

# Birmingham City Council

## June 2016 Flooding: Flood and Water Management Act, Section 19 Investigation



May 2017

This report has been prepared by Birmingham City Council as Lead Local Flood Authority and WSP, 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 Birmingham City Council, and WSP, cannot be held responsible.

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## EXECUTIVE SUMMARY

When made aware of flooding, Birmingham City Council, in their 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.

A number of storms occurred in June 2016 across the West Midlands which impact many areas, including Birmingham. The storms which occurred were typical of summer storms in the UK, with them being short, intense and highly localised storms.

As a result of these storms, a significant number flooding incidents were reported to Birmingham City Council. Immediately following the events, Birmingham City Council distributed 'Flood Surveys' to all residents within, or in close proximity, to all areas where flooding was reported. Over 700 responses were received, providing accounts of duration and depth of flooding along with any other pertinent information.

These responses reported flood incidents which included internal property flooding, flooding to gardens and flooding to highways and surrounding areas. In total, 435 incidents of flooding were reported, with 23 areas identified to have experienced internal property flooding.

Birmingham City Council, in partnership with the Environment Agency and Severn Trent Water, has undertaken an investigation in each of the 23 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).

For each of the 23 areas, 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.

# 1 INTRODUCTION

A number of storms occurred in Birmingham during June 2016, with the most significant storms occurring on 8<sup>th</sup>, 10<sup>th</sup> and 16<sup>th</sup> June. These storms caused widespread flooding to highways and properties across Birmingham and as a result, Birmingham City Council have undertaken investigations in the areas where flooding occurred.

This report is aimed at providing a broad overview of the causes of the June 2016 flooding and identifies the next steps, if any, to be taken.

## LEAD LOCAL FLOOD AUTHORITY

Following Royal Assent of the Flood and Water Management Act in 2010 (FWMA), Birmingham City Council became the Lead Local Flood Authority (LLFA). As such, Birmingham City Council is responsible for the management of surface water flood risk, groundwater flood risk and the flood risk from ordinary watercourses<sup>1</sup>.

As LLFA, Birmingham City Council is required to work in partnership with other agencies and authorities to manage flood risk. These agencies and authorities include, but are not exclusive to:

- 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.

Birmingham City Council has, set out in its *Draft Local Flood Risk Management Strategy*,<sup>2</sup> a three stage 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.

<sup>1</sup> An ordinary watercourse is defined as all watercourses not designated as 'Main River,' i.e. watercourse that are not managed by the Environment Agency.

<sup>2</sup> <https://www.birmingham.gov.uk/downloads/file/2556/draft-local-flood-risk-management-strategy>

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.

## JUNE 2016

As a result of the storms in June 2016, more specifically the storms that occurred on the 8<sup>th</sup> and 16<sup>th</sup> June 2016; widespread flooding occurred across Birmingham. 435 incidents of flooding were reported, ranging from waterlogged gardens, impassable roads and water outflowing from highway gullies to rivers breaching banks, manholes and sewers surcharging and internal property flooding.

*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.*

### Storm Events

The Environment Agency operates a network of rain gauges across the UK which record rainfall data at 15 minute intervals. This recorded data allows for an estimate of the rate of rainfall i.e. its intensity. In contrast, the Met Office uses radar to measure rainfall at 1km grid square resolution which was thereafter sampled by the Environment Agency to a grid of 5km covering the West Midlands.

The Environment Agency has conducted an analysis on the rainfall data recorded by the gauges, which has been supplemented with the Met Office rainfall radar data.

From this analysis, the events recorded on the 8<sup>th</sup> and 16<sup>th</sup> June were of high intensity and highly localised which is consistent with storms typically experienced in summer. Some rain gauges recorded a significant total rainfall depth whilst other gauges recorded very little further supporting the above assertion.

Rainfall depths varied significantly across Birmingham as recorded by different rain gauges:

- During the period June 8<sup>th</sup> to June 10<sup>th</sup> 2016, 18mm of rainfall was recorded at the Frankley rainfall gauge compared with 24mm recorded at Saltley gauge and 34.2mm recorded at Walsall Wood gauge. However, rainfall accumulation as predicted by Met Office radar indicates approx. 39.5mm rainfall over the 48 hour period in the vicinity of Perry Beeches. Approximately 32-38mm of this total depth was recorded within one 1hr period;
- During the period June 14<sup>th</sup> to June 17<sup>th</sup> 2016, 72.8mm of rainfall was recorded at the Frankley rainfall gauge and 88.4mm was recorded at the Saltley gauge compared with 44.8mm recorded at the Walsall Wood gauge. Rainfall accumulation as predicted by Met Office radar indicates approx. 111mm rainfall over the 48 hour period in the vicinity of Selly Oak. Approximately a quarter of the total depth fell within one half-hour period.

The main areas affected by the June 2016 storms are shown below in Figure 1-1.

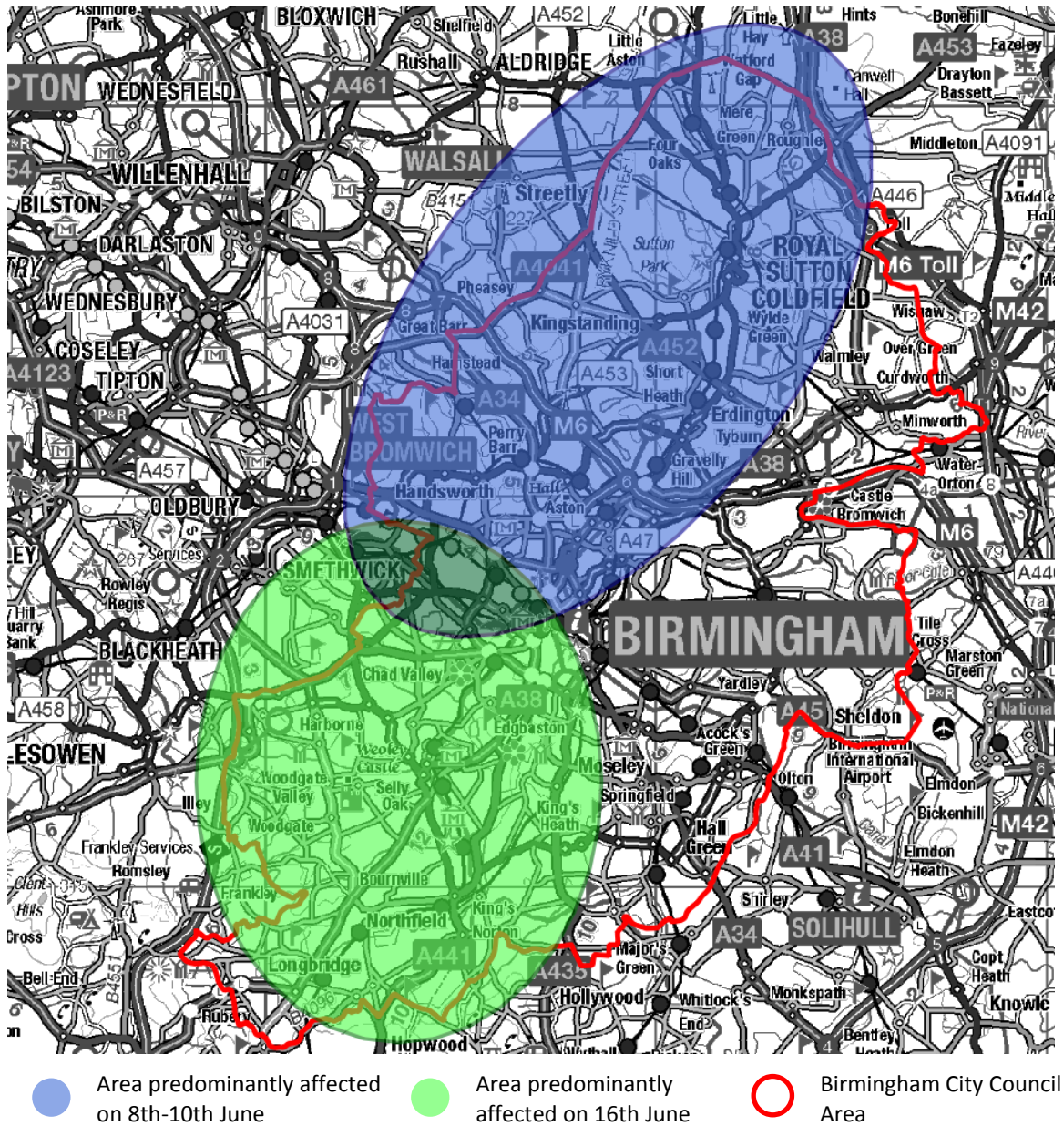


Figure 1-1 Areas Affected by June 2016 Storms

### Investigation into Flooded areas

Following the events of June 2016, Birmingham City Council, in their role as LLFA, has undertaken the steps as outlined below:

#### Step 1: During the Flood Event

- Birmingham City Council received a high number of calls during the event, which reported flooding of properties, gardens and highways.
- During the flood events, 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

- Through the use of call records, flooding investigation questionnaires and site visits, the LLFA identified the locations where flooding occurred and distributed 'Flood Surveys' to all property owners and residents directly affected by flooding and those within the surrounding area.
- Over 700 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 23 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 23 areas where a minimum of one property experienced internal flooding. It should be noted that Birmingham City Council 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 June 2016.
- 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 23 affected areas, 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.

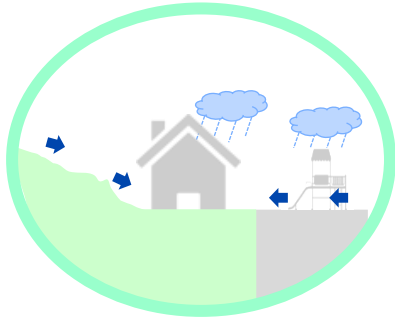
The following section of this report provides a summary of the findings from the works undertaken to date with regard to the 23 affected areas.

## 2 TYPES OF FLOODING

The following section explores the various types of flooding that were experienced during the events in June 2016.

### 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.



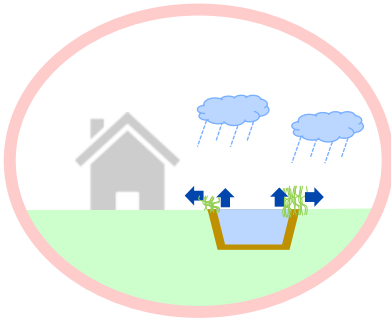
- **Soft surfaces**, known as *permeable surfaces*, allow water to soak (infiltrate) into the ground. These are typically in the form of gardens, parks, fields and green spaces,
- **Hard surfaces**, known as *impermeable surfaces*, do not allow any rainfall to soak into the ground and this rainfall will 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 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 river banks, 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<sup>3</sup>, 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 a number of 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.

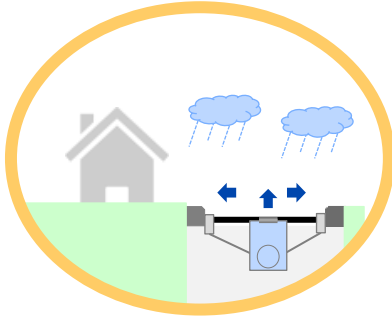
During most storm events, rivers are capable of conveying flows within their channels however, during an extreme event where the volume of water may be significant, flows may exceed the channel capacity and spill from the river in an uncontrolled manner.

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<sup>3</sup> The Environment Agency produce a guide entitled Living on the Edge for riparian owners which outlines their rights and responsibilities.

## 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 the city.

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

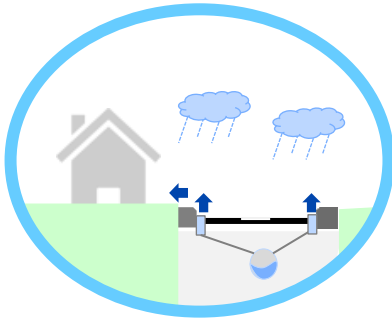
- There is a blockage, or the sewer itself collapses, which restricts or prevents flow within the sewer network. This causes water to back-up through the network and find its way to the surface, typically through a manhole or associated drainage structure.
- There is a period of heavy and/or prolonged 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 undertaker, is responsible for the operation and maintenance of the public sewers within the Birmingham 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% 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 are in agreement with the existing standards.

Therefore, at the time of construction of much of the sewer network across Birmingham, 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 Birmingham, 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 a number of 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.

Birmingham City Council, in their role as the local highway authority, is responsible for the highway drainage and gullies across Birmingham. The maintenance of highway assets is currently undertaken by Amey, the Council's Maintenance and Management Partner, under a 25 year PFI contract. This work includes maintenance of the highway drainage including roadside gully pots.

## 3 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 publically 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<sup>4</sup>. 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 publically available for use, and is available online<sup>5</sup>.

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<sup>4</sup> <https://flood-warning-information.service.gov.uk/long-term-flood-risk/map>

<sup>5</sup> <https://www.gov.uk/government/publications/flood-maps-for-surface-water-how-they-were-produced>

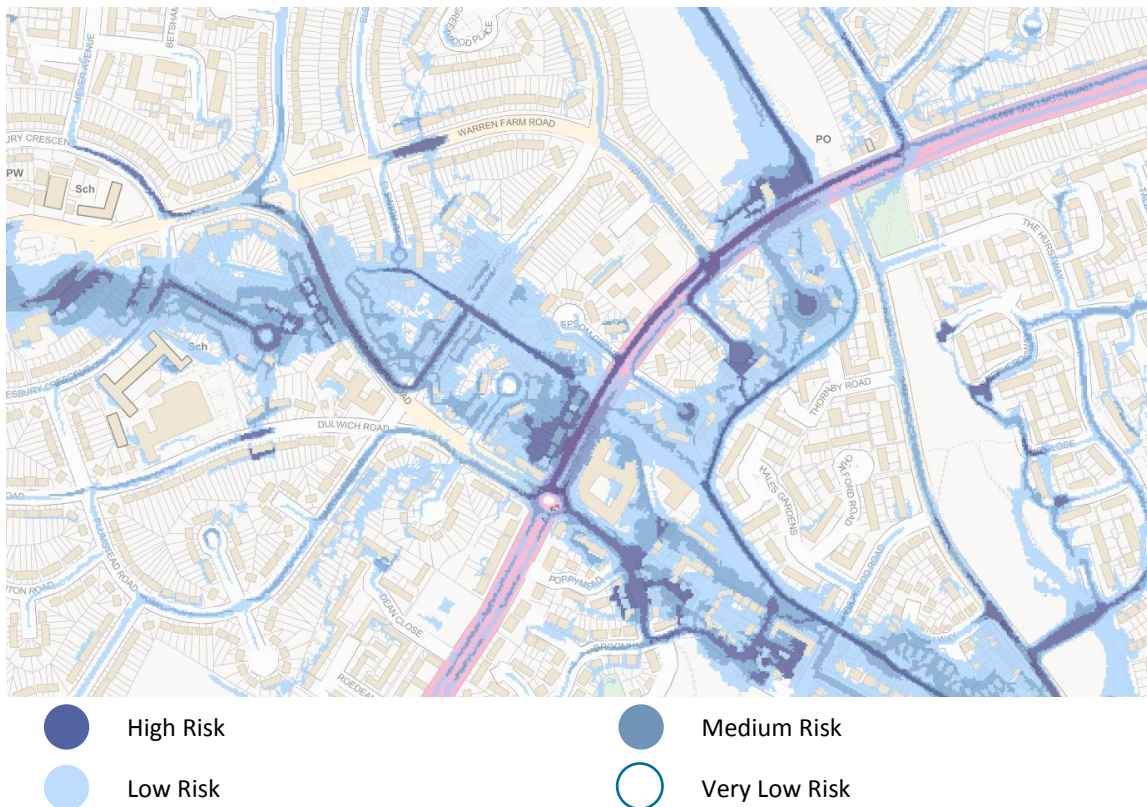


Figure 3-1 Flood Risk from Surface Water Mapping

#### Local Information on Surface Water Flood Risk

In addition, Birmingham City Council has developed maps that indicate the areas shown to be at risk of surface water flooding known as the Surface Water Management Plan Map (SWMP). This data does not cover the entire City, just those areas that were considered to be at the most significant risk of surface water flooding prior to the June 2016 events. This mapping is publically available for use, and is available online<sup>6</sup>.

