the Hoar Cross monitoring station that identifies the highest recorded level of 1.91m since records began at 05:00hrs on February 16th. Source: Environment Agency WISKI (Raw Water Resources Monitoring Data) service

ReFH software has also been used to create a hydrograph from observed rainfall and catchment characteristics, as well as modelled hydrographs for design storms of different return periods. The resulting hydrograph is available in **Figure 14**. This shows rainfall from February 14th to 19th 2020 and identifies peak rainfall at 06:55hrs on February 16th that resulted in responding levels from the River Swarbourn with a peak discharge of 8.1m^{3}/s at 16:15hrs on February 16th. Comparison of modelled peak flows has calculated the return period of this River Swarbourn event as less than a 1-year return period.

Yet, while ReFH modelling has calculated the flow, it may have underestimated the antecedent conditions and the saturation of the catchment that increases run off and overland flow rates of rainfall entering the River Swarbourn. The software may also have underestimated the levels already in the River Swarbourn, leading up to Storm Desmond event. For instance, the 2008 Hydraulic Modelling report identifies that the levels in the River Swarbourn at the Hoar Cross monitoring station remain consistently above 0.2m for the length of the record and was recorded prior to the increase in river levels from February 14th to 16th (**Figure 13**).

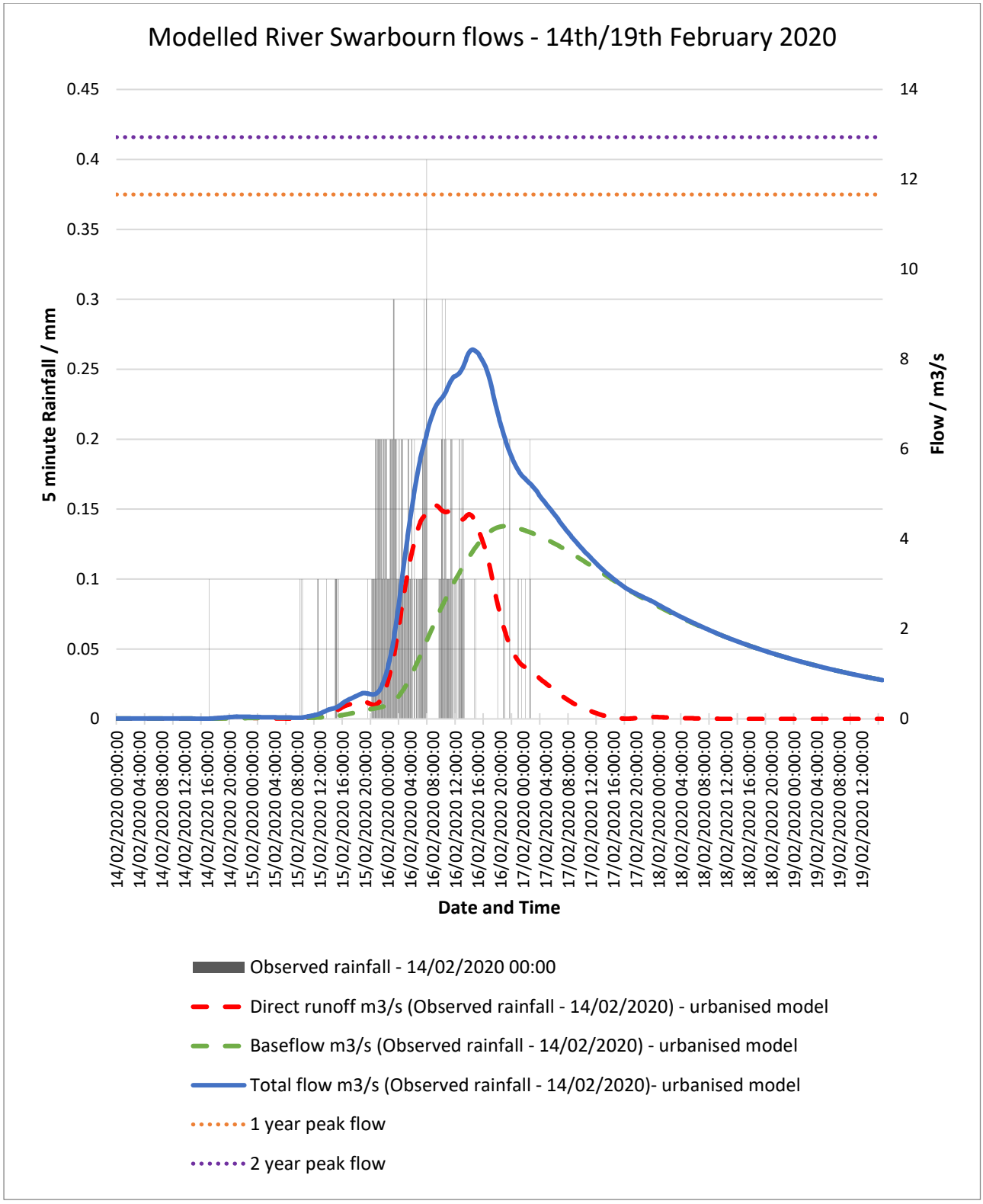

Figure 13: Modelled ReFH hydrograph of observed rainfall and modelled response on River Swarbourn levels between February 14th and 19th 2020. The results indicate a return period of less than 1-year peak flow. Source: HydroMaster software

Therefore, while this is a useful tool to identify the amount of rainfall during the Storm Dennis and response by River Swarbourn levels in Yoxall, rainfall may not have been the entire driving factor of flooding and the previous saturation event across the Swarbourn catchment and antecedent conditions leading up to the event are key factors of the flooding event.

