2020 Flood Events:

Flood and Water Management Act

Section 19 - Investigation

Newton Leys, Burton-Upon-Trent

Figure 1: Aerial Photo of Area

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, in its role as Lead Local Flood Authority, has a duty to investigate the flood to determine the causes of the flooding and determine appropriate actions that may be undertaken by the relevant Risk Management Authority.

Several storms occurred in 2020 across the Midlands region which impacted many areas. Storm Dennis, in February, was a long duration, low-to-moderate intensity event, causing widespread flooding nationwide. The event led to a severe weather warning over much of Wales and the Midlands. As a result of these storms, a significant number of flooding incidents were reported to Staffordshire County Council, including Newton Leys, Burton-Upon-Trent.

Staffordshire County Council, in partnership with the Environment Agency and Severn Trent Water, has undertaken an investigation in each of 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 flooding from highway drainage).

This report focuses on Newton Leys, Burton-Upon-Trent. The investigation undertaken has been summarised, outlining the extent of flooding reported, the most likely cause of the flooding and the actions that have been completed, or are proposed to be completed in the future.

Introduction

Several storms occurred in the Midlands in 2020 resulting in flooding at several locations in Staffordshire. Storm Dennis hit Burton-Upon-Trent on the 16th February 2020.

This storm caused widespread flooding to highways and properties across Staffordshire and as a result, Staffordshire County Council has undertaken investigations in the areas where flooding occurred.

This report will aim at providing a broad overview of the causes of the flooding on Newton Leys during the event in February 2020 and to identify the next steps, if any, that need to be taken.

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.

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.

[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

SCC has set out in its *Local Flood Risk Management Strategy*[2]*, in Appendix D 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: S19 Investigation
- Stage 3: S19 Report and publish

It follows that there will be requirements for coordination and cooperation between Risk Management Authorities at each stage and, where required, following the outcome of a S19 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:

Human Health Flooding of 5 residential properties
Economic Activity Flooding of 2 businesses
Critical Services Flooding of 1 critical service or the marooning of one critical service, or
Road and Rail The flooding of a motorway or strategic road where it is closed for over 2 hours
Environment - Harmful consequence to 1 nationally or internationally designated site or nationally or internationally recognised heritage site

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.

The LLFA does not undertake detailed 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.

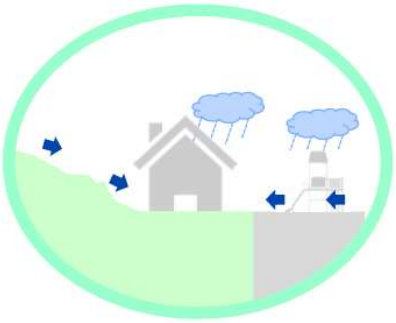
Step 4: Recommended Actions

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

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.



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

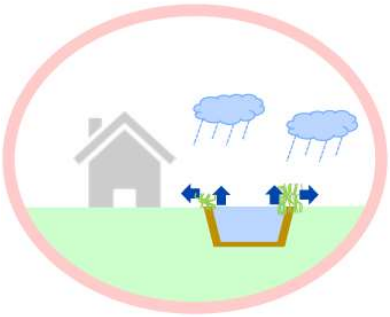
Hard surfaces, known as *impermeable surfaces*, do not allow any rainfall to soak into the ground and this rainfall will become (surface water) runoff. Runoff is usually very quick too. These are typically in the form of highways and roads, roofs, car parks and public squares.

Surface water flooding occurs under several 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.

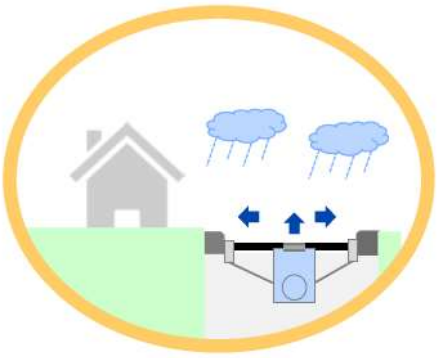
The Environment Agency holds responsibility for the management of flood risk on Main Rivers. All other watercourses, which are not specified as Main Rivers are termed Ordinary Watercourses. Flood risk management of these watercourses is the responsibility of the LLFA. However, in both cases, the riparian 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 carry rainfall and surface water away from properties to watercourses.

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

Combined Sewer 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 several circumstances, most commonly occurring when:

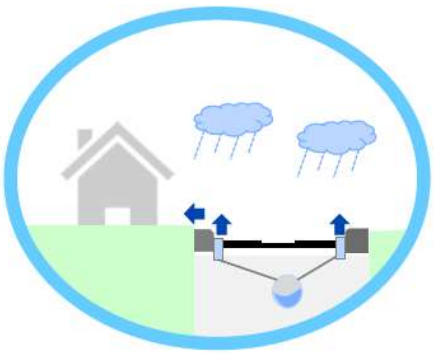
- There is a blockage, or the sewer itself collapses, which restricts or prevents flow within the sewer network. This causes water to back-up through the network and find its way to the surface, typically through a manhole or associated drainage structure.
- There is a period of heavy and/or prolonged 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 (6th Edition, published 2006). 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 the last 10 to 15 years. In addition, improvements in computer aided design and calculations also ensure designs agree 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 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:

https://flood-warning-information.service.gov.uk/long-term-flood-risk/postcode

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, considering 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.

https://flood-warning-information.service.gov.uk/long-term-flood-risk/postcode

Analysis of Flooding Location

Newton Leys, Winshill, Burton-upon-Trent

The following sections of this report describe the flooding event that occurred at Newton Leys, Winshill on 16th February 2020. The event has been assessed through the review of anecdotal evidence from local residents and through consultation with the various Risk Management Authorities (RMAs).