The flood extents are based on detailed hydraulic models that take account of rivers, minor open watercourses and piped networks of culverted watercourses and public sewers.

The Environment Agency guidance on surface water flood risk information recommends that LLFAs should review, discuss, agree and record with partners what surface water information best represents local conditions, this is known as 'locally agreed surface water information'. Birmingham City Council's locally agreed surface water information consists of the Flooding from Surface Water maps overlaid by the SWMP maps in areas where detailed studies were carried out.

#### 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.

<sup>6</sup> [https://localview.birmingham.gov.uk/My\\_Local\\_Information/Sites/Flood/](https://localview.birmingham.gov.uk/My_Local_Information/Sites/Flood/)

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<sup>7</sup> and is available online.

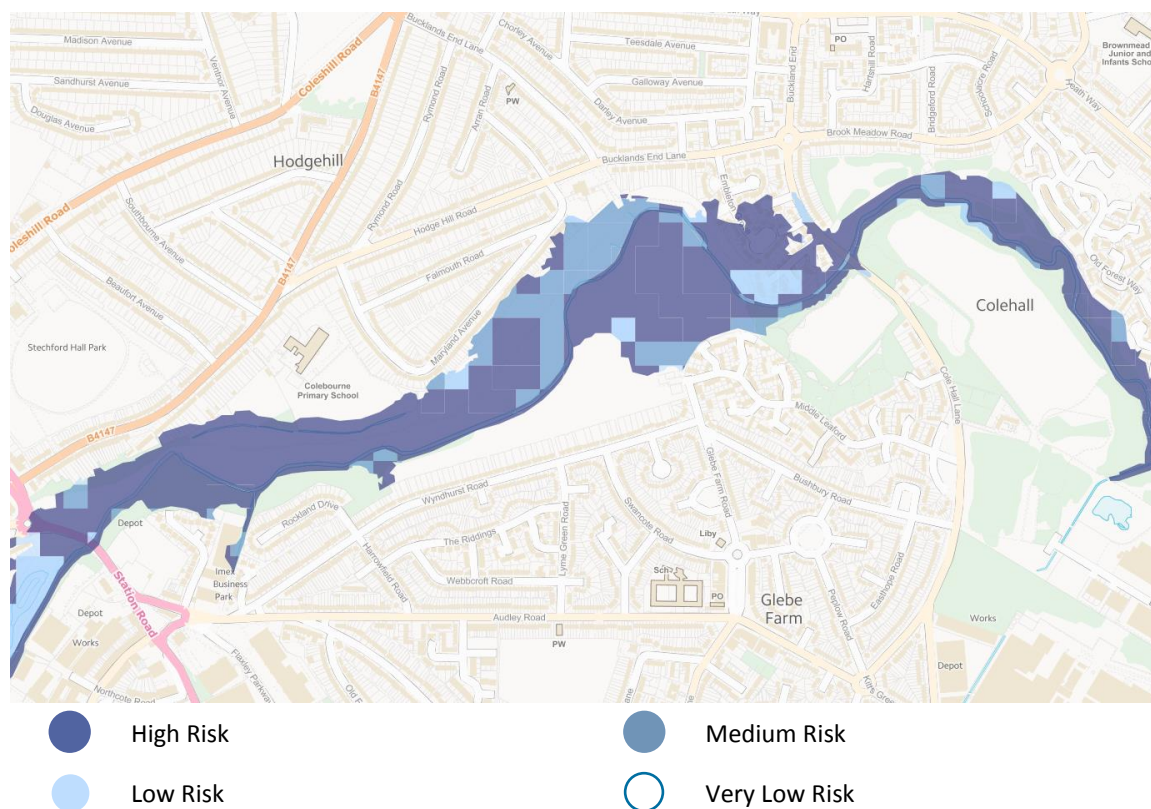


Figure 3-2 Flood Risk from Rivers or the Sea map

<sup>7</sup> <https://flood-warning-information.service.gov.uk/long-term-flood-risk/map>



# 4 ANALYSIS OF FLOODING LOCATIONS

The following chapter provides a summary of the detailed investigation and analysis undertaken by Birmingham City Council, in their role as LLFA, of the 23 sites that experienced internal property flooding and identifies further actions to be undertaken.

## 4.1 ALUM ROCK

### What happened?

On the 16<sup>th</sup> June, three properties in Alum Rock Road reported internal flooding, together with flooding to surrounding highway and gardens.

### Why did it happen?

The flooding in this area has been identified to be surface water flooding and flooding from highway drainage.

Over the course of the storm event, the prevailing topography directed rainwater to a low point in Alum Rock Road. Whilst a number of gullies are identified at this location, the capacity of these features appeared to be restricted by debris. As a result, the surrounding highway became inundated with water overflowing into the adjacent properties.

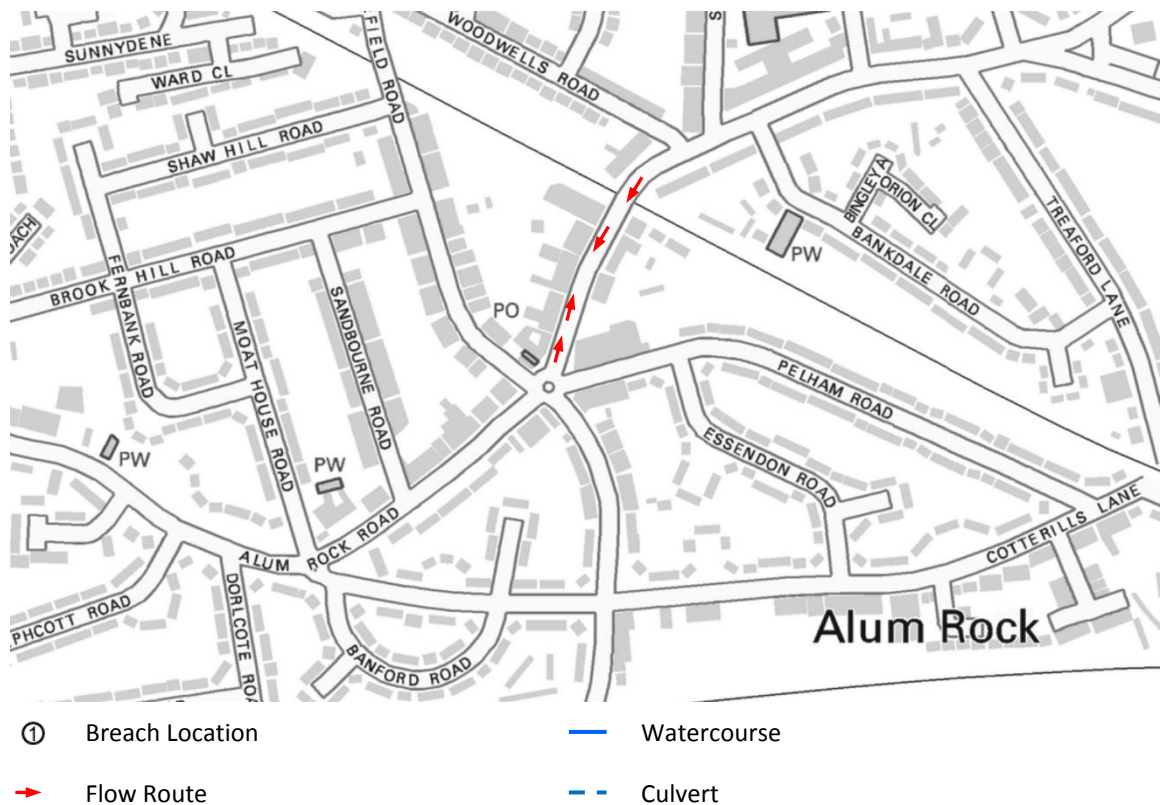
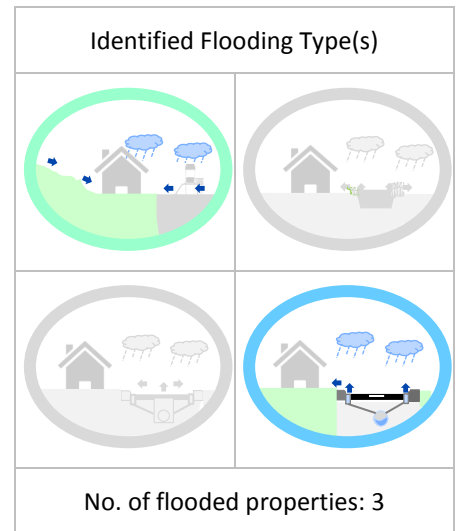


Figure 4-1 Potential overland flow routes

Post storm event, due to the potential capacity limitations in the receiving gullies, flood waters receded at a reduced rate.

### *What has been done?*

Following the June 2016 storms, Birmingham City Council (Highways) has cleared the gullies of any debris.

### *What next?*

The following table outlines the recommended actions for this area to be undertaken by the appropriately identified RMA.

Recommended Actions	Identified Party / RMA
<b>Assess whether additional gullies are required to allow runoff to drain</b>	Birmingham City Council (Highways)
<b>Review maintenance regime to ensure gullies are free from debris</b>	Birmingham City Council (Highways)

## 4.2 BARTLEY GREEN





### What happened?

On 16<sup>th</sup> June, four properties in Bartley Green, in the vicinity of Middle Acre Road and Rush Green were affected by the storms. In addition to this property flooding, flooding of highways and footpaths occurred throughout this area, including Green Drive and Ambleside.

### Why did it happen?

The flooding in this area has been identified to be surface water flooding and flooding from rivers.

The Stonehouse Brook, an Environment Agency Main River, runs northwards from Bartley Reservoir, through Senneleys Park and onward through Bartley Green, before discharging into the Bourn Brook near Osmaston Road. In the vicinity of Senneleys Park, there are two other ordinary watercourses: the Bartley Brook which runs north-easterly to the rear of the properties on Ambleside and a smaller tributary of Stonehouse Brook within Senneleys Park. Flooding in the vicinity of Middle Acre Road was caused by breaches from two of the watercourses; the Bartley Brook and the Stonehouse Brook.

Identified Flooding Type(s)	
	
	
No. of flooded properties: 4	

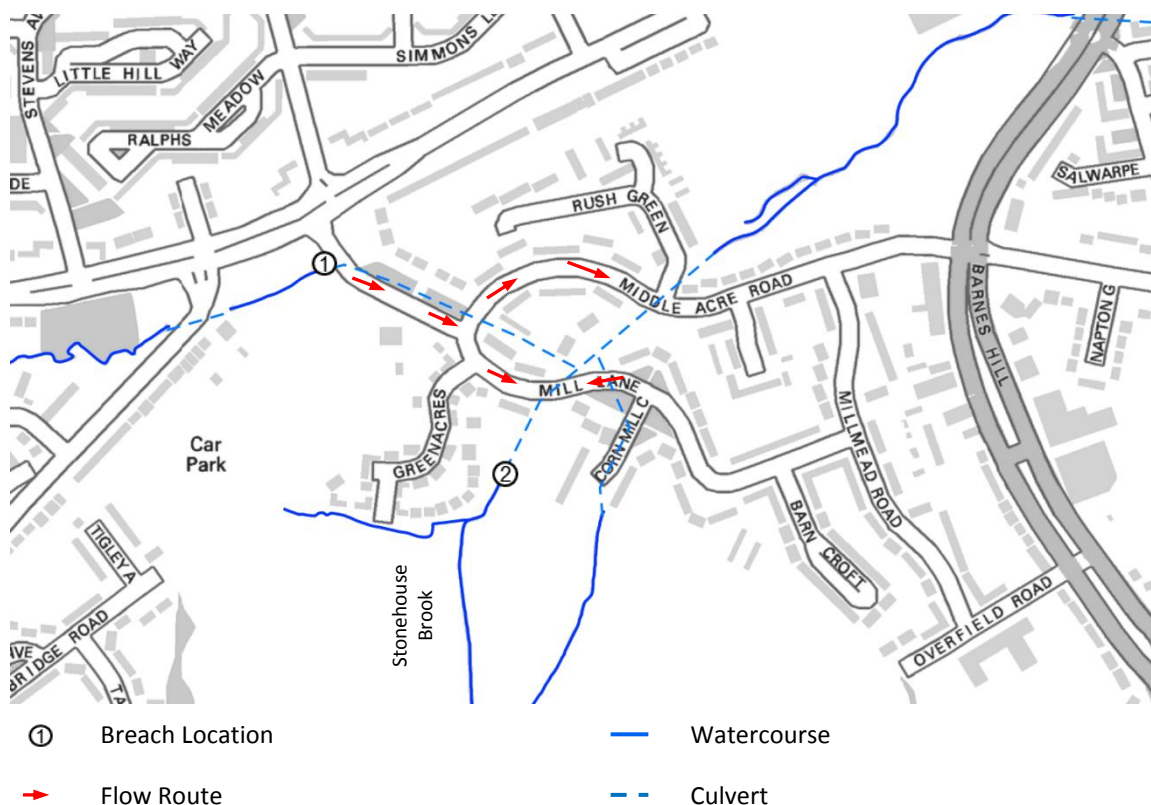


Figure 4-2 Potential watercourse breaches and overland flow routes

Figure 4-2 shows the locations of where the watercourses are understood to have breached. At Breach Location 1, the Bartley Brook breached at Mill Lane where the watercourse enters culvert. This resulted in overland flows running south-eastwards along Mill Lane and into Middle Acre Road.

The Stonehouse Brook is also understood to have breached where it enters culvert beneath Mill Lane, as indicated as Breach Location 2. This resulted in river waters flowing into Mill Lane, following the footpath and entering Middle Acre Road.

In both cases, the flooding was likely due to the flow in the watercourses exceeding the capacity of the culverts causing water levels upstream of the culverts to increase and spill from the banks into the adjacent Mill Lane and then flowing into Middle Acre Road and Rush Green.

The Stonehouse Brook is a Main River and the Environment Agency has modelled this brook as part of the wider River Rea catchment. The areas at risk of flooding from the Stonehouse Brook are shown on the extract of the Flood Risk from Rivers or the Sea map shown in Figure 4-3. The flooding reported correlates with the high risk areas from the mapping further emphasising the source of flooding was the watercourses within the immediate area.



Figure 4-3 Flood Risk from Rivers or the Sea map

### *What has been done?*

Prior to the 16<sup>th</sup> June, Birmingham City Council (Housing) has previously installed property level resilience measures.

Following the 16<sup>th</sup> June, Birmingham City Council (LLFA) has undertaken a site walkover of the affected areas and has conducted an initial review of the existing drainage infrastructure. The Bartley Brook culvert between mill Lane and Stonehouse Brook has been inspected to assess the structural condition and for blockage.

### What next?

The following table outlines the recommended actions for this area to be undertaken by the appropriately identified RMA.

Recommended Actions	Identified Party / RMA
<b>Investigate the capacity of the Bartley Brook and culvert</b>	Birmingham City Council (LLFA) in partnership with Environment Agency
<b>Develop an updated model of the watercourse through Senneleys Park including the Bartley Brook and other watercourses</b>	Environment Agency in partnership with Birmingham City Council (LLFA)
<b>Investigate options to manage overland flows</b>	Birmingham City Council (LLFA)
<b>Investigate options for flood mitigation scheme</b>	Environment Agency in partnership with Birmingham City Council (LLFA)
<b>Develop catchment options across the upper Bourn Brook catchment to manage flooding from all sources.</b>	Birmingham City Council (LLFA), Severn Trent Water and Environment Agency
<b>Assess the effectiveness of the installed property level resilience measures</b>	Birmingham City Council (Housing)

### 4.3 BARTLEY GREEN – DAINTON GROVE

*What happened?*

One property in Dainton Grove reported internal flooding due to the storms on 16<sup>th</sup> June 2016. Flood questionnaires have since been sent out to residents in the vicinity of the affected property; however no further reports of internal property flooding have been reported

*Why did it happen?*

The flooding in this area has been identified to be surface water flooding.