Further, restrictions on the channel capacity of the River Swarbourn to convey flows through Yoxall may have played a part in the February 2020 flood incident. The 2008 Hydraulic Modelling report identified the main flooding mechanisms in Yoxall, which appear to be consistent with the flooding seen in February 2020. At the Town Hill Bridge, flood water backs up against the structure and this was outlined as the main flood mechanism that leads to properties on Main Street flooding. As well as water backing up against the bridge, it is noted that there is insufficient channel capacity to convey flows during a 5% AEP flood event (1 in 20-year return period). The calculated flow and rating curve devised from the 2008 Hydraulic Modelling report identifies this event as approximately, if not close to, a 5% AEP event and therefore is consistent with this anecdotal evidence that the channel is unable convey flows of this magnitude. A similar mechanism is noted at Bond End where water can back up against the Bond End Footbridge and spill out to affect properties at Bond End. This mechanism was seen during the February 2020 flood incident. The channel is also reported to have an insufficient capacity to convey flood waters in this area during a 2% AEP flood event (1 in 50-year return period).

Consultation with the Staffordshire County Council (SCC) Highways team has identified that no blockages or obstructions of the Town Hill Bridge were reported during the February 2020 event, which was a key factor during the serious flood event in November 2000 when a branch was suggested to have blocked one of the arches. The bridge is inspected by the Highways team every two years and there has been no record of any recent blockages, with the Town Hill Bridge documented in May 2019 showing no blockages (**Figure 15**). However, it is noted that by the Highways team that a large tree could easily become grounded and butt up against the bridge, so further inspections of this should continue in the future. High River Swarbourn levels were also experienced at the Town Hill Bridge during Storm Christoph in January 2021 (**Figure 16**). However, the river levels remained below the soffit level of the bridge, and no blockages were reported.

It was also agreed following consultation with the Environment Agency and SCC Highways that the weir upstream at the north elevation can worsen flooding events in Yoxall, previously being noted as a key factor in the November 2000 flood event. Weirs have a significant impact on the flow regime both upstream and downstream and this problem can be heightened during high rainfall events. During high rainfall events weirs can cause increased water levels, depth, and flow width along with reduced flow velocity. This is a known problem at Yoxall and was likely a factor during the February 2020 event.