Event Background

Several storms occurred in winter 2019-2020 across the UK and Midlands. The combined impacts of Storms Ciara, Dennis and Jorge led to exceptionally high rainfall totals across the UK, causing flooding in several areas.

Storm Dennis (15-16 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 months prior to Storm Dennis, Staffordshire had exceptionally high rainfall compared to the average (Figure 2). Rainfall in December and January was unremarkable. However, rainfall totals in February were exceptionally high, 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 3). 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.

[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

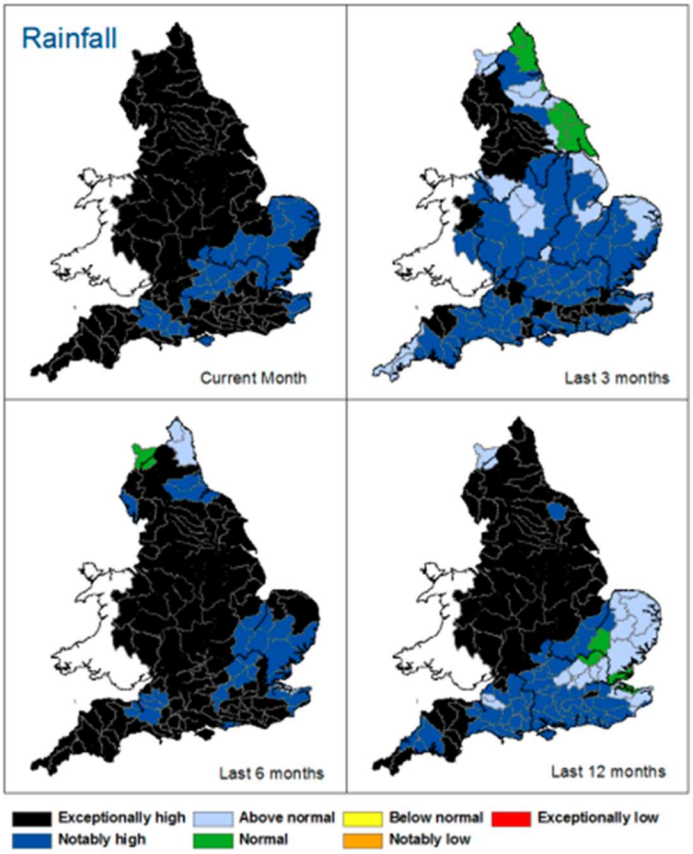


Figure 2: Total Rainfall Across England up to February 29 2020 (Source: Environment Agency[4])

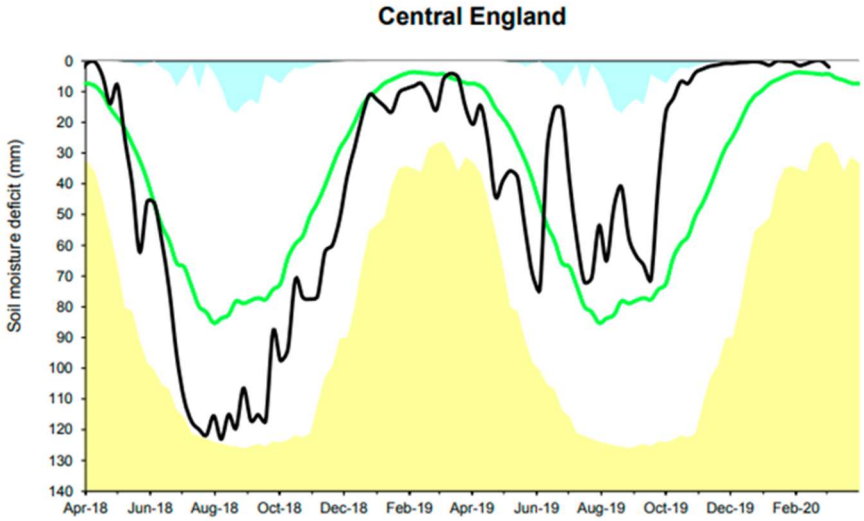


Figure 3: Central England Soil Moisture Deficit (Source: Environment Agency)

[4] 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

On 14 February, Storm Dennis developed off the west coast of Ireland moving east and arriving in England by 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 15 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 16 February. Figure 4 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 Denis please refer to The Met Office[5] and Centre for Ecology and Hydrology[6].