The flooding at this location was the result of rainfall falling onto the rear garden and flowing over the ground into the property as the back garden slopes towards the property. There may have been some runoff also coming from the adjoining rear garden in Jiggins Lane. The potential flow routes are shown in Figure 4-4.

The problem of water coming into the property may be exacerbated by the low threshold levels to the kitchen and living room. The small drain on the patio which takes rainwater from the patio and the kitchen waste, which although not blocked was not able to cope with the volume of storm water.





Identified Flooding Type(s)	
	
	
No. of flooded properties: 1	



Figure 4-4 Potential watercourse breaches and overland flow routes

### *What has been done?*

Birmingham City Council (LLFA) conducted a walkover of the affected area.

### *What next?*

Due to the highly localised nature of the flooding there are few options available at a strategic level. The following table outlines recommended actions that may be undertaken at a local level.

Recommended Actions	Identified Party / RMA
<b>Explore the potential for flood mitigation by re-landscaping the garden and improving property drainage</b>	Birmingham City Council (Housing)
<b>Develop catchment options across the upper Bourn Brook catchment to manage flooding from all sources</b>	Birmingham City Council (LLFA), Severn Trent Water and Environment Agency

## 4.4 BORDESLEY GREEN




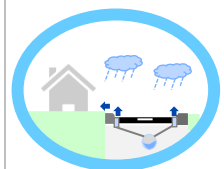
### What happened?

In June 2016, two properties in Pretoria Road reported internal flooding within the ground floor rooms.

### Why did it happen?

The flooding in this area has been identified to be flooding from highway drainage and surface water flooding.

Flood investigation questionnaires have been sent out to the residents in this area, and these suggest that during the storm, leaves, twigs and other debris accumulated on the surface of gullies and reduced flows entering the highway drainage system.

Identified Flooding Type(s)	
	
	
No. of flooded properties: 2	

Following investigation of the flooding, it is highly likely that the intensity of the storm increased the amount of debris within the highway which did restrict flows entering the highway drainage system. As such, surface water runoff flowed down the highway as shown in Figure 4-5 and ponded in the low point of the highway. This was further exacerbated as the kerbs adjacent to the gullies are ‘drop kerbs’ meaning that they are at similar levels to the surface of the highway. As such, when water began to pond in this area it quickly overtopped the kerb and flowed over footpaths and gardens into properties.

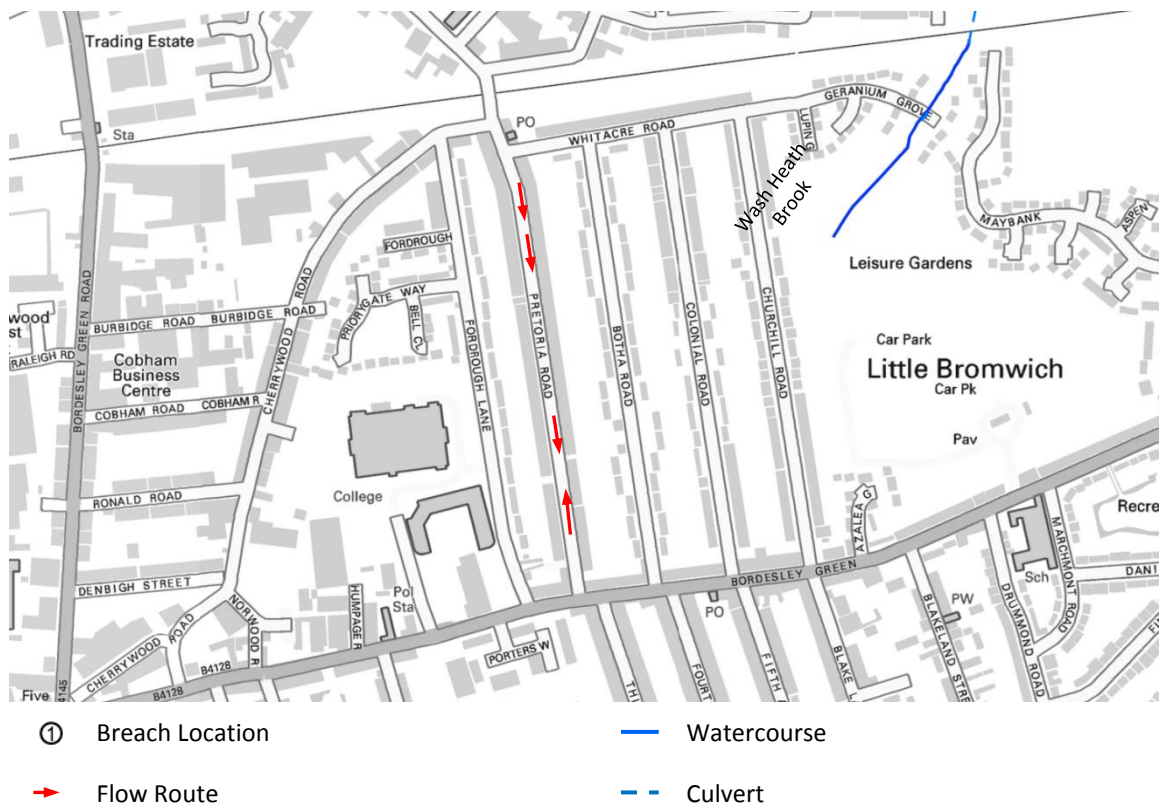


Figure 4-5 Potential overland flow routes



### *What has been done?*

Birmingham City Council (LLFA) has undertaken a site walkover of the affected areas and has conducted an initial review of the existing drainage infrastructure.

### *What next?*

Due to the highly localised nature of the flooding and the lack of any obvious flow paths there are few options available at a strategic level. The following table outlines recommended actions that may be undertaken at a local level.

Recommended Actions	Identified Party / RMA
<b>Review maintenance regime to ensure gullies are free from debris</b>	Birmingham City Council (Highways)
<b>Explore the potential for flood mitigation</b>	Birmingham City Council (LLFA) & Home owners

## 4.5 BOURNVILLE

### What happened?

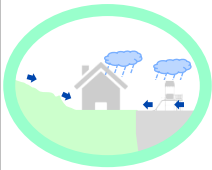


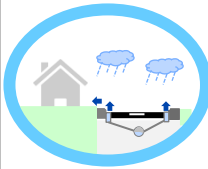
On the 16<sup>th</sup> June, a single property in Kingfisher Way reported internal flooding, with multiple reports of flooding to surrounding highway, footpaths and gardens.

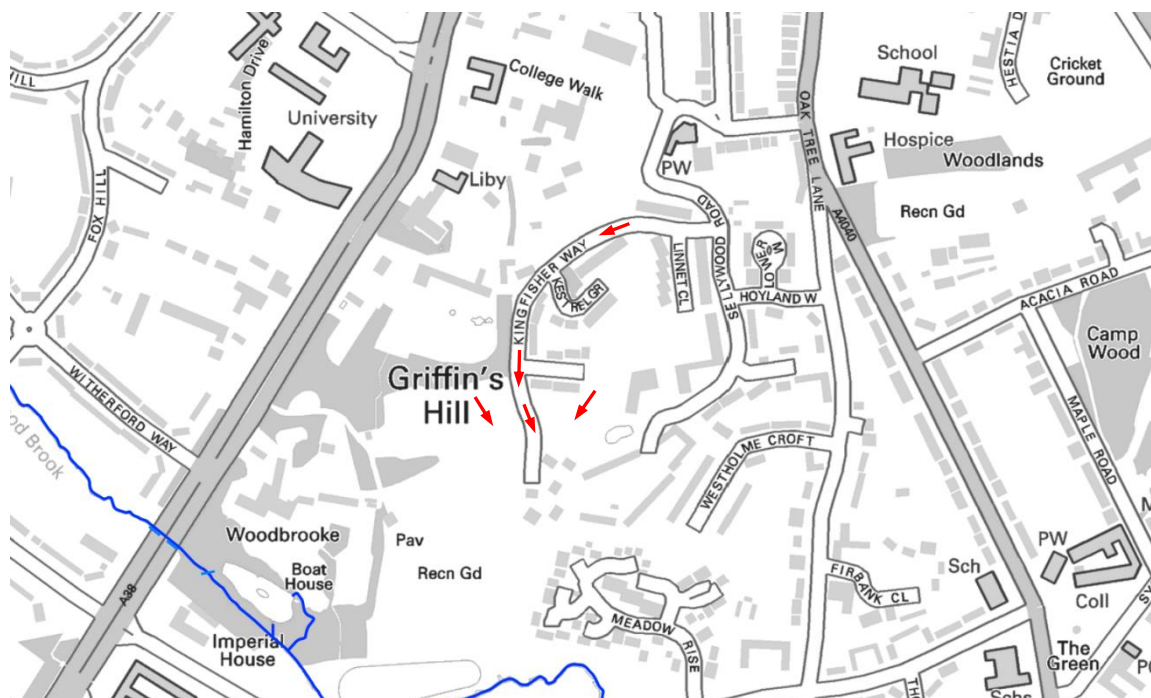
### Why did it happen?

The flooding in this area has been identified to be surface water flooding and highway drainage flooding.

Kingfisher Way is a steep highway catchment falling in a southerly direction. Located adjacent to Kingfisher Way is a significant amount of open space which is managed and maintained by Bournville Village Trust. Due to the intensity of the rainfall, it is likely the rain falling on the open space was unable to soak into the ground and resulted in surface water flowing over the open space, following the local topography, into the highway and towards the properties in Kingfisher Way. The potential surface water flow routes are shown in Figure 4-6.

The surface water overtopped the kerbs and flowed into adjacent properties that are set lower than the highway. This was further exacerbated as many of kerbs, particularly those at entrances to driveways, are 'drop kerbs' meaning that they are at similar levels to the surface of the highway. As such, when water began to pond in this area it quickly overtopped the drop kerbs and flowed over footpaths and gardens into properties.

Identified Flooding Type(s)	
	
	
No. of flooded properties: 1	



- ① Breach Location
- ➔ Flow Route
- Watercourse
- - - Culvert

Figure 4-6 Potential overland flow routes

### *What has been done?*

Birmingham City Council (LLFA) has completed an initial site visit, which included a walk over inspection of the affected area, onsite review of the existing highway drainage and assessment of overland flow paths.

Following this initial site visit, two new highway gullies have been installed and initial discussions with Bournville Village Trust regarding potential mitigation measures have been undertaken.

### *What next?*

Due to the highly localised nature of the flooding and the lack of any obvious flow paths there are few options available at a strategic level. The following table outlines recommended actions that may be undertaken at a local level.

Recommended Actions	Identified Party / RMA
<b>Explore the potential to manage surface water flows within the public open space through SuDS and other measures</b>	Bournville Village Trust

## 4.6 FALCON LODGE

### What happened?

Two properties in the Falcon Lodge area of Sutton Coldfield, reported internal property flooding as a result of the extreme weather on 16<sup>th</sup> June.

### Why did it happen?

The flooding in this area has been identified to be surface water flooding, sewer flooding and flooding from rivers.

The topography in the area forms a valley from Rectory Road in the north and Newdigate Road in the south sloping down to the low point located between Glover Road and Churchill Road. Due to the magnitude of the storm on 16<sup>th</sup> June, highway drainage and sewer infrastructure was overwhelmed by the volume of rainfall and as a result, the prevailing topography directed surface water runoff towards the low point of the valley, utilising the highways as conveyance channels. This was further exacerbated in some locations through the use of dropped kerbs, thereby allowing water to spill from the highways at shallower depths.

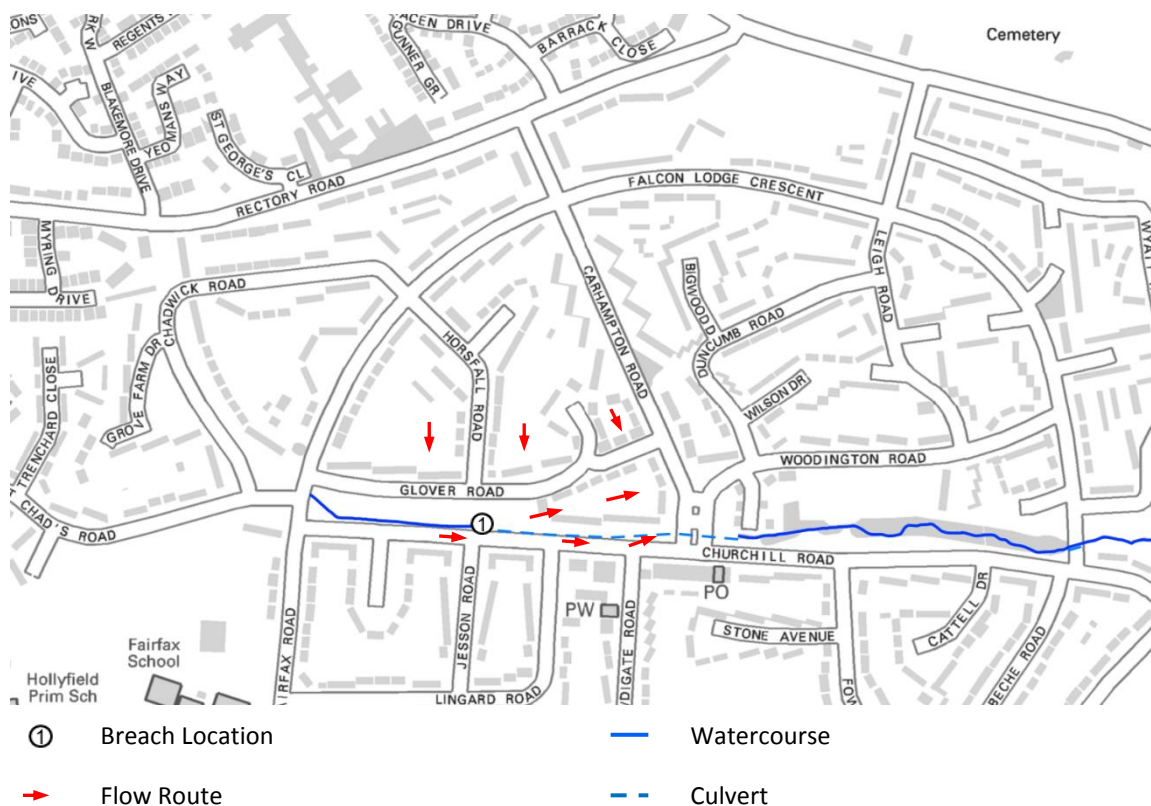
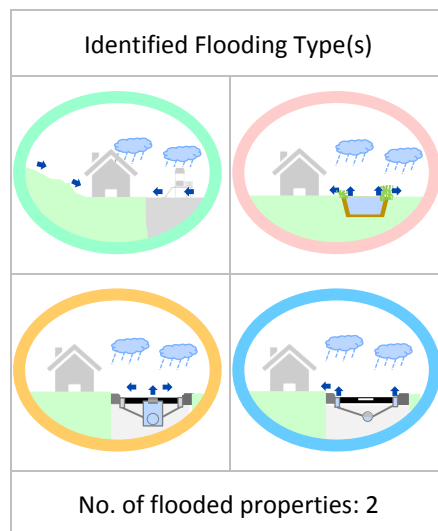


Figure 4-7 Potential watercourse breach and overland flow routes

In addition, to the surface water runoff from the surrounding properties and highways, it was reported that Churchill Brook to the west, shown in Figure 4-7, exceeded its capacity and water levels rose beyond the banks and flowed out of the channel adding to flooding. Responses to the Flooding investigation questionnaires suggest flows in this watercourse breached the banks at Breach Location 1, and followed

the local topography, flowing through open space and gardens before ultimately ponding in the low point near the affected properties on Carhampton Road.