Figure 14: Town Hill Bridge in May 2019 showing no blockage prior to February 2020 Flood Event

Figure 15: High river levels at Town Hill Bridge during Storm Christoph, January 2021

Like the Town Hill Bridge, the Bond End Footbridge (**Figure 17**) acts as another significant constriction in the channel that water can back up against. This was also acknowledged in the 2008 Modelling Report. Additionally, It is noted that this stretch of the River Swarbourn also has insufficient capacity to convey flood waters during a 2% AEP event (1 in 50-year return period). This mechanism of flows backing up against the Bond End Footbridge, and record flow levels in the River Swarbourn in the February 2020 event, resulted in several properties in Bond End flooding internally during the early hours of February 16th, 2020.

Figure 16: Bond End Footbridge photographed in 2021 during a period of typical flow on the River Swarbourn

We conclude that the flooding event in Yoxall during Storm Dennis in February 2020 was the result of an exceedance event caused by a prolonged period of rainfall in the weeks prior and an already saturated catchment. This ultimately meant that the River Swarbourn could no longer convey the vast amount of water draining into it from the surrounding catchment and thus water levels on the River Swarbourn rose to record levels and flooded the surrounding land including several residential and commercial properties in Yoxall. At the following structures in the channel: The Town Hill Bridge, the Bond End Footbridge and Weir, no significant blockages at these structures were found to be a major cause during the February 2020 event unlike in the 2000 flood event. However, the structures continue to allow flood waters to back up against them in periods of extended rainfall and thus exacerbate flooding in Yoxall.

No previous investigations undertaken by the Environment Agency for flood alleviation in Yoxall has identified any feasible solutions. A new initial assessment of potential solutions, that will consider options such as Natural Flood Management (NFM), Property Flood Resilience (PFR), maintenance and improvement work, is being considered by the Environment Agency for the current programme of works from April 2021 to 2027.

Surface Water:

While the main factor of flooding in Yoxall has been identified as river flooding, surface water flooding was identified to have started to pool at the Bond End and Mainstreet junction (A515) and Town Hill (B5016). Surface water is also identified to have flowed down Savey Lane towards the Bond End and Main Street junction. These surface water flows followed the prevailing topography of the area and may have exacerbated river flood waters that were directed into gardens and properties in Yoxall.

Highway Drainage:

Evidence shows that highway drainage infrastructure on Bond End and Main Street became overwhelmed and resulted in some potential surcharging. The main roads in the village became unpassable to some residents, with members of the public unable to leave their properties until flood water had receded. Issues with potentially blocked gullies along Savey Lane may also have been a factor in conveying surface water towards the Bond End and Main Street junction. However, the main factor of flooding in Yoxall has been identified as river flooding, and while some surcharging of the local drainage system may have occurred during the event from the added ingress of River Swarbourn flows larger than the system capacity, this was not thought to be a major contributing factor during the event.

Recommended Actions

As part of this flood investigation, it is also important to establish a set of recommended actions that may help to alleviate flooding and reduce risk to properties in the future. Some of the actions will focus specifically on Main Street and Bond End, Yoxall, whilst other actions are relevant to the wider catchment. **Table 2** below outlines a variety of recommended actions that could help to alleviate flooding risks in Yoxall.

Before discussing recommendations for Yoxall following the February 2020 flood event, the flood alleviation options suggested in the 2008 River Swarbourn Modelling Report, commissioned by the Environment Agency, are included here for discussion. The report included some 'hard engineering' options such as widening of the channel in the river section upstream of the Town Hill Bridge, and/or widening of the channel upstream of the Bond End Footbridge. However, this option was dismissed due to it being unlikely to significantly reduce flooding, as well as requiring significant works and disruption for only minimal benefit.

The removal of the Town Hill Bridge and Bond End Footbridge, the structures that strongly influence the flood levels in Yoxall, were also discussed. Although this method would likely significantly reduce flood levels in Yoxall as the constrict River Swarbourn flows, removing the structures is not economically feasible and would require very intensive construction and demolition works. Furthermore, the Town Hill Bridge is a grade 2 listed structure that results in added conservatory constraints for this proposal.