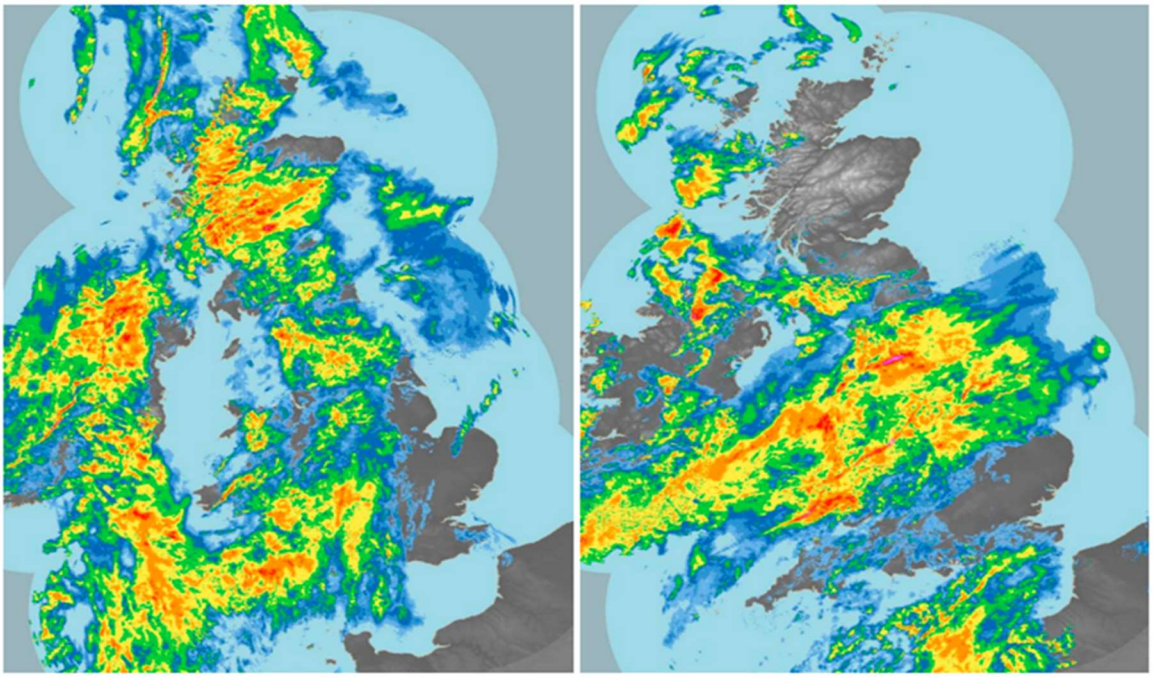


Figure 4: Rain-radar images at 12 UTC 15th and 00 UTC 16th February 2020 (Source: The Met Office[5])

[5] 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

[6] 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

Location Background

Newton Leys is a quiet urban street located within the Winshill area of Burton-Upon-Trent. This area lies East of the River Trent which flows through the heart of the town. Newton Leys sits right on the Staffordshire border with neighbouring county Derbyshire. In fact, the county border in the rear gardens of Newton Leys was relocated in 1990/91. Originally the county border was the Dale Brook itself but this was realigned to the rear of the fence lines with the public footpath running along the farmers field to the north, so the properties gardens on Newton Leys are now situated wholly in Staffordshire and don't straddle both counties.

The Environment Agency's fluvial (river) Flood Zones only include watercourses with catchments of greater than 3km^2 so the Dale Brook at this location is not included.

The risk of flooding from surface water map gives a good indication of the flood risk from surface water and smaller watercourses. The map does not contain sufficient information for it to be used to determine flood risk to individual properties, but it does give an indication of whether the area may be affected by surface water flooding and to what extent.

Many properties on Newton Leys lie within the 1 in 30yr RoFSW Zone or the 1 in 100yr RoFSW zone. This means each year, the area has a chance of flooding of greater than 1 in 30 (3.3%), or greater than 1 in 100 (1%). The surface water flooding extents can be seen in Figure 5 below.

Figure 5: Newton Leys Location Plan with Risk of Flooding from Surface Waters Layers. RoFSW 1 in 30 years (Dark Blue), RoFSW 1 in 100 years (Light Blue)

Staffordshire
County Council

Local Watercourses:

Dale Brook is an ordinary watercourse running along the rear of the properties to the north of Newton Leys. An ordinary watercourse is defined as any watercourse not designated as 'Main River,' i.e. a watercourse that is not managed by the Environment Agency. The Dale Brook ultimately feeds into the River Trent which is a Main River.

Riparian land ownership is a legal term given to a landowner who owns land adjacent to a watercourse (river, stream, ditch etc.). Riparian landowners are responsible for maintaining the flow of water through their land and obtaining prior approval before carrying out any alterations.

The catchment area that feeds into Dale Brook covers approximately 1.8km^2, and is relatively steep (Figure 6). Approximately one third of the catchment is urban. This means runoff can reach the watercourse quickly during a storm, causing levels to rise rapidly.

Figure 6: Newton Leys Catchment Area Map

Public Sewer Network:

Newton Leys is served by a gravity fed foul sewer network as well as a gravity fed surface water sewer network, both of which are maintained by Severn Trent Water.

The surface water sewer has two outfalls on Newton Leys, both into the Dale Brook behind the street. The first outfall is situated behind 61 Newton Leys, with a pipe diameter of 675mm. The second outfall is located at the end of Newton Leys, this stretch of the surface water network is passed through a 225mm pipe before joining a larger 450mm pipe network before eventually reaching the outfall behind property number 11.