While it is not confirmed that the brook did breach, if this occurred it is likely due to capacity of the culvert being exceeded due to the magnitude of the storm and not due to any blockage. The trash screen at the western end of the culvert was inspected prior to and immediately following the event and was free from blockage on both occasions.

### *What has been done?*

Following the storm, Birmingham City Council (Highways) has inspected and cleared the road gullies in this area and has inspected the trash screen on the Churchill Brook.

Birmingham City Council (LLFA) has undertaken a site walkover of the affected areas and has conducted an initial review of the existing drainage infrastructure and identified potential flow routes.

### *What next?*

Due to the highly localised nature of the flooding there are few options available at a strategic level. The following table outlines recommended actions that may be undertaken at a local level.

Recommended Actions	Identified Party / RMA
<b>Assess the condition and capacity of the sewer network in the vicinity of Carhampton Road, Glover Road and Churchill Road</b>	Severn Trent Water
<b>Assess the condition and capacity of the highway drainage network to establish if additional gullies are required</b>	Birmingham City Council (LLFA and Highways)
<b>Assess the condition and capacity of the Churchill Brook to establish if additional capacity is required</b>	Birmingham City Council (LLFA)
<b>Explore the potential for flood mitigation</b>	Birmingham City Council (LLFA and Housing)

## 4.7 FOUR OAKS

### What happened?

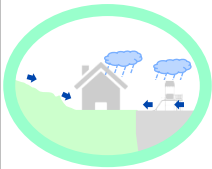

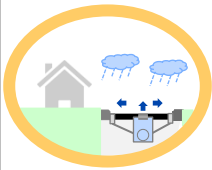
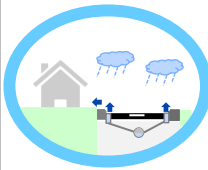
During the storm event on the 8<sup>th</sup> June, one incident of internal property flooding was reported in Highcroft Drive. Additional flooding to highways and gardens was also recorded in the surrounding area including Knighton Drive and Park View Road.

While there are historic records of internal property flooding in Knighton Drive, no reports of internal property flooding in Knighton Drive has been received as a result of the storms in June 2016.

### Why did it happen?

The flooding in this area has been identified to be surface water flooding, flooding from sewer infrastructure and highway drainage flooding.

Due to the magnitude of the storm on 8<sup>th</sup> June 2016, property drainage, highway drainage and sewer infrastructure was overwhelmed by the intensity of the rainfall. The resulting surface water runoff followed the topography of the area, using highways as conveyance channels, ultimately ponding in low lying areas. As the storm progressed, the highway became inundated allowing water to overtop the kerbs and flow into properties.

Identified Flooding Type(s)	
	
	
No. of flooded properties: 1	



- ① Breach Location
- Flow Route
- Watercourse
- - Culvert

Figure 4-8 Potential overland flow routes

It was reported that blockages in the drainage systems, in particular the highway gullies, resulted in the flooding within this area. However following the event, flood waters receded via the onsite drainage systems (including property and highway drainage and sewer infrastructure). As such it is likely that the intensity of the storm, and volume of rainfall, overwhelmed the highway drainage and sewer infrastructure generating surface water flows which resulted in flooding.

### *What has been done?*

Birmingham City Council (LLFA) has undertaken a site walkover of the affected areas and has conducted an initial review of the existing drainage infrastructure.

Birmingham City Council (Highways) have inspected and cleared the road gullies in this area.

### *What next?*

Due to the highly localised nature of the flooding there are few options available at a strategic level. The following table outlines recommended actions that may be undertaken at a local level.

<b>Recommended Actions</b>	<b>Identified Party / RMA</b>
<b>Assess the condition and capacity of the sewer network</b>	Severn Trent Water
<b>Assess the condition and capacity of the highway drainage network to establish if additional gullies are required</b>	Birmingham City Council (LLFA and Highways)
<b>Explore the potential for flood mitigation measures</b>	Birmingham City Council (LLFA) and Homeowners

## 4.8 HAMPSTEAD





### What happened?

During the storm event on the 8<sup>th</sup> June, one property in Old Walsall Road reported internal flooding; highway and garden flooding was also reported.

### Why did it happen?

The flooding in this area has been identified to be surface water flooding.

Richmond Croft, located to the east of Old Walsall Road, is adjacent to a large area of public open space. Due to the intensity of the rainfall, it is likely that the rain falling on the open space was unable to soak into the ground. This resulted in surface water flowing from east to west, following the local topography, into the rear gardens of properties in Old Walsall Road as shown in Figure 4-9.

Identified Flooding Type(s)	
	
	
No. of flooded properties: 1	

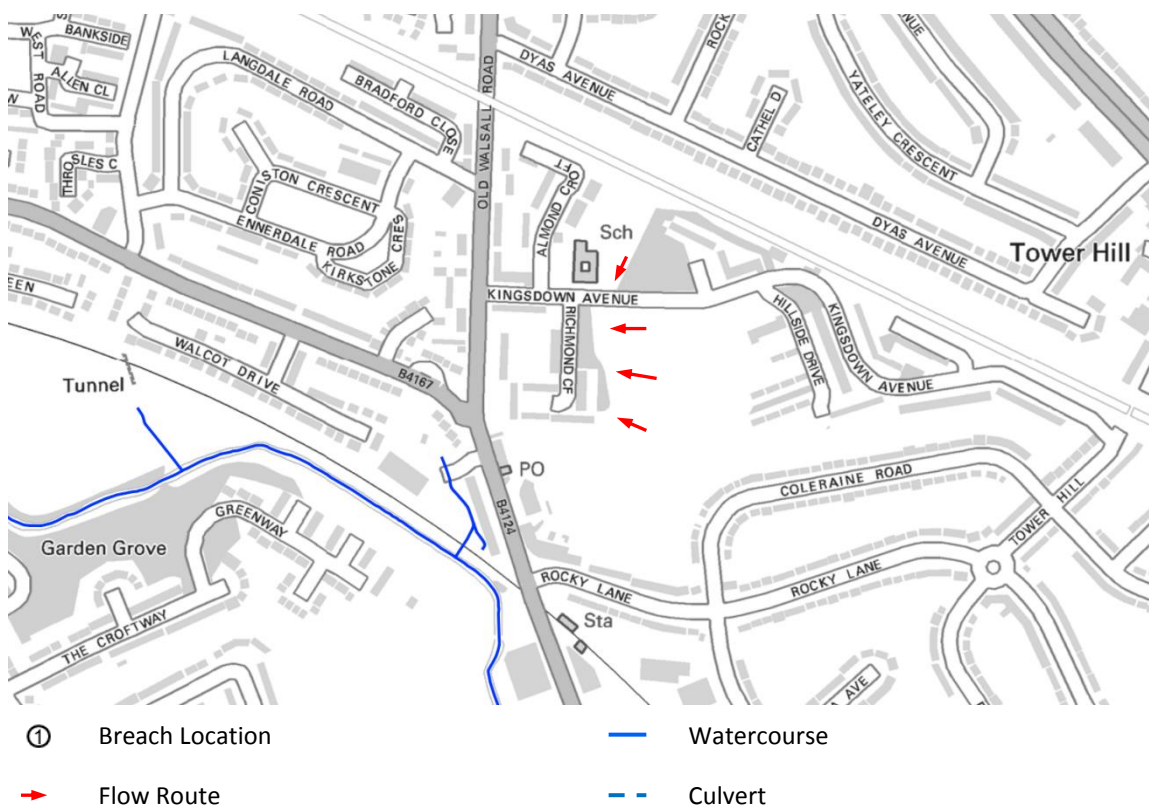


Figure 4-9 Potential overland flow routes

### What has been done?

Birmingham City Council (LLFA) has undertaken a site walkover of the affected areas and has conducted an initial review of the existing drainage infrastructure and identified potential flow routes.



### *What next?*

The following table outlines the recommended actions for this area to be undertaken by the appropriately identified RMA.

Recommended Actions	Identified Party / RMA
<b>Explore the potential for flood mitigation measures</b>	Birmingham City Council (LLFA & Leisure Services) and Homeowners

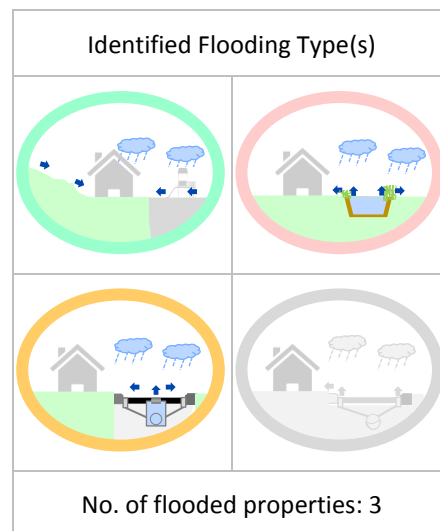
## 4.9 HANDSWORTH WOOD – GRESTONE

### What happened?

During the storm event on the 8<sup>th</sup> June, three properties reported internal flooding in Greystone Avenue and Sunningdale Close, with flooding to highways, footpaths and gardens also reported in Craythorne Avenue.

### Why did it happen?

The flooding in this area has been identified to be flooding from rivers, sewer flooding and surface water flooding.



Due to the magnitude of the storm on 8<sup>th</sup> June 2016, property drainage, highway drainage and sewer infrastructure was overwhelmed by the intensity of the rainfall. The resulting surface water runoff followed the topography of the area, using highways as conveyance channels, ultimately ponding in the low point in Greystone Avenue, Craythorne Avenue, Acfold Road and Sunningdale Close. As the storm progressed, the highway became inundated allowing water to overtop the kerbs and flow into properties that lie lower than the road level.

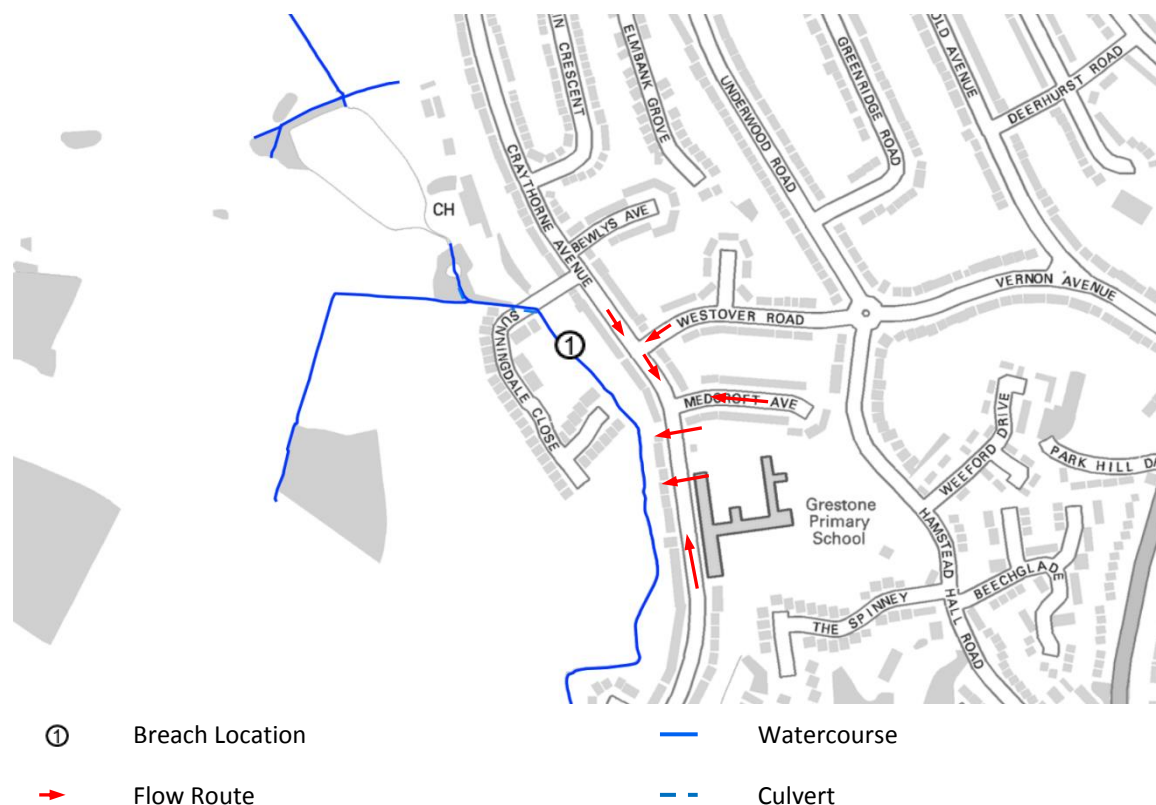


Figure 4-10 Potential watercourse breach and overland flow routes

There are sewer outfalls into the Hilltop Brook to the rear of properties on Greystone Avenue which were inspected following the storm event. It was determined that the capacity of the sewer network was compromised due to the accumulation of sediment and silt within the outfall and the Hilltop Brook itself.

As a result, the highway drainage and sewer system were full to capacity further exacerbating the surface water flooding in the area.

In addition, the Hilltop Brook was unable to convey flows during the storm. Flood waters rose within the channel and overtopped the banks at Breach Location 1; the capacity of the watercourse culvert passing under Sunningdale Close was compromised due to sediment accumulation and vegetation growth.

### *What has been done?*

Birmingham City Council (LLFA) has undertaken a site walkover of the affected areas and has conducted an initial inspection of the Hilltop Brook in the vicinity. This identified that there was substantial restriction to flows within the watercourse, culvert and sewer outfall due to sediment accumulation and overgrowth of vegetation. Sediment and vegetation has been removed from sections of the watercourse and the submerged outfalls have been cleared.

Furthermore, Birmingham City Council (Highways) have inspected and cleared the road gullies in this area.

### *What next?*

The following table outlines recommended actions that may be undertaken at a local level.

Recommended Actions	Identified Party / RMA
<b>Review of maintenance regime for Hilltop Brook</b>	Birmingham City Council (LLFA and Leisure Services) and Riparian Owners
<b>Assess the condition and capacity of the Hilltop Brook</b>	Birmingham City Council (LLFA and Leisure Services)
<b>Assess the condition and capacity of the sewer network</b>	Severn Trent Water
<b>Assess potential for future flood storage scheme on Hilltop Brook</b>	Birmingham City Council (LLFA and Leisure)

## 4.10 HANDSWORTH WOOD – SILVERCROFT

### What happened?


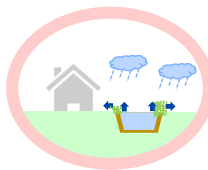
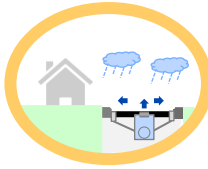

During the storm event on the 8<sup>th</sup> June, six properties located within Silvercroft Avenue and Grestones Avenue reported internal property flooding. Further flooding to highways, footpaths and gardens also reported.

### Why did it happen?

The flooding in this area has been identified to be flooding from rivers, surface water flooding and sewer flooding.

The Hilltop Brook runs in a northerly direction at the north-eastern end of Silvercroft Avenue. The brook flows through an area of allotments and public open space before passing through a culvert, under a footpath adjacent to Silvercroft Avenue, and continuing downstream where it is bordered to the west by public open space and to the east by residential properties, as shown in Figure 4-11.

During the storm, flows within the Hilltop Brook increased, eventually exceeding the capacity of the culvert under the footpath, shown as Breach Location 1, which resulted in water levels upstream increasing and eventually overtopping the footpath and highway and flowing over the surface into properties.