The Environment Agency are looking to include a new initial assessment of potential solutions on their April 2021 to 2027 programme, that will consider flood alleviation options such as NFM, PFR, maintenance and other improvement works such as those in Table 2.

Table 2: Recommended actions for RMAs following the February 2020 flooding in Yoxall, East Staffordshire

Issue/Risk	Recommendations/Actions	Responsible RMA
The Town Hill Bridge becoming blocked with debris	Current inspection of the bridge is undertaken every two years should continue as normal. SCC Structures Team to explore the possibility of performing a special inspection of the Town Hill Bridge following flood events on the River Swarbourn as large debris can become trapped during a flood event. This would enable a record of blockages at the structure during flood events, with associated actions taken to reduce this if there is a resulting high likelihood.	Staffordshire County Council (SCC) Highways

The Bond End Footbridge becoming blockage with Debris	Current inspection of the bridge is undertaken every two years should continue as normal. SCC Structures Team to explore the possibility of performing a special inspection of the Bond End Footbridge following flood events on the River Swarbourn as large debris can become trapped during a flood event. This would enable a record of blockages at the structure during flood events, with associated actions taken to reduce this if there is a resulting high likelihood.	SCC Highways
Removal of the upstream Weir	Further investigation to remove the upstream weir to help prevent water backing up against it during a flood and allowing flood waters to pass through the system more efficiently. It would be vital to consult SCC Structures team to assess any impacts the removal may have on the bridges, especially Town Hill Bridge.	Environment Agency (EA) / SCC
Flooding from the River Swarbourn including condition of the channel	The Environment Agency should continue to review the area to provide a new initial assessment of potential solutions to reduce flooding from the River Swarbourn within their 2021 to 2027 programme. This may include, but is not limited to, NFM, PFR, maintenance of the channel with an investigation into the current condition of the watercourse, as well as other improvement works.	EA
Hydraulic Modelling of River Swarbourn at Yoxall	The EA could consider updating the 2008 River Swarbourn Hydraulic Model and re-evaluate the Flood Alleviation Options considered in the modelling report.	EA / East Staffordshire Borough Council (ESBC)
Maintenance of highway drainage infrastructure on Main Street and Bond End	The condition and capacity of the highway drainage network should be assessed to investigate the effectiveness of highway gullies. Maintenance schedules should be reviewed, and opportunities to increase frequency of maintenance and/or incorporation of additional maintenance tasks should be explored.	SCC Highways
Property Flood Resilience (PFR)	Opportunities to provide PFR should be explored to establish whether potential resilience measures may be appropriate for property owners. This should include investigating any measures that have previously been installed to assess their effectiveness.	East Staffordshire Borough Council (ESBC) / SCC
Yoxall Catchment becoming saturated due to antecedent precipitation	Opportunities for Natural Flood Management (NFM) measures in the Yoxall Catchment to help slow down the flow of water into Yoxall village during extended periods of rainfall should be explored.	SCC / Landowners

Engage with local Yoxall community on flood risk	All relevant RMAs to engage with the local community in a coordinated matter to make residents aware of their risks to flooding. This includes considering any appropriate or possible improvements to the existing Flood Warning Service (FWS). To help improve the FWS, residents or other RMAs who may have recorded flood levels or photographic evidence of flood events to help check warning triggers are asked to provide these to the EA. It should be ensured residents are aware of and using the FWS service, with this improved through the local community networking and community events if necessary. Any changes to flood risks from improvements to the FWS and/or RMA actions should also be made aware to residents.	EA / SCC / ESBC and Yoxall Community
Impact of future development on flood risk	Flood risk challenges within the catchment should be communicated to ESBC planners and Councillor to ensure it has been appropriately considered when assessing future development within Yoxall.	ESBC Planning Department

Risk Management Authorities and Other Parties

In addition to the recommended actions, an RMA or alternative party has been identified to undertake these actions. While some actions require collaboration and partnership, the RMA or alternative party identified will co-ordinate all parties to ensure that the action is completed in a timely manner.