The gravity fed foul sewer runs along Newton Leys through a 225mm VC pipe. The sewer network travels north-west down Newton Leys before connecting to a larger 525mm CO pipe on Wheatley Lane. The foul network then continues to run alongside the Dale Brook before ultimately meeting a larger pipe on Newton Road where it is then sent to a sewage pumping station around 2km away from Newton Leys on the bank of the River Trent.

Highway Drainage Network:

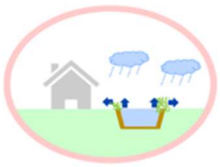
The local highway drainage network comprises of traditional highway gullies and connections. A series of highway gullies connect into clay pipes and then run-down Newton Leys. Some of the highway drains discharge into the Dale Brook which runs behind the back of the properties on Newton Leys, at an outfall 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 on Newton Leys

Burton-Upon-Trent has a long history of flooding, mainly associated with the River Trent. The Hydro chronology Database has records dating back to 1795. This includes a major event in 1875 where thousands of acres around Burton were underwater leaving many streets impassable, homes uninhabitable and large losses of crop and livestock.

An extreme summer storm in the mid-late 1990's caused huge damage to the highway on Sales Lanes, Bend Oak Drive, Newton Leys and Melbourne Avenue; also to the public surface water sewer system which flooded a number of properties on Bend Oak Drive and Newton Leys. Following consultation with residents on Newton Leys it was revealed that flooding has been a regular occurrence over the past 40 years. Fortunately, the nature of flooding has always been external, mainly affecting gardens and driveways.

February 2020 - Flood Event Description

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

On the 16th February, multiple properties on Newton Leys reported that they had experienced flooding. Accounts obtained from residents describe that flood waters entered properties in the early hours of Sunday 16th February. Records passed to us from East Staffordshire Borough Council (ESBC) indicate that 7 properties flooded internally. This information came via properties that claimed for damages as a result of the flooding. This means that it is possible that some properties did flood internally yet did not claim. Reports from resident suggest that this figure may indeed be higher. In addition to the properties that flooded internally, there was also flooding to gardens, garages and driveways reported.

Rainfall Analysis

Figure 7 shows the 3 nearest rain gauges to Newton Leys. The closest rain gauge at Stretton recorded 44mm of rainfall between 00:00hrs on the 15th February and 23:45hrs on the 16th February. The rain gauge at Tatenhill just west of Burton-on-Trent recorded a similar 40.6mm of rainfall in the same 48-hour period and the gauge located in Overseal, south of the town of Swadlincote, recorded 42.4mm of rain. This means that close to 42mm of rain fell on the Newton Leys catchment in the days prior to the flooding.

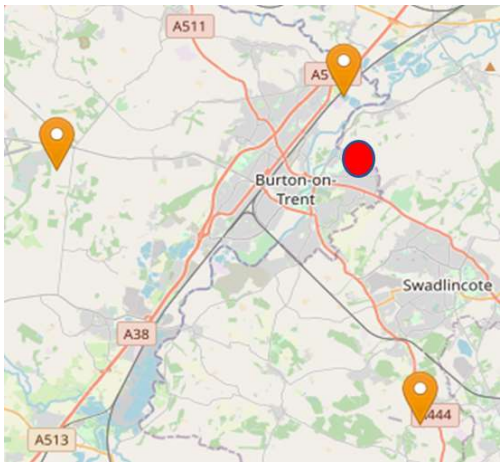


Figure 7: Locations of nearest rain gauges to Newton Leys (red dot). Tattenhill (West), Stretton (North) and Swadlincote (South-East)

For the Dale Brook catchment, 5 minute radar rainfall data has been obtained using HydroMaster software[7].

Between 10pm on the 15th and 2pm on the 16th February 2020, 37mm of rain fell across the catchment, following lighter rain earlier in the day.