Identified Flooding Type(s)	
	
	
No. of flooded properties: 6	

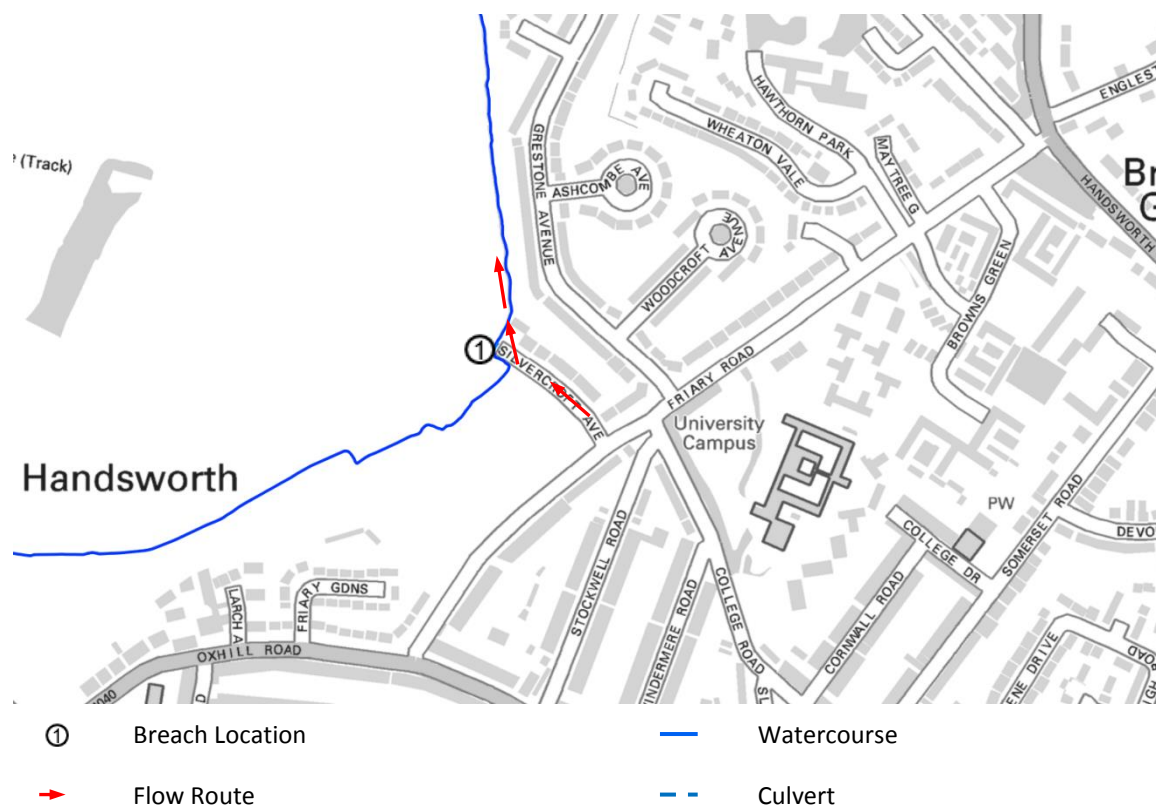


Figure 4-11 Potential watercourse breach and overland flow routes

Following an initial inspection of the culvert, it was determined that the capacity was compromised due to the accumulation of sediment and silt within the culvert which restricted flows. As such, it is likely that the surface water flooding was exacerbated by flooding from the Hilltop Brook.

In addition to this, due to the intensity of the storm on 8<sup>th</sup> June 2016, the formal drainage systems including property drainage, highway drainage and sewer infrastructure, were overwhelmed. This resulted in surface water runoff, which followed the topography of the area, ponding in the low point of Silvercroft Avenue where water levels rose and overtopped kerbs, flowing down driveways into properties that are situated at a lower level than the adjacent highway.

### *What has been done?*

Birmingham City Council (LLFA) has undertaken a site walkover of the affected areas and has conducted an initial inspection of the Hilltop Brook in the vicinity. This identified that there was substantial restriction to flows within the watercourse and culvert due to sediment accumulation and overgrowth of vegetation. Localised blockages and accumulations of silt have been removed.

### *What next?*

The following table outlines recommended actions that may be undertaken at a local level.

Recommended Actions	Identified Party / RMA
<b>Installation of trash screen and review of maintenance regime for Hilltop Brook</b>	Birmingham City Council (Leisure Services)
<b>Assess the condition and capacity of Hilltop Brook</b>	Birmingham City Council (LLFA and Leisure Services)
<b>Assess the condition and capacity of the sewer network</b>	Severn Trent Water

## 4.11 HARBORNE – BOURN BROOK

### What happened?


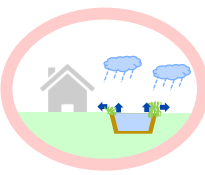
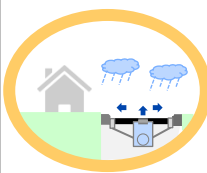
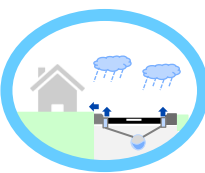
During the storm event on the 16<sup>th</sup> June, 33 incidents of internal property flooding were reported in Osmaston Road, Swinford Road, Elford Road, Reservoir Road, Quinton Road, and Lismore Drive. Additionally flooding to highways, public open space, footpaths and external property areas such as gardens was also reported in Mellors Close Northfield Road, and Derry Close.

### Why did it happen?

The flooding in this area has been identified to be flooding from rivers, sewer flooding and highway drainage flooding.

The area sits at the confluences of two tributaries of the Bourn Brook, the Harts Green Brook and the Stonehouse Brook. Due to the magnitude of the storm on 16<sup>th</sup> June 2016, the capacity of the Bourn Brook channel was exceeded, leading to rear garden and internal flooding to properties in Osmaston Road and Reservoir Road.

This was exacerbated by an accumulation of debris and vegetation in the channel, possibly due to reductions in maintenance over the last few years, together with increasing levels of silt most notably reducing the capacity of the bridge arches at the Elford Road crossing, shown as Breach Location 1 in Figure 4-12.

Identified Flooding Type(s)	
	
	
No. of flooded properties: 33	

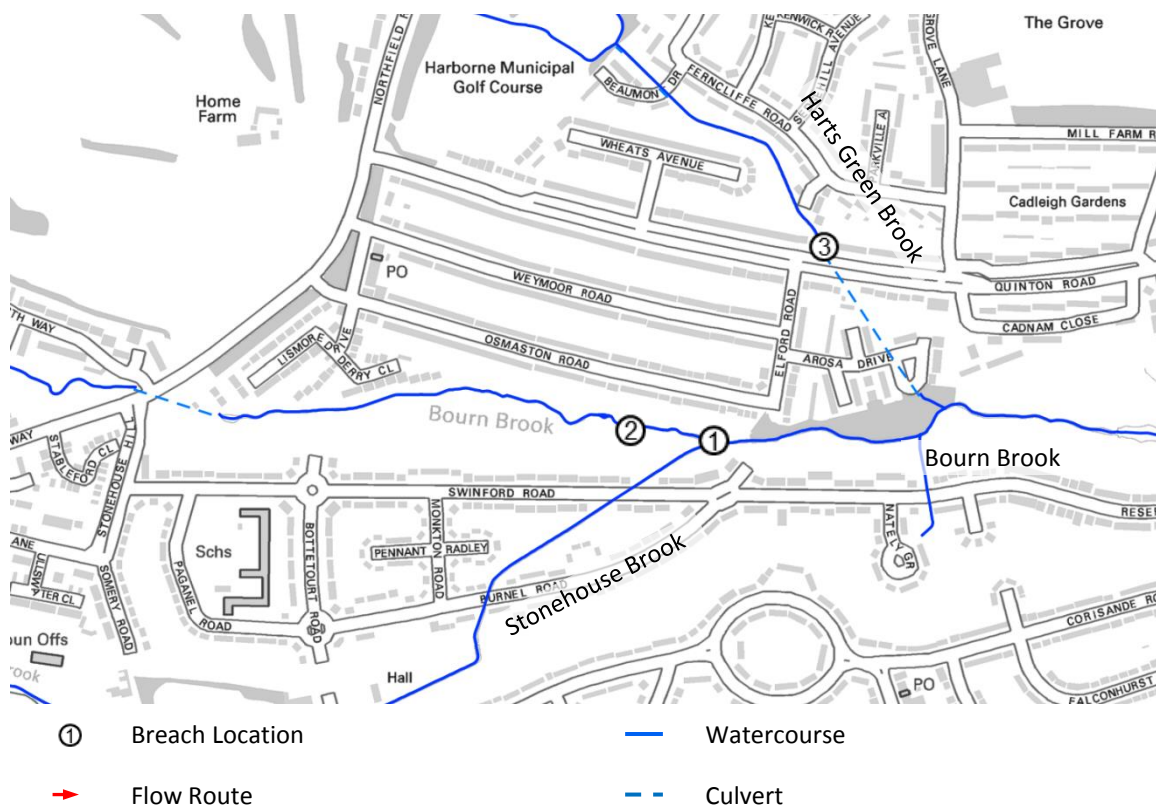


Figure 4-12 Potential watercourse breach and overland flow routes

In addition to this it was suggested the debris caught on the new Bourn Brook Walkway footbridge upstream of the confluence with Stonehouse Brook marked as Breach Location 2. There was also reported blockage at the entrance to the culvert of Harts Green Brook approximately 250m from its confluence with Bourn Brook, resulting in the channel overtopping and flooding properties in Quinton Road; this is marked as Breach Location 3.

Flooding also occurred as a result of sewer and highway drainage flooding in Reservoir Road, Swinford Road, Elford Road and Osmaston Road. In many cases properties flooded from the river at the rear and sewer/highway flooding at the front. It is reported that the highways in these roads were inundated with water with the highway gullies being unable to discharge to the sewer system which was overloaded. Foul flooding was also reported at Swinford Road and Osmaston Road.

Both the Bourn Brook and the Stonehouse brook are classified as Main Rivers and are therefore the responsibility of the Environment Agency. The areas at highest risk of flooding from these watercourses are shown on the Flood Risk from Rivers or the Sea, an extract of which is shown below in Figure 4-13.

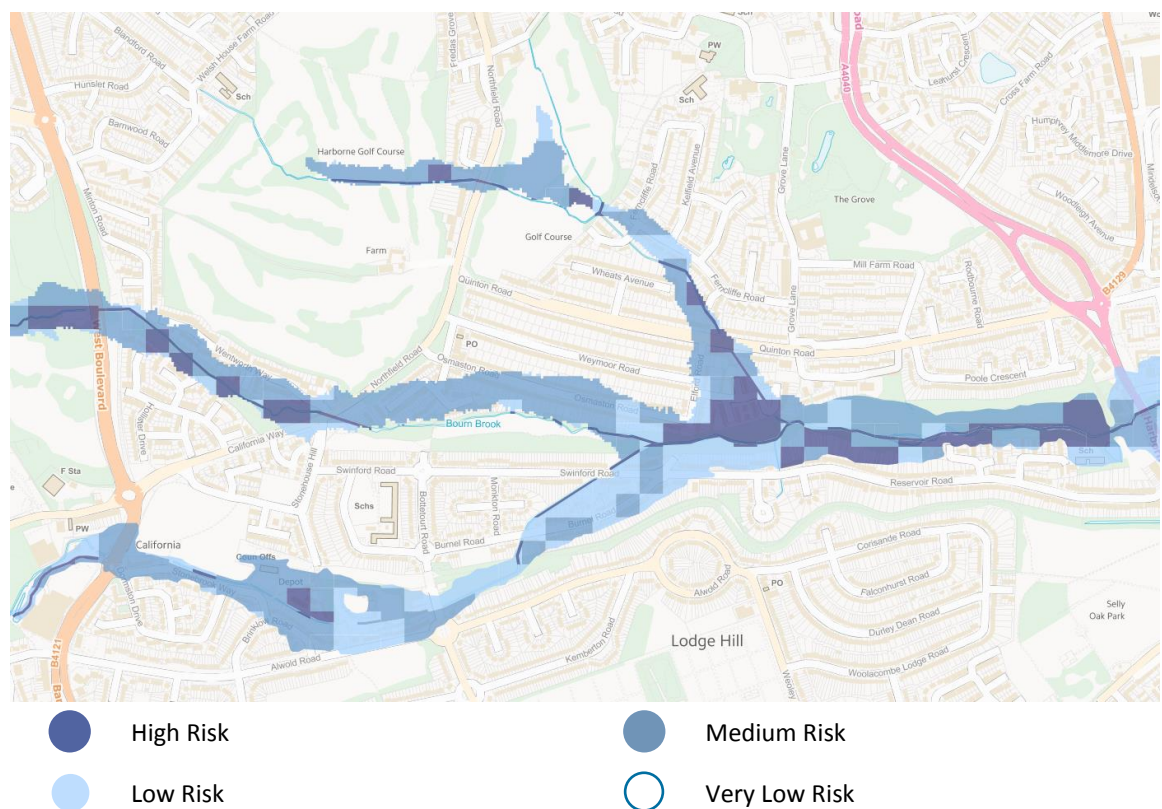


Figure 4-13 Flood Risk from Rivers or the Sea map

### *What has been done?*

Birmingham City Council (LLFA) has completed an initial review of the site.

Following the event all highway drainage was checked, cleared and jetted by Birmingham City Council (Highways)

The Harts Green Brook culvert beneath Quinton Road, adjacent to Mellors Close was inspected and cleansed. There was a low level of debris found in the open channel following the flood flows and this was removed, further debris/vegetation clearance of the channel between the Harborne Municipal Golf Course and Quinton Road is programmed.

Debris had accumulated on bridge and weir structures on the Bourn Brook and Environment Agency teams have carried out debris clearance and some tree and brush work.

### *What's next?*

The following table outlines the recommended actions for this area to be undertaken by the appropriately identified RMA.

Recommended Actions	Identified Party / RMA
Assess the condition and capacity of the sewer network	Severn Trent Water
Investigate reported instances of foul flooding	Severn Trent Water
Assess the condition and capacity of the highway drainage network	Birmingham City Council (Highways)
Routine maintenance of the Bourn Brook and maintain capacity of the bridge arch	Environment Agency
Develop catchment options across the upper Bourn Brook catchment to manage flooding from all sources	Birmingham City Council (LLFA), Severn Trent Water and Environment Agency



## 4.12 HARBORNE – FREDAS GROVE

### What happened?

During the storm event on the 16<sup>th</sup> June, one incident of internal property flooding was reported in Fredas Grove, with flooding to highways and gardens also reported.

### Why did it happen?

The flooding in this area has been identified to be surface water flooding.

Fredas Grove is bound to the west by Harborne Golf Course and is located within a natural valley, whereby the surrounding topography falls towards Fredas Grove generating a significant flow path, as shown on the flood risk from surface water mapping in Figure 4-14.

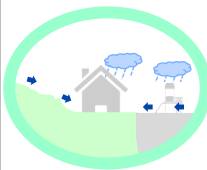



Identified Flooding Type(s)	
	
	
No. of flooded properties: 1	



Figure 4-14 Flood Risk from Surface Water map

Due to the magnitude of the storm on 16<sup>th</sup> June 2016, the rate of rainfall exceeded the rate at which it was able to soak into the ground within the Golf Course which resulted in substantial surface water runoff. As a result of the topography, surface water runoff collected at the low point immediately west of properties in Fredas Grove. As the event continued, surface water began to flow through rear gardens and properties into the highway, where the highway drainage and sewer infrastructure was unable to accommodate this runoff.

There is a historic watercourse that once flowed through the Golf Course, which has been culverted and now forms part of the sewer infrastructure; this is shown below in Figure 4-15. This may have further exacerbated the surface water flooding from the Golf Course as there is no longer a watercourse for surface water to discharge to, and as such surface water currently leaves the Golf Course in an uncontrolled manner. The potential surface water flow routes are also shown in Figure 4-15.