A summary of each of the RMAs, about their role in flood risk management, is provided below:

Environment Agency
https://www.gov.uk/government/organisations/environment-agency
The Environment Agency has a strategic overview of all sources of flooding and hold responsibility for flood risk management activities on Main Rivers.

Staffordshire County Council (LLFA)
https://www.staffordshire.gov.uk/environment/Flood-Risk-Management/Home.aspx
LLFAs are county councils or unitary authorities which are required to prepare and maintain a strategy for local flood risk management in their areas, investigate significant local flooding incidents and publish the results of such investigations and play a lead role in emergency planning and recovery after a flood event.

Staffordshire County Council (Highways)
Highways authorities have the lead responsibility for providing and managing highway drainage.

Severn Trent Water
https://www.stwater.co.uk/my-supply/pipes-and-drains/help-with-pipes/sewer-flooding/
As a water and sewerage company, Severn Trent Water manage the risk of flooding to water supply and sewerage facilities and the risk to others from the failure of their infrastructure. They ensure their systems have the appropriate level of resilience to flooding, and maintain essential services during emergencies, maintain and manage their water supply and sewerage systems to manage the impact and reduce the risk of flooding and pollution to the environment.

East Staffordshire Borough Council (ESBC)
https://www.eaststaffsbc.gov.uk
As the Local Planning Authority, ESBC are responsible for determining planning applications within the Yoxall Catchment in accordance with local and national policies.

Riparian Owners
https://www.gov.uk/government/publications/riverside-ownership-rights-and-responsibilities
A riparian owner is any party or individual who has a watercourse within or adjacent to any boundary of their property. They are responsible for maintaining the riverbed and banks within their section of the watercourse to preventing obstruction to the water flow and mitigate flood risk.

Conclusions

Several storms occurred in 2020 across the Midlands region that impacted many areas. In February 2020, a long duration, low-to-moderate intensity event, named Storm Dennis, led to severe weather warnings across much of Wales and the Midlands. As a result, a significant number of associated flooding incidents to properties and highways were recorded across Staffordshire, and reported to SCC, as well as nationwide. This includes the flooding incident that occurred on Main Street and Bond End, Yoxall.

The flooding in Yoxall had a significant impact on the community, with records indicating that 8 residential properties and 1 commercial property experienced internal flooding. Flooding to gardens, garages, summer houses and driveways were also reported. The flooding in February 2020 also caused main roads through the village to become unpassable which left some residents on Main Street and Bond End cut off and unable to leave their homes for a period.

Three main types of flooding have been identified as river flooding from the River Swarbourn, surface water flows flooding, and flooding from highway drainage infrastructure becoming overwhelmed. The dominant flooding mechanism has been identified as water backing up against various structures in the River Swarbourn at Yoxall, including the Town Hill Bridge and Bond End Footbridge. This was coupled with record river levels in the Swarbourn at the time of the February 2020 event that have been calculated as approximately, or very close to, a 5% AEP event (1 in 20-year return period) from data included in the 2008 Hydraulic Modelling report. The 2008 report also identified that the channel at the Town Hill Bridge and Bond End Footbridge has insufficient capacity to convey flows during a 5% AEP event.

Previous flood alleviation and improvement measures have been considered to reduce flooding from the River Swarbourn, including those explored in the 2008 Modelling Report such as removal of the structures in the channel. However, no feasible solutions have been identified. The Environment Agency are now reconsidering whether are feasible works could reduce flood risk in Yoxall that include PFR and consulting with landowners in the upper reaches of the catchment to discuss NFM works alongside other options.

Staffordshire County Council (SCC) in its role as LLFA will continue to work with the Environment Agency and other identified RMAs to try to reduce flood risk to properties and infrastructure, as well as assisting the local community to ensure that is resilient and prepared for flood events, should they occur in the future.