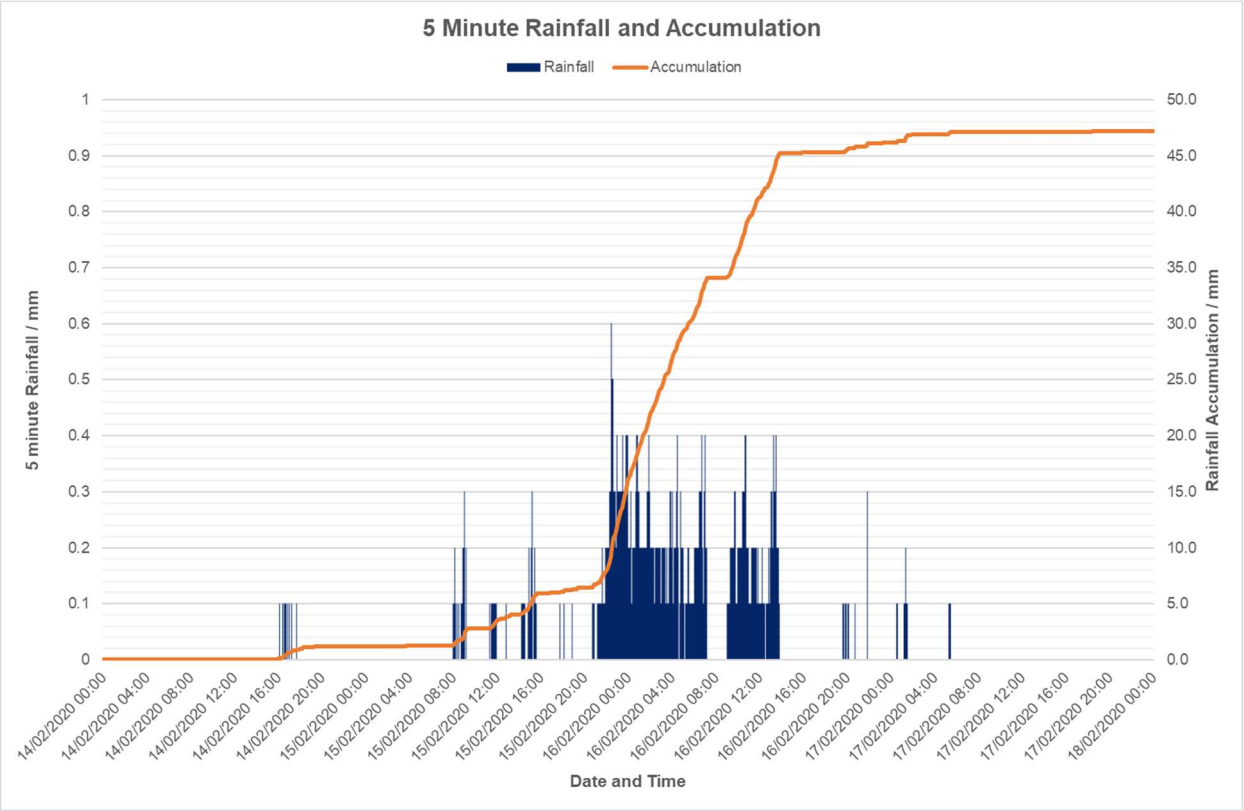


Figure 8 - 5 minute rainfall and rainfall accumulation (mm) from 14th to 17th February 2020

The estimated return period of the heaviest rainfall is between 1 in 2, and 1 in 5 years.

ReFH software was used to create a hydrograph from the observed rainfall and catchment characteristics, along with a series of modelled hydrographs for design storms of different return periods. Comparison of the peak flows enabled the flow return period to be estimated.

[7] Hydromaster: https://app.hydromaster.com/applications/index.html

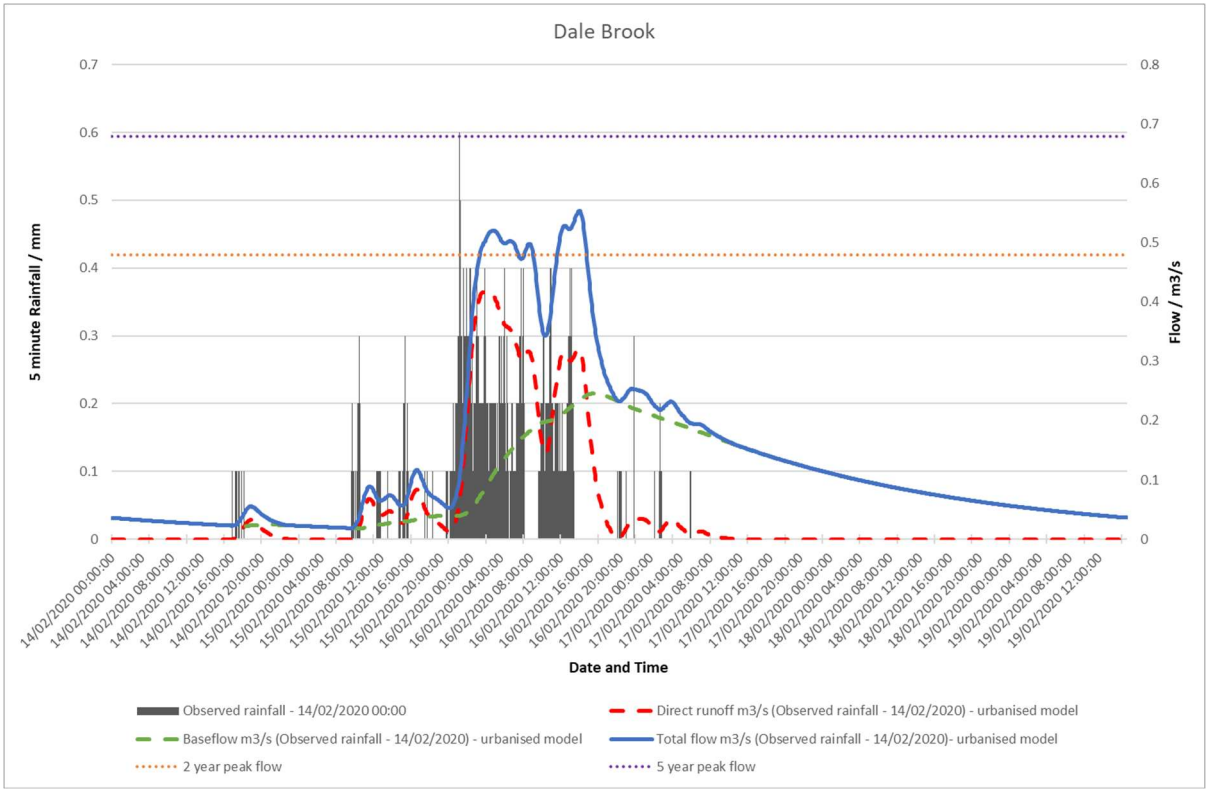


Figure 9 - Modelled Hydrograph for the observed rainfall event on 16th February 2020

The resulting hydrograph indicates that the peak runoff was equivalent to an event with return period between 1 in 2 (or a 50% chance of occurring in any year) , and 1 in 5 years (or 20% chance of occurring in any year).