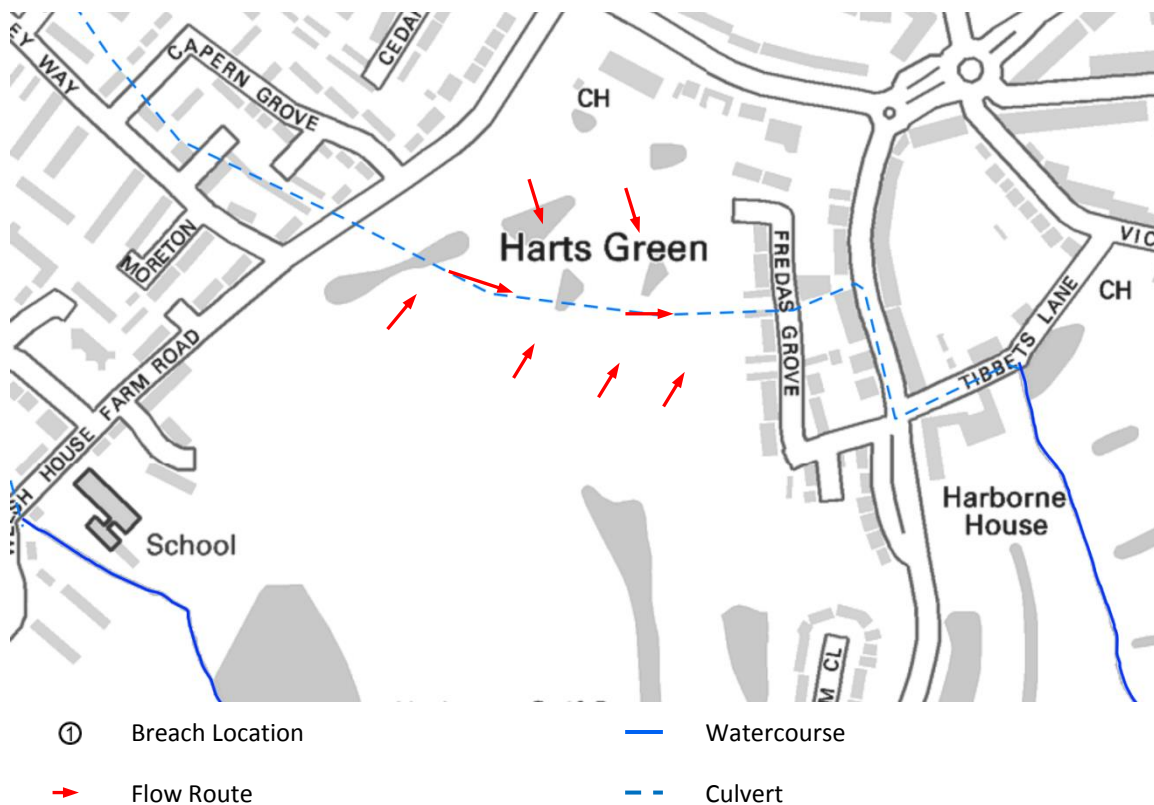


Figure 4-15 Potential overland flow routes

### What has been done?

Birmingham City Council (LLFA) and Harborne Golf Course have completed a site walkover of the affected areas, including an onsite initial review of the potential flow routes.

### What next?

The following table outlines the recommended actions for this area to be undertaken by the appropriately identified RMA.

Recommended Actions	Identified Party / RMA
Explore the potential to integrate flood storage within the Golf Course	Birmingham City Council (LLFA) and Harborne Golf Course
Develop catchment options across the upper Bourn Brook catchment to manage flooding from all sources	Birmingham City Council (LLFA) Severn Trent Water and Environment Agency



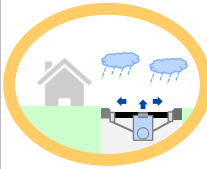
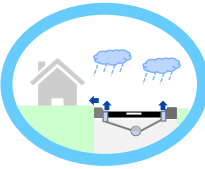
## 4.13 HARBORNE – QUEENS PARK

### What happened?

During the storm event on the 16th June, six internal property flooding incidents were reported in Queens Court and Harts Green Road, with flooding to highways, footpaths and gardens also reported in Lelant Grove, Conington Grove and Battenhall Road.

### Why did it happen?

The type of flooding responsible for flooding in this area has been identified to be surface water flooding, flooding from sewer infrastructure and highway drainage flooding.

Identified Flooding Type(s)	
	
	
No. of flooded properties: 6	

Due to the intensity of the storm on 16<sup>th</sup> June 2016, the rate of rainfall exceeded the rate at which it was able to soak into the ground within the park resulting in surface water runoff. The prevailing topography then directed runoff southwards through Queen’s Park and into Queen’s Court and Harts Green Road with further flows passing through Green Road, Lelant Grove, Conington Grove and Battenhall Road as shown in Figure 4-16; runoff then accumulated in the low point of Harts Green Road at the south-east end.

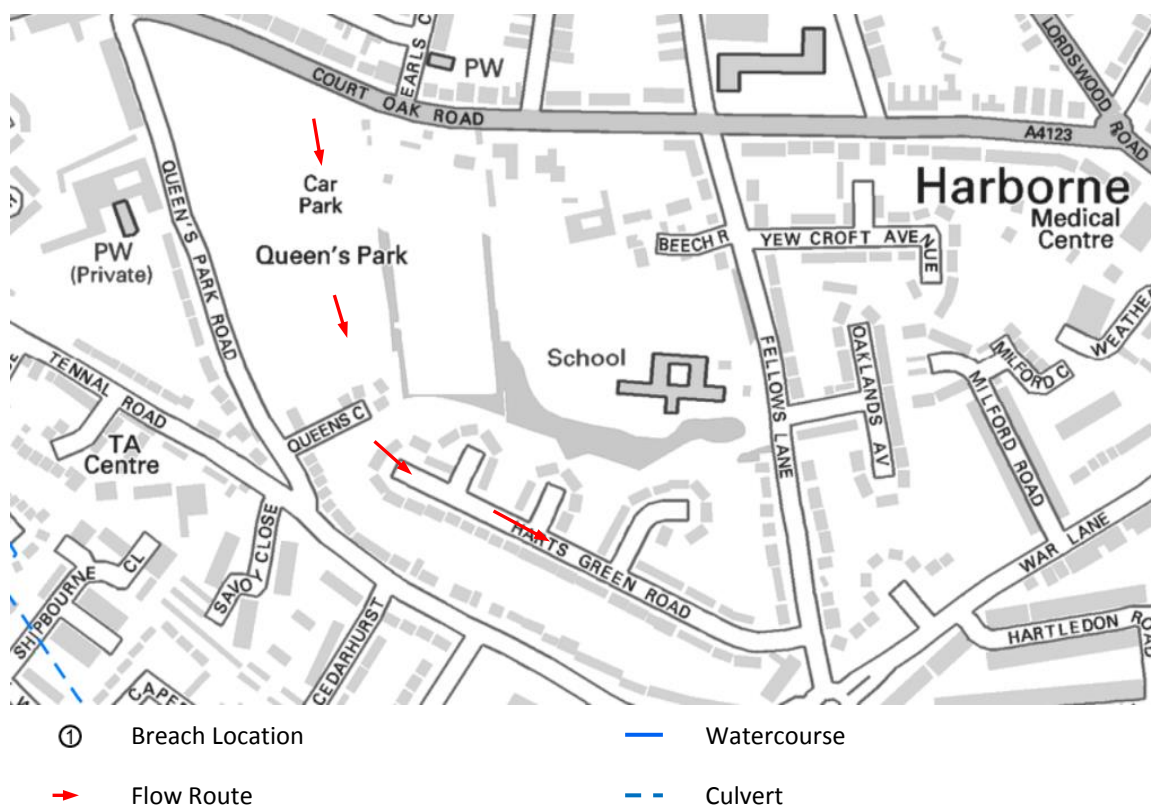


Figure 4-16 Potential overland flow routes

Further surface water flow paths were noted by residents; however these are considered to be minor flow paths and did not result in internal property flooding, as shown in Figure 4-17.



Figure 4-17 Flood Risk from Surface Water map

Given the volume of rainfall during the storm, it is likely that property level drainage, highway drainage and sewer infrastructure was overwhelmed which increased surface water flows and exacerbated ponding within low points. However it was noted there is often ponding in this low point and therefore the capacity of the sewer system and highway drainage may be a contributing factor.

### *What has been done?*

Birmingham City Council (LLFA) has completed a site walkover of the affected areas, including an onsite initial review of the existing park and highway drainage.

Furthermore, Birmingham City Council (LLFA) is undertaking a scheme to alleviate surface water flooding from the park. The current proposal is to construct a flood storage area at the southern boundary of the park which will store water during a flood event this will then drain down into the existing surface water sewer network following a storm event. The planning application for the scheme was approved in Spring 2017 and construction is due to be completed Autumn 2017.

### *What next?*

The following table outlines the recommended actions for this area to be undertaken by the appropriately identified RMA.

Recommended Actions	Identified Party / RMA
<b>Implementation of the proposed flood alleviation scheme</b>	Birmingham City Council (Leisure)
<b>Assess the condition and capacity of the sewer network</b>	Severn Trent Water
<b>Assess the condition and capacity of the highway drainage network</b>	Birmingham City Council (Highways)
<b>Develop catchment options across the upper Bourn Brook catchment to manage flooding from all sources</b>	Birmingham City Council (LLFA) Severn Trent Water and Environment Agency



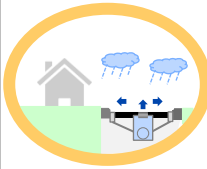
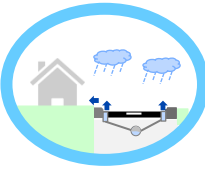
## 4.14 MERE GREEN

### What happened?

During the storms on the 10<sup>th</sup> and 16<sup>th</sup> June, five properties reported internal property flooding, located in Cremorne Road and Mere Green Road. Flooding to highways, footpaths and gardens was also reported.

### Why did it happen?

The flooding in this area has been identified to be surface water flooding, flooding from sewer infrastructure and highway flooding.

Identified Flooding Type(s)	
	
	
No. of flooded properties: 5	

The area of reported internal flooding in Cremorne Road is at the lowest point of the surrounding ground. Reports of the flooding suggest that surface water flow entered the properties from the rear, which is consistent with available surface water mapping, as shown in Figure 4-18 below, where flows follow the slope of the land from north to south.



Figure 4-18 Flood Risk from Surface Water map

Due to the intensity of the storms in June 2016, it is likely that highway drainage and the overall sewer infrastructure in Mere Green Road was overwhelmed and was unable to accommodate the volume of runoff within the system. This excess water was initially contained within highways, however as the storm progressed the highways became inundated with water overtopping into adjacent properties. The potential overland flow routes are shown below in Figure 4-19.

Following receipt of the flooding surveys distributed to residents, some reports indicate that the highway drainage and sewer infrastructure surcharged and water was seen to flow back out of gullies and manholes into the highway.

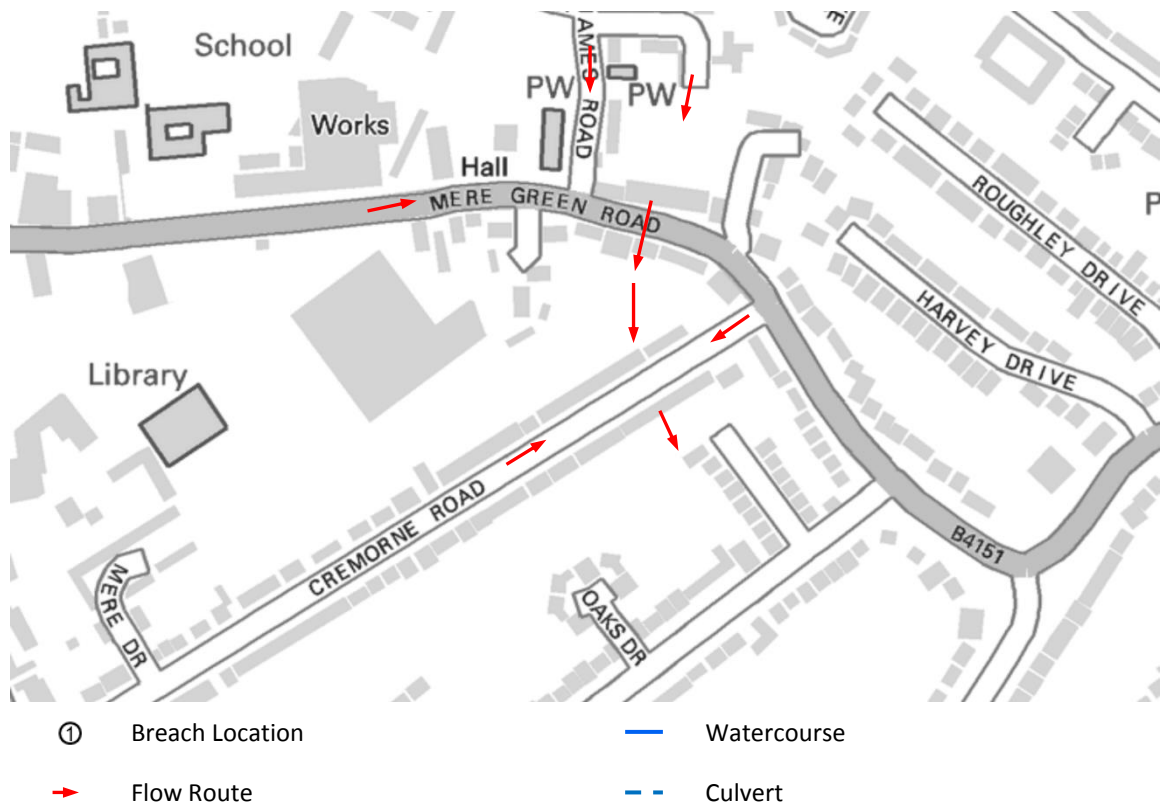


Figure 4-19 Potential overland flow routes

### *What has been done?*

Birmingham City Council (LLFA) has completed an initial review of the site.

Property level resilience measures were installed by Severn Trent Water to five properties in Mere Green Road in 2015.

### *What next?*

The following table outlines the recommended actions for this area to be undertaken by the appropriately identified RMA.

Recommended Actions	Identified Party / RMA
<b>Assess the condition and capacity of the sewer network</b>	Severn Trent Water
<b>Assess the condition and capacity of the highway drainage network</b>	Birmingham City Council (Highways)
<b>Explore the potential for flood mitigation</b>	Birmingham City Council (LLFA), Severn Trent Water and Home owners
<b>Assess the effectiveness of the installed property level resilience measures</b>	Severn Trent Water



## 4.15 OSCOTT

### What happened?





During the storm on the 8<sup>th</sup> June, two properties reported internal property flooding in Oscott School Lane, in the vicinity of the recreation grounds bound by Aldridge Road, Shady Lane, Felstone Road and Oscott School Lane.

### Why did it happen?

The flooding in this area has been identified to be surface water flooding.

Due to the magnitude of the event, rain fell on the recreation grounds at a rate that exceeded the rate that it could soak into the ground resulting in significant surface water runoff. The recreation ground slopes from west to east and this topography directed runoff towards the eastern edge of the recreation ground where it ponded in a low point adjacent to an access path along the eastern boundary.

As ponding increased and water levels rose, water spilled into the access path and adjacent properties. There was substantial flooding to rear gardens in the area, with flows passing through properties before joining Oscott School Lane where this water entered the highway drainage, or was contained within the highway and conveyed away from properties.