Whilst the rainfall data and modelled hydrographs suggest a return period of between 1 in 2 years and 1 in 5 years, the magnitude of flooding experienced and local history of flooding obtained from residents indicate a more severe, less frequent flooding event.

There are a number of factors beyond simply the rainfall and expected catchment response that are likely to have exacerbated the flooding, leading to more severe consequences.

These include:

- Extreme saturation of the soils within the catchment (discussed under *Event Background*)
- Bare soil, lack of crops and other vegetation to intercept runoff, due to the season
- Obstructions in the floodplain can divert or release flood water rapidly

Runoff Characteristics

Error! Reference source not found. illustrates the main flow routes observed on Newton Leys and the surrounding catchment during the February 2020 event. As previously stated, the antecedent conditions were such that the ground was saturated and therefore runoff was greatly increased. Details provided from resident questionnaire responses suggest that the flooding occurred from a variety of sources but predominantly from surface water draining from the fields behind Newton Leys and into the Dale Brook and subsequently onto the public footpath which was overwhelmed with water. Although less visible, Dale Brook would also have been conveying runoff from the surface water sewer system.

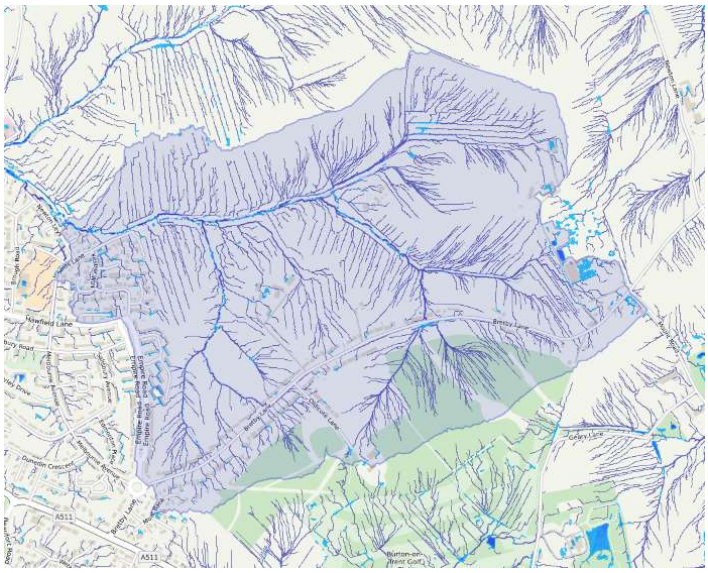


Figure 10 – Flow accumulation within Dale Brook Catchment

It is believed that the agricultural land behind Newton Leys had been ploughed which effectively created little drainage channels heading down towards Newton Leys and the Dale Brook. This coupled with the saturated ground meant that the rainfall was able to run off the fields rapidly into the watercourse. As well as the water running off the fields, there is also a 675mm Severn Trent Water outfall which will have brought surface water runoff from the urban part of the catchment into the Dale Brook. This will also have contributed to the volume of water in the channel at the time of the flood and will have been a significant factor.

Runoff from both the impermeable urban part of the catchment and the saturated rural area would have been rapid, with both peaking quickly and coinciding. If the ground had been less saturated the peak rural runoff may have been delayed, causing a broader, lower peak in river level.

Figure 11 and Figure 12 illustrate the impact of rapid runoff from saturated ground coinciding with peak runoff from the urban catchment.

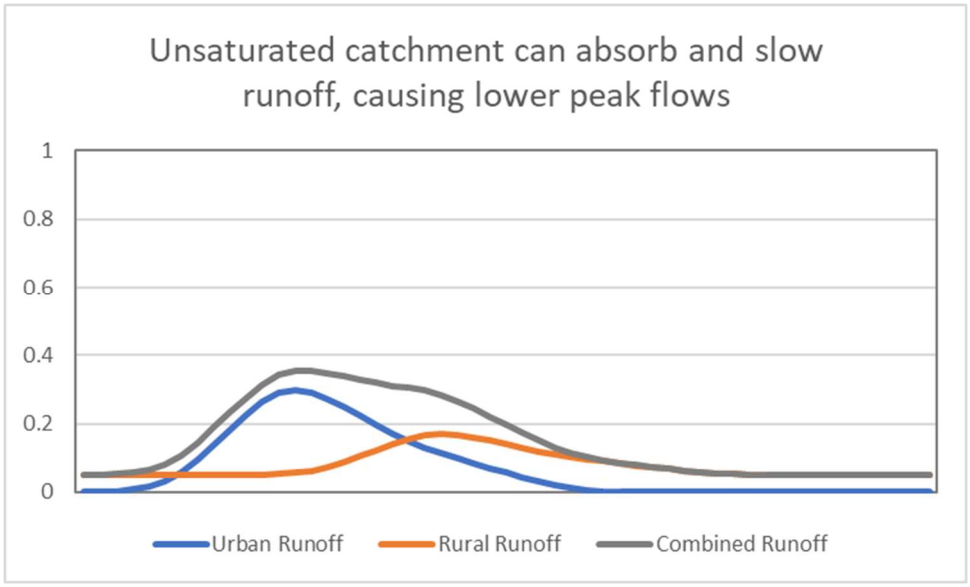


Figure 11 - Unsaturated catchment absorbs and slows runoff

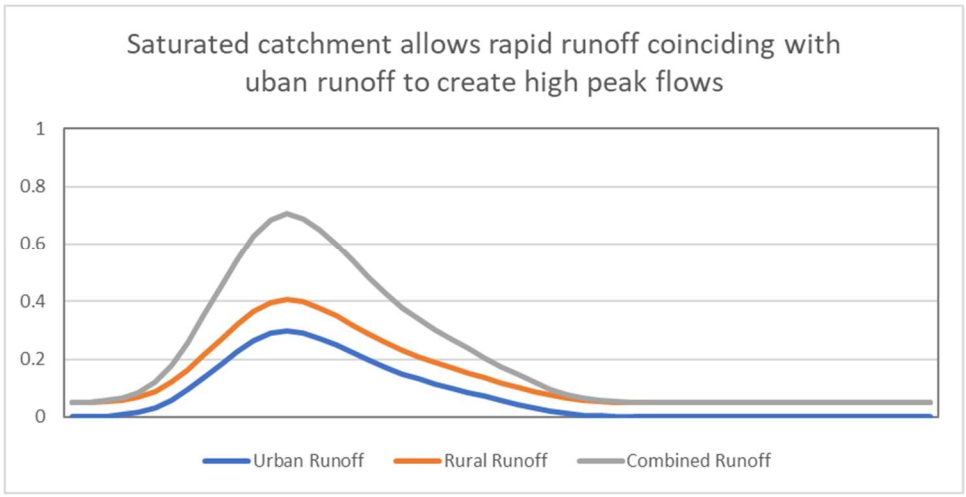


Figure 12 - Saturated catchment creates rapid runoff, with peaks coinciding

Channel and Floodplain Features

Figure 13 shows the locations of two culverts where footpaths cross Dale Brook. These have the potential to constrict flow in the channel, particularly if blocked by debris.

Figure 13 - Culverts (red circles) where footpaths cross the watercourse

Culvert 1 (Figure 14) is approximately 450mm in diameter, with a trash screen.

Following consultation with residents it is thought that the pipe and screen were installed around 30 years ago. The pipe connects to a culvert which takes the Dale Brook underneath the garden of a property at the end of Newton Leys before becoming an open channel again.

Figure 14 – Culvert 1: 450mm pipe and trash screen at eastern footpath crossing

During the February 2020 event, it is understood that the capacity of this pipe was exceeded by the flows in the watercourse. There is no indication or reports from residents that the trash screen or pipe was blocked at the time of the event. During an initial site visit the screen and pipe appeared to be clear. This therefore suggests the pipe was overwhelmed by sheer volume of water coming off the fields rather than a blockage in the screen or pipe.

As water overwhelmed the pipe, it began to back up and spill onto the footpath. There are fences between the footpath and watercourse, so floodwater would have built up before re-joining the channel downstream.

During consultation with residents, it was suggested that the pressure from the floodwater caused sections of fencing to collapse, which could have caused an additional surge of floodwater along the channel.

Culvert 2 (Figure 15) is approximately 1m in diameter and provides a crossing place for the footpath.

Figure 15 - Culvert 2: Approximately 1000mm diameter

The footpath is fenced on both sides with solid fencing, so forms a continuous barrier across the floodplain. Any flow exceeding the capacity of the culvert therefore backs up behind the fences and is forced out along the footpath (Figure 16) towards the highway as shown in Figure 13.

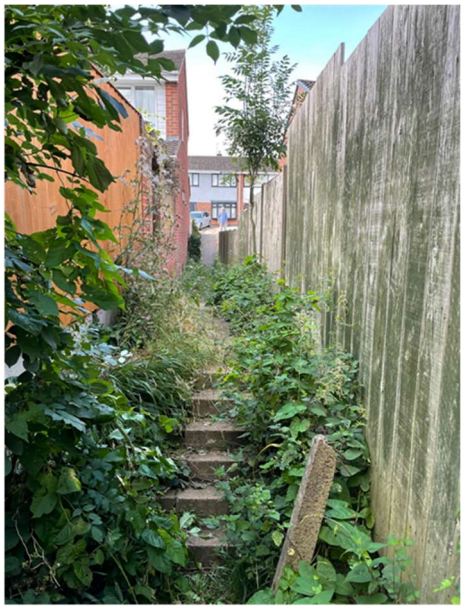


Figure 16: Footpath at Culvert 2

As illustrated in Figure 13, flood water then followed the topography of the road and down towards properties on either side of the footpath.

Floodplain Obstructions

Dale Brook flows through the back gardens of the properties along Newton Leys, which means that the residents are riparian owners.