Identified Flooding Type(s)	
	
	
No. of flooded properties: 2	

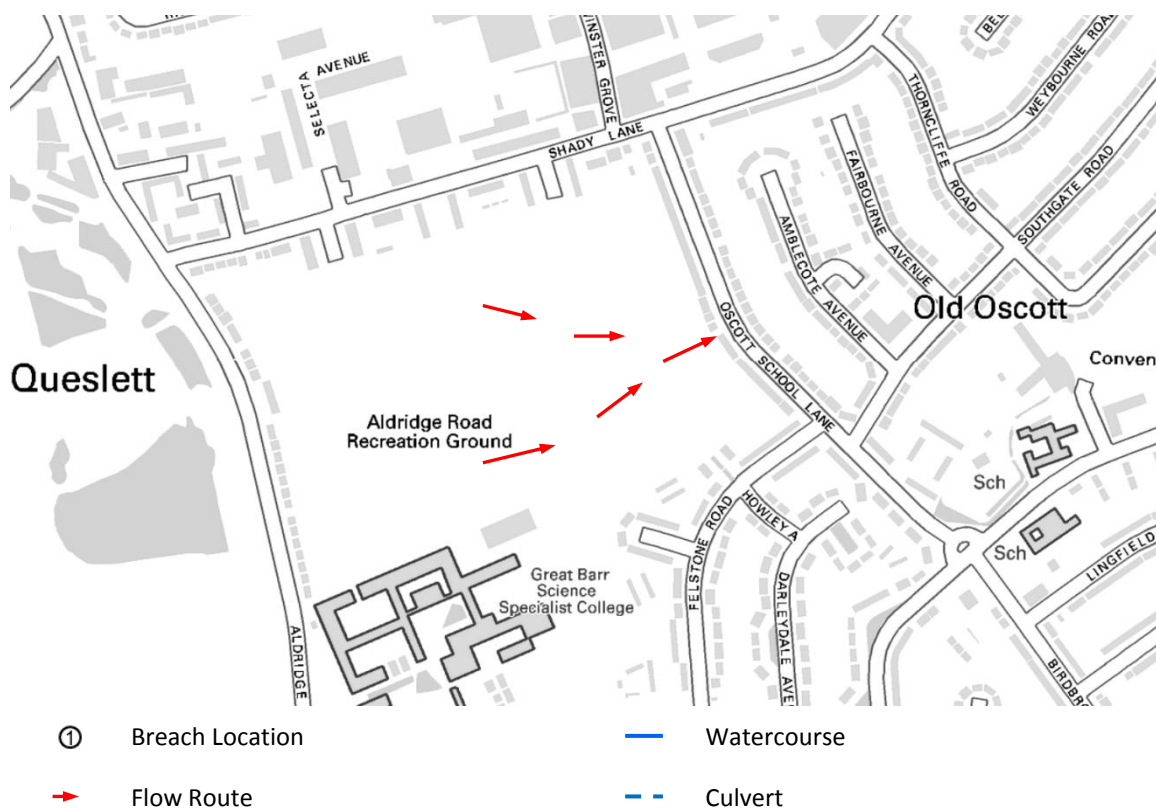


Figure 4-20 Potential overland flow route

### *What has been done?*

Birmingham City Council (LLFA) has undertaken a site visit, and associated investigation, into property flooding within this area.

### *What next?*

The following table outlines the recommended actions for this area to be undertaken by the appropriately identified RMA.

Recommended Actions	Identified Party / RMA
<b>Investigate options to manage overland flows from the recreation ground</b>	Birmingham City Council (LLFA and Leisure Services)
<b>Explore the potential for flood mitigation</b>	Birmingham City Council (LLFA) and Home owners

## 4.16 PERRY BARR

### What happened?

During the storm on the 8<sup>th</sup> June, two properties reported internal property flooding located within Church Road, in the vicinity of the Perry Brook. This location has flooded previous on at least three occasions.

### Why did it happen?

The flooding in this area has been identified to be flooding from rivers and flooding from sewers

Due to the magnitude of the event, the Perry brook came out of channel where the watercourse enters the culvert to the rear of the Church Tavern; marked as Breach Location 1 in Figure 4-21. The volume of water was so great that it overtopped the flood defence bund within Perry Park, and flowed into Church Road flooding properties.

In addition to the river flooding, the surface water and foul water sewers in Church Road were exceeded by the storm event causing manholes to surcharge and flood, preventing the highway gullies from being able to convey water from the highway, exacerbating flooding.

There is also a possibility that the flood defence wall built to protect properties from the River Tame backing up which runs at the side of the Church Road properties made the flooding worse because it stopped water flowing from Church Road back into the brook.

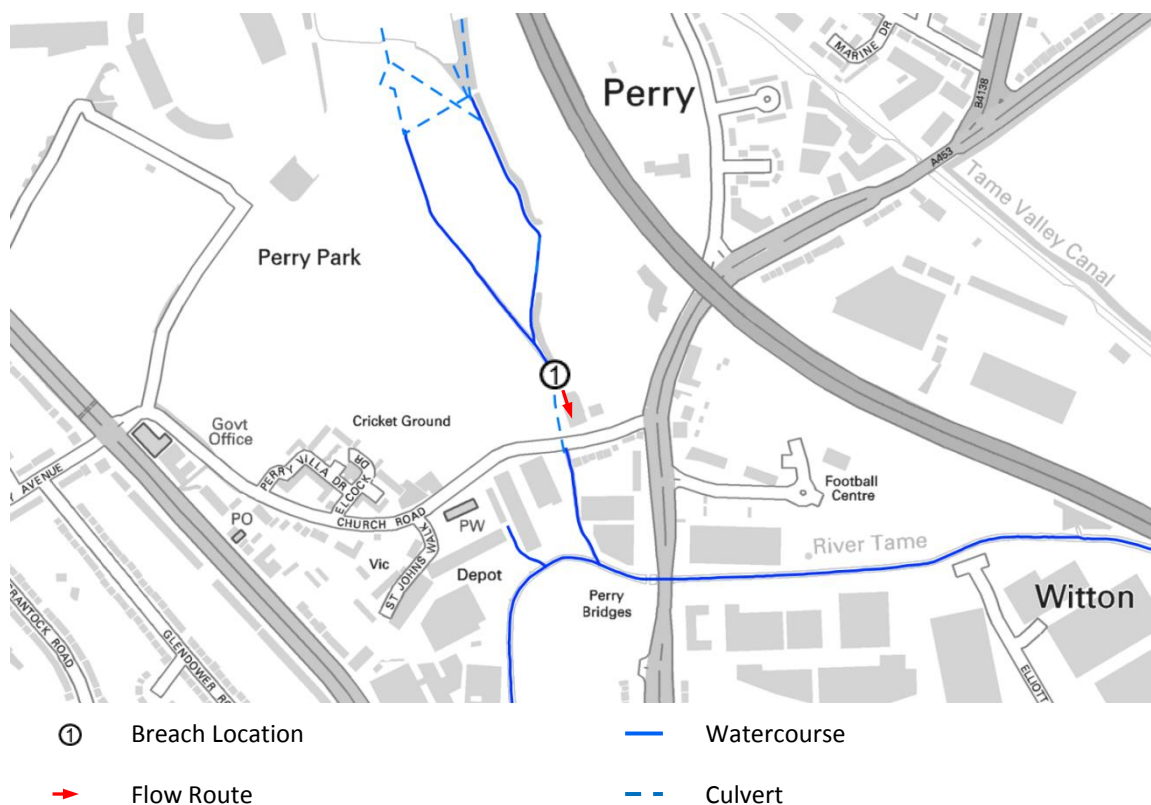
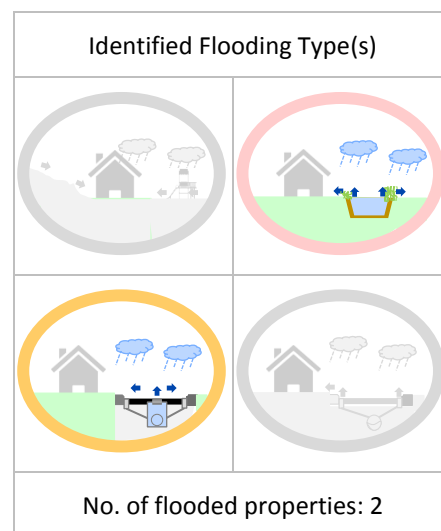


Figure 4-21 Potential watercourse breaches and overland flow routes

The Perry Brook is a Main River from the point it enters the culvert to the rear of the Church Tavern and the Environment Agency has modelled this watercourse as part of the wider River Tame catchment modelling. The areas at high risk of flooding from the watercourses are shown on the extract of the Flood Risk from Rivers or the Sea map in Figure 4-22.

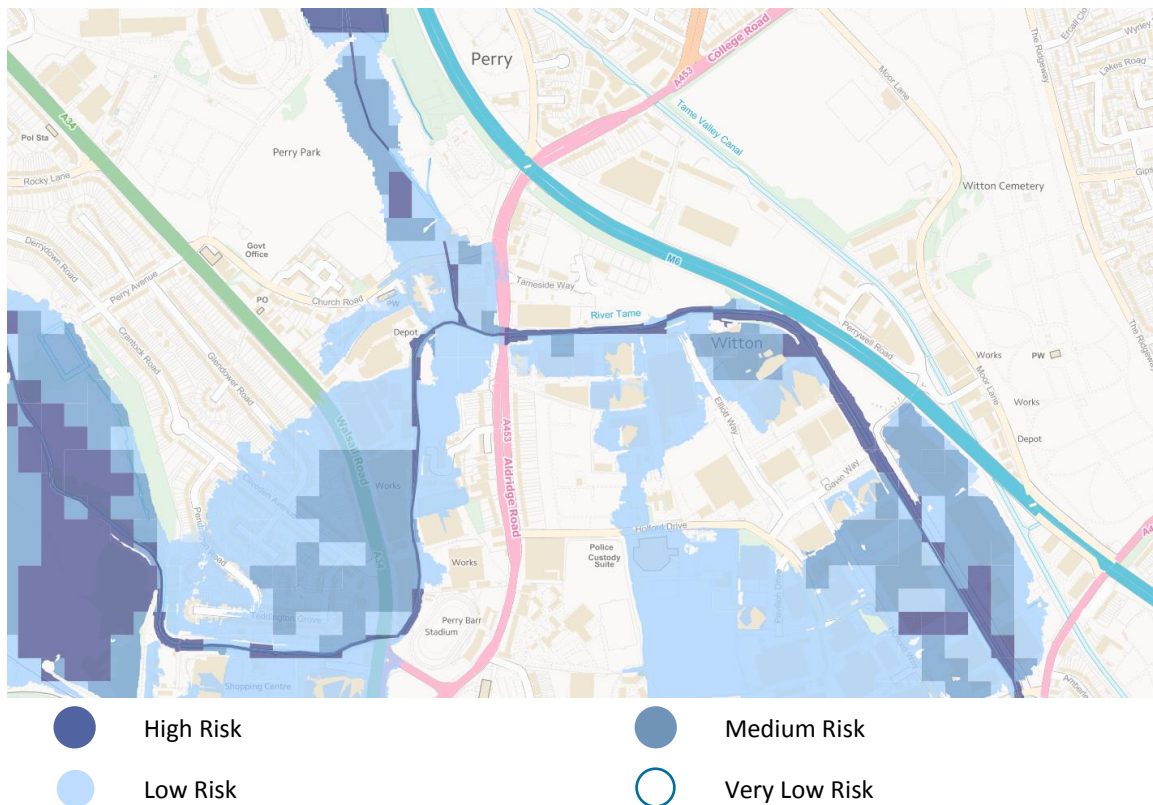


Figure 4-22 Flood Risk from Rivers or the Sea map

The flooding reported correlates with the high risk areas in the Flood Risk from Rivers or the Sea map, emphasising the primary source of flooding was the watercourse.

### *What has been done?*

Birmingham City Council (LLFA) has undertaken a site visit, and associated investigation, into property flooding within this area.

Birmingham City Council (Highways) have inspected and cleared the highway drainage

The trash screen at the entrance to the culvert which is on the Environment Agency regular clearance programme was also checked and cleared by Birmingham Council.

In 2007, Birmingham City Council undertook a study to understand the cause of the flooding at this location following the previous flooding event in 2005. This report notes that the culvert under the Church Tavern car park is a lot smaller than the culvert under the Road, thus restricting the capacity. It also noted that the earth bund in Perry Park varies in height therefore not holding back as much water as it potentially could.

### *What next?*

The following table outlines the recommended actions for this area to be undertaken by the appropriately identified RMA.

<b>Recommended Actions</b>	<b>Identified Party / RMA</b>
<b>Investigate options to manage overland flows from the Perry Park, including increasing the height of the bund</b>	Birmingham City Council (Leisure Services)
<b>Investigate capacity of Perry Brook culvert and interaction with River Tame defences</b>	Environment Agency
<b>Assess the condition of the sewer network in the catchment area</b>	Severn Trent Water

## 4.17 PERRY BEECHES

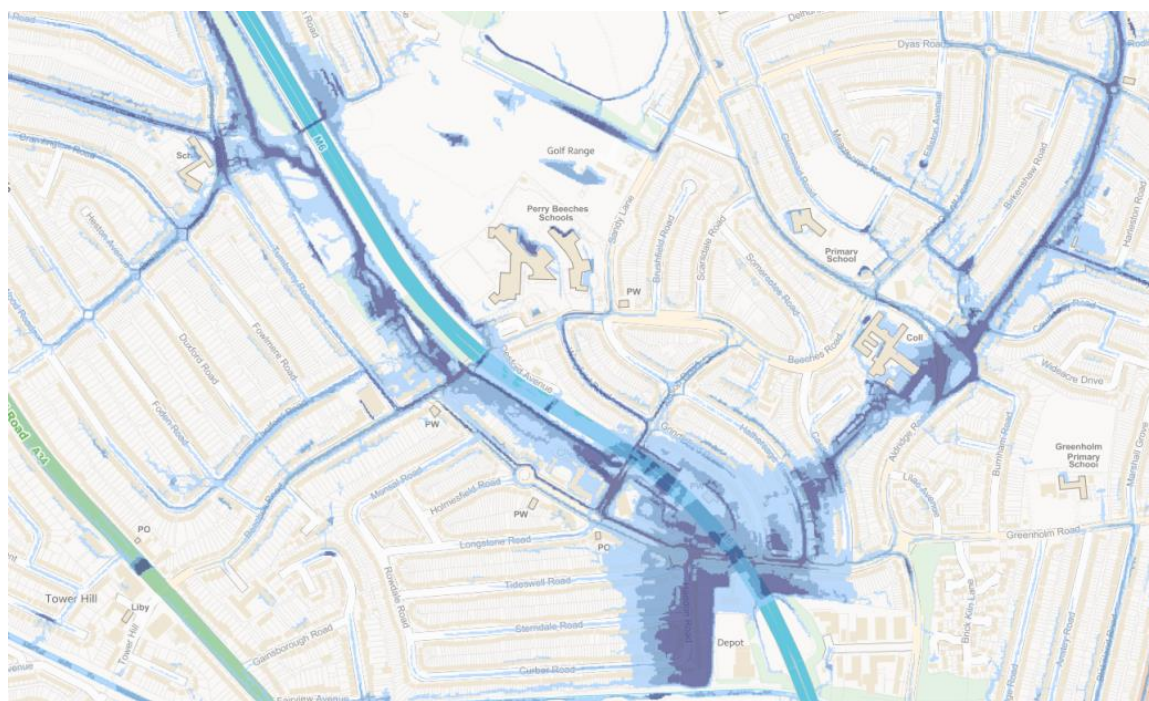
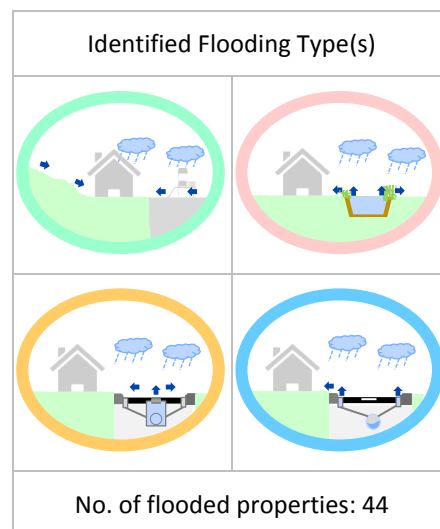
### What happened?

Significant flooding occurred across Perry Beeches following the storm on 8<sup>th</sup> June 2016. 44 incidents of internal property flooding were reported in 10 roads around the Beeches Estate including Beeches Road, Bradfield Road, Curbar Road, Grindleford Road, Haddon Road, Hassop Road, Sterndale Road, Thornbridge Avenue, Trehurst Avenue and Turnberry Road

Garden and highway flooding was reported across much of the area with more than 20 roads affected.

### Why did it happen?

The flooding in this area have been identified to be a combination of surface water flooding, river flooding, flooding from sewer infrastructure, flooding from highway drainage and flooding from the motorway/motorway maintenance depot.