A riparian owner is anyone who owns a property where there is a watercourse within or adjacent to the boundaries of their property. A watercourse could be a ditch, stream, or river, and may have been modified over time, for example by diverting or piping (culverting) sections. A riparian owner is responsible for watercourses or culverted watercourses passing through their land, and must:

- Let water flow naturally by removing blockages, fallen trees or overhanging branches from your watercourse. You must cut back trees and shrubs on the bank if they could reduce the flow or cause flooding to other landowners' properties. You could be liable for damages if this happens.
- Ensure that any trash screens, weirs, mill gates, bridges or other structures that may impede the natural flow of water are removed unless they have been consented.
- Keep any trash screen, weir, mill gate, bridges, or other structure clear of debris
- Ensure that the water is not polluted. Do not throw wastewater, chemicals, or anything else which could cause pollution on the banks or in the water.
- Remove litter and animal carcases from the banks/watercourse

As well as maintaining the channel, it is important to remember that the land alongside a watercourse naturally acts as a floodplain.

A natural watercourse channel can usually convey the runoff from the average annual storm, but for larger storms the floodplain around the channel will also be used to store and convey flood water. Any obstructions can force floodwaters elsewhere and increase the risk of flooding to nearby homes.

It is advisable to:

- Avoid locating sheds, decking, or other large obstructions in the floodplain.
- Consider raising fence panels or leaving gaps for floodwater to flow downstream.

Flood Incident Response (wider Burton-on-Trent area):

On Sunday 16th February 2020, Staffordshire Council received a significant number of calls through its emergency telephone lines informing the Council of localised flooding throughout the Borough, including the Burton-on-Trent area. Officers immediately put the Town Hall on standby in case it needed to be mobilised as a rest centre.

Over the course of Monday 17th February, the Council was advised that flooding was potentially becoming more widespread within the Borough and at 5pm on Monday, officers chaired a multiagency conference call which resulted in formal Strategic and Tactical Co-ordinating groups being set up. This included Staffordshire County Council, Police, Fire, West Midlands Ambulance Service and the Civil Contingencies Unit (CCU) as part of the local resilience forum response.

As part of the response, it was highlighted that a number of properties may need to be evacuated and the Town Hall was mobilised as a rest centre, to accommodate any residents displaced due to flooding. However, emergency services indicated that this would not be required, and rest centre facilities were closed shortly after.

On the morning of 18th February, the Strategic Coordinating Group stood down the response phase and moved into the recovery phase. Following the event, East Staffordshire Borough Council collected information from local residents that had experienced flooding in order to process Flooded Property Claims to help fund repairs for the damages caused by the February 2020 event.

Recommended Actions

As part of this flood investigation, it is vital to determine what contributed to the flood event and also to establish a set of recommended actions that may help to alleviate flooding in the future or at least reduce risk to properties.

Table 2 below sets out relevant Risk Management Authorities (RMAs) and other interested parties, actions that have been taken to date and those actions planned for the future, with the relevant RMA who will lead.

Table 1 - Recommendations and Actions

Issue/Risk	Recommendations/Actions	Responsibility
Rapid runoff from the rural catchment	Explore options for Natural Flood Management and other land management practices with landowners	SCC as LLFA, working in partnership with Environment Agency and landowners
Rapid runoff from developed areas	Ensure that major new developments comply with Technical Standards for Sustainable Drainage Systems	SCC as statutory consultee to the Local Planning Authority
Maintenance of open channel, structures and screens	Increase awareness of riparian responsibilities and importance of maintaining floodplain conveyance	SCC as LLFA, working with Councillor to inform residents and landowners

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:

Staffordshire County Council (LLFA)
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.

Derbyshire County Council (LLFA)
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.

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.

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)
As the Local Planning Authority, ESBC are responsible for managing the long-term land use within the Newton Leys catchment

Conclusions

Several storms occurred in 2020 across the Midlands region which impacted many areas. Storm Dennis, in February was a long duration, low-to-moderate intensity event, causing widespread flooding nationwide. Following the February 2020 storm event, incidents of flooding were reported to Staffordshire Council, including on Newton Leys, Winshill, Burton-On-Trent.

The flooding on Newton Leys had a significant impact on the community, with records indicating that 7 residential properties experienced internal flooding. In addition to this, flooding to gardens, garages, summer houses and driveways was also reported. Three main types of flooding have been identified as the cause for the incidences of flooding. These include flooding from the Dale Brook as well as surface water flows and highway drainage infrastructure becoming overwhelmed.

The dominant mechanism of flooding can be attributed to several factors. Firstly, the antecedent conditions of the catchment. The catchment was extremely saturated due to previous weeks of heavy rainfall, this meant that the ground could take up no more water so surface water flows and flows in the Dale Brook were increased. Secondly, obstruction of the floodplain and potential failure of fences under the pressure of floodwater. It is believed that the sudden release of flood water may have created an additional surge down the Dale Brook which ultimately found its way into properties. The watercourse has capacity for 'normal flows' but during extreme events the watercourse cannot contain high volumes and it spills over into the gardens on Newton Leys which now effectively act as the floodplain for the Dale Brook.

Staffordshire County Council in its role as LLFA will continue to work with the identified RMAs to try and reduce the 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.