- High Risk
- Medium Risk
- Low Risk
- Very Low Risk

Figure 4-23 Flood Risk from Surface Water map

Due to the intensity of the storms in June 2016, it is likely that highway drainage and the public sewer infrastructure were overwhelmed and unable to accommodate the volume of runoff within the system. At several locations manhole covers were blown off by the pressure of water escaping out of public sewer systems. This excess water increased as the storm progressed, with water levels rising resulting in flooding to highways, gardens and properties located at the lowest points in the area. Overland surface water flows

from surrounding roads not able to enter the highway drainage and public sewer systems ran down steep adjacent roads, adding to the flood levels.

The Risk of Flooding from Surface Water map covering Perry Beeches is shown in Figure 4-23. This shows the surface water flow routes through the area as a result of runoff from the surrounding higher areas and correlates with the areas affected by flooding on the 8<sup>th</sup> June.

Figure 4-24 shows the likely flow routes in the area. The ground in the area forms two relatively steep sided valleys and when it rains, surface water runoff flows downhill towards the valley floor. The valleys are arranged in a 'Y' shape, following the M6 in a north-west to south-east direction, and Birdbrook Road and Bradford Road in a north-east to south-west direction. This topography causes surface water flows to be funnelled towards the low point of the valley, near Haddon Road.

The Perry Brook flows in a south-easterly direction from Beeches Road parallel to the M6. The watercourse then enters a culvert at Hassop Road which extends south to Perry Park. Water flooded out of the open channel upstream of Hassop Road where it goes into culvert, indicated as Breach Location 1 above. This water flooded the allotments and Chervil Close and then flowed into Hassop Road flooding properties. It then flowed down Becton Grove and to the rear of properties in Thornbridge Avenue contributing to the flooding from the public sewer infrastructure in Thornbridge Avenue, Grindleford Road and Haddon Road.

The Perry Brook is not a Main River therefore the responsibility for flood risk management and investigating flooding from the watercourse falls to the Lead Local Flood Authority, although the landowners above and either side of the watercourse are responsible for its structure and maintenance. The flood zones associated with the Perry Brook are shown in Figure 4-25. These flood zones correlate with those properties affected by river flooding on 8<sup>th</sup> June.



Figure 4-24 Potential watercourse breaches and flow routes

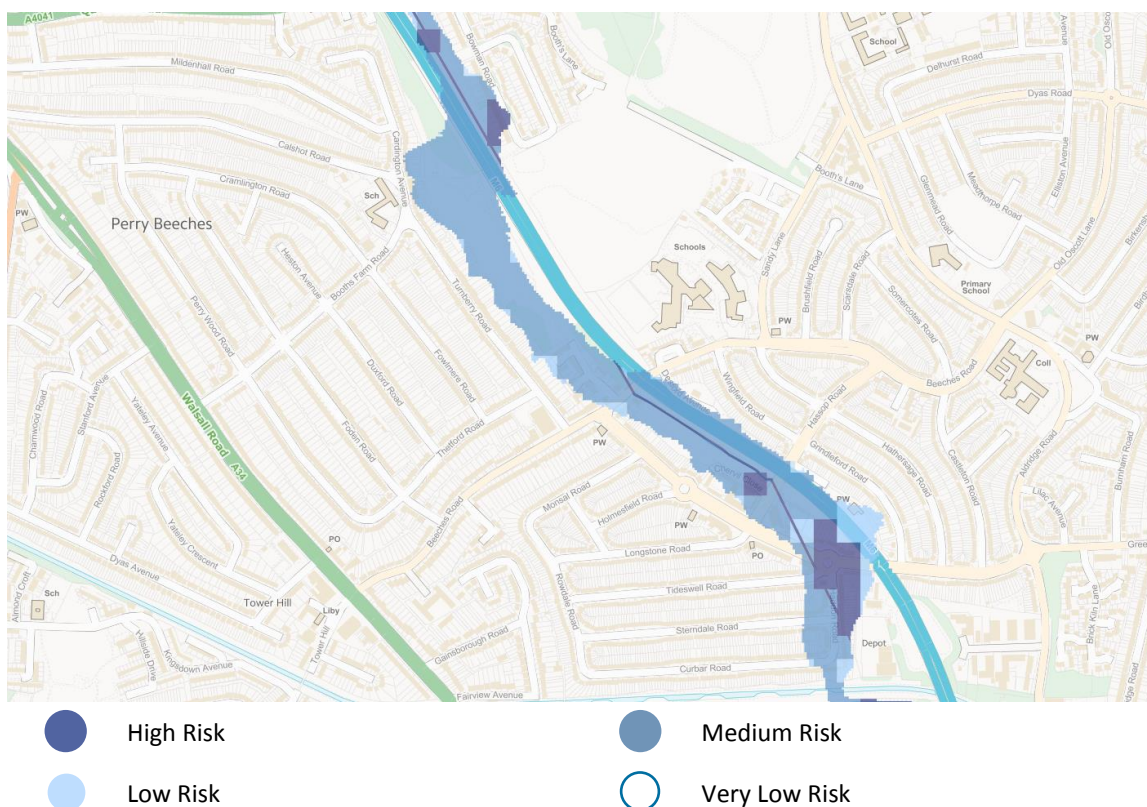


Figure 4-25 Flood Risk from Rivers or the Sea map

At Thornbridge Avenue, water also came from the Motorway Control Centre into the rear gardens of Haddon Road.

Following the storm event, flood waters receded with water draining through gullies as capacity became available in the highway drainage and sewer infrastructure, and following overland flow routes into watercourses.

### *What has been done?*

Birmingham City Council (Highways) has cleared the gullies in the area

Birmingham City Council (LLFA) has investigated the condition of the Perry Brook culvert between Hassop Road and Perry Park. Birmingham City Council has undertaken localised silt removal between Beeches Road and Hassop Road, although further silt removal is required in the section of culvert owned by Highways England.

Furthermore, Birmingham City Council (LLFA) has been successful in securing a government grant for funding to carry out a detailed assessment of the cause of flooding in this area and to develop a number of options which, if implemented, could mitigate some or all of the flood risk.

Highways England has inspected the drainage infrastructure from the raised sections of the M6 Motorway and has implemented corrective measures where it was found to be deficient.

### *What next?*

The following table outlines the recommended actions for this area to be undertaken by the appropriately identified RMA.



Recommended Actions	Identified Party / RMA
<b>Assess the condition and capacity of the sewer network in the catchment area</b>	Severn Trent Water
<b>Construct a hydraulic model to enhance understanding of flooding mechanisms and develop a set of options to mitigate flooding within the area</b>	Birmingham City Council (LLFA)
<b>Review maintenance regime to ensure gullies are free from debris</b>	Birmingham City Council (Highways)
<b>Fix and maintain the drainage infrastructure from the elevated sections of the M6.</b>	Highways England
<b>Regular inspections of the Perry Brook culverts</b>	Highways England
<b>Regular inspections and maintenance of the open channel through Perry Park</b>	Birmingham City Council (Leisure)

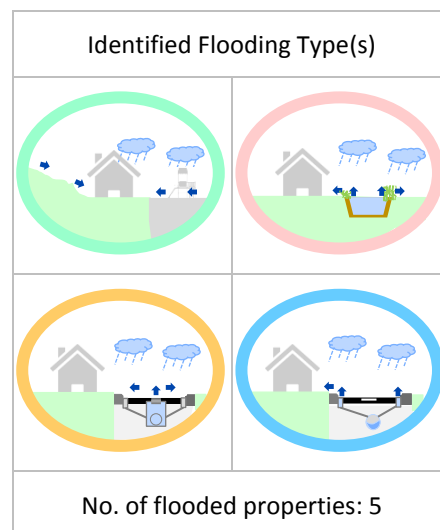
## 4.18 QUINTON

### What happened?

Five properties located in Ridgemont Croft, Overdale Road and Firsby Road were affected by internal property flooding as a result of the June 2016 storms. Further flooding to the highways, footpaths and gardens occurred.

### Why did it happen?

The types of flooding responsible for flooding in this area have been identified to be surface water flooding, flooding from sewer infrastructure, flooding from rivers and flooding from highway drainage.



The affected properties in Ridgemont Croft, Overdale Road and Firsby Road are located at the low point of the surrounding topography, in a natural valley. As a result, surface water runoff followed the local topography and highways to pond at the lowest point resulting in the highway becoming inundated and water overtopping into the adjacent properties.

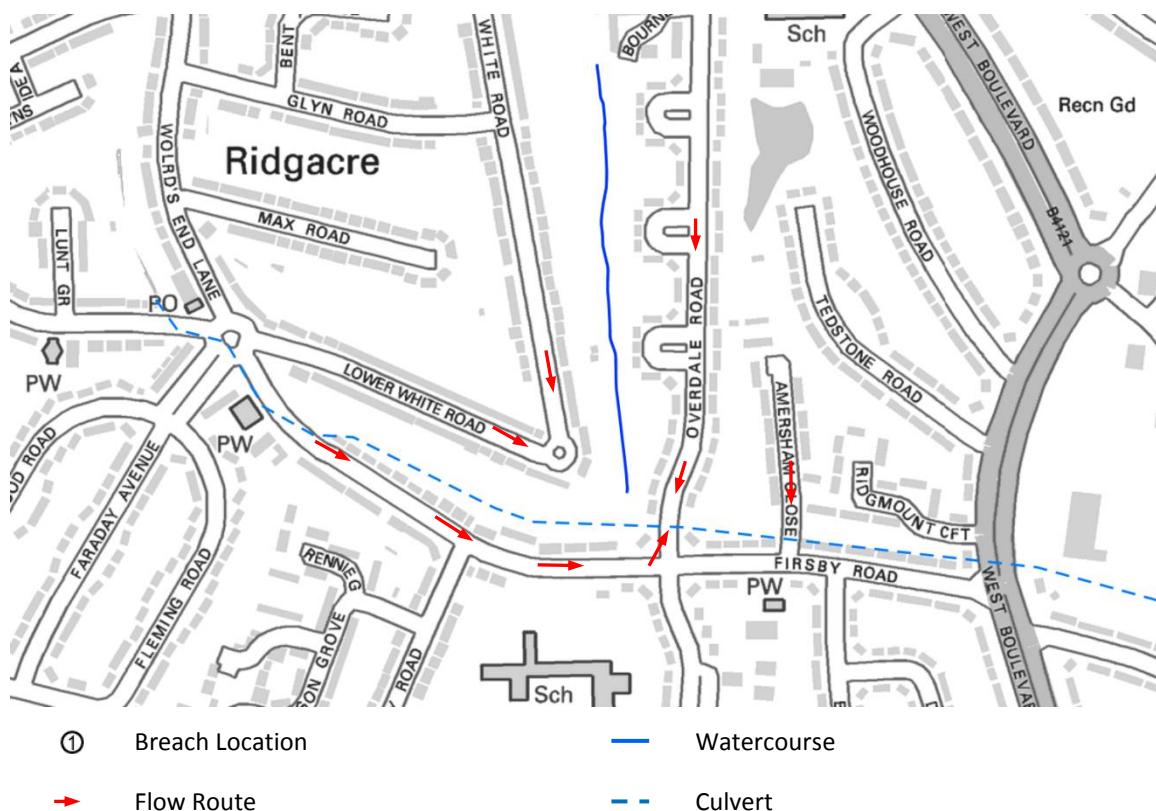


Figure 4-26 Potential overland flow routes

The area is drained by public surface water sewers which flow into the culverted Welches Brook which runs west to east beneath Overdale Road. The culvert at this location is under the ownership of Birmingham City Council Housing as it passes underneath their land. As such, Birmingham City Council Housing is responsible for maintenance of the culvert.

As a result of the local topography, the affected properties all sit within a significant surface water flow route as shown on the Risk of Flooding from Surface Water mapping in Figure 4-27.

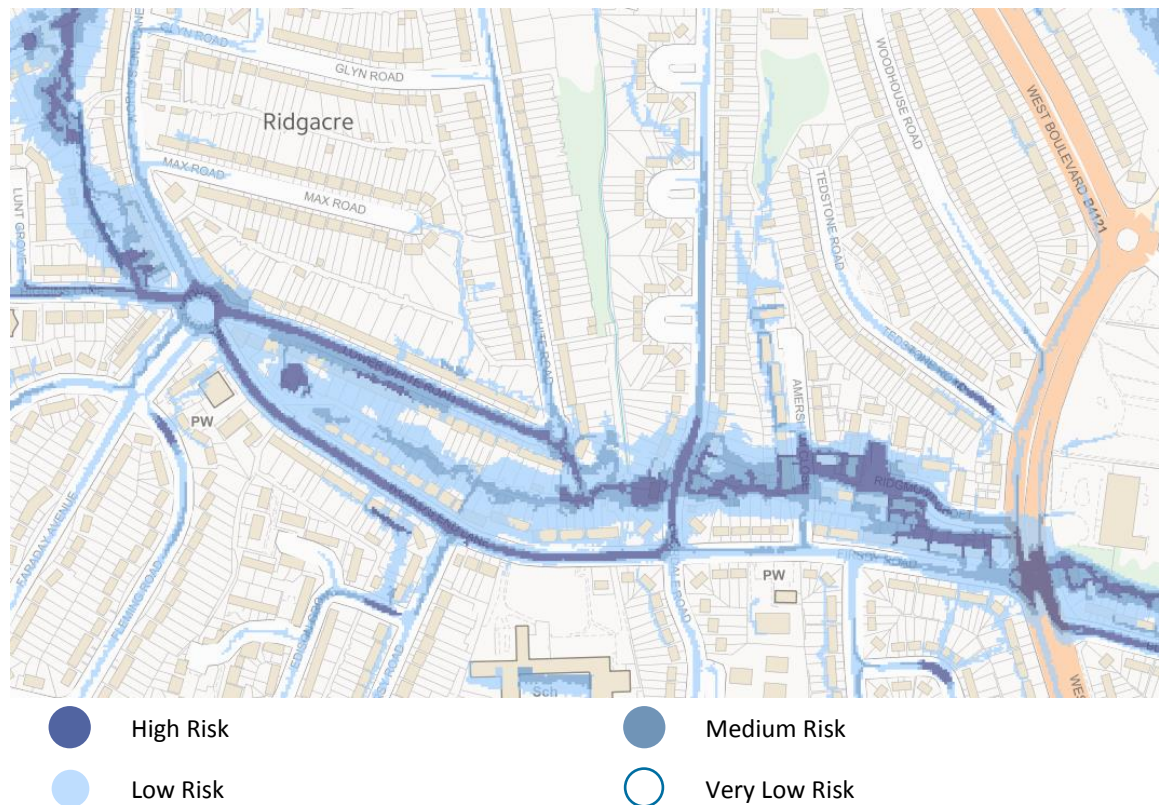


Figure 4-27 Flood Risk from Surface Water map

Responses to the flooding investigation questionnaires suggest following the storm events, water was able to drain away which suggests the highway drainage and sewer infrastructure were not blocked and instead the system was overwhelmed as it was operating above its design capacity. Further to this, the catchment and the highways are relatively steep and as such, due to the intensity of the storm and volume of rainfall, it is likely that surface water runoff flowed over gullies and onto the next one.

The flooding investigation questionnaires suggest flooding was exacerbated by river flooding from an unnamed watercourse to the rear of properties in Overdale Road and White Road, however further investigation of the watercourse has concluded that this is not a functioning watercourse. There is no formal inflow or outflow, and this area is simply a depression in the landscape which is incorrectly shown on public mapping.

A property level resilience scheme was installed at some properties in Overdale Road, unfortunately the properties flooded during the event in June 2016.

### *What has been done?*

Birmingham City Council (LLFA) has completed an initial review of the existing highway drainage and sewer infrastructure.

Birmingham City Council, Severn Trent Water and Environment Agency are working in partnership to identify flood mitigation options across this area, this project is at an early stage, however the intention is to develop a number of small schemes across the Bourn Catchment which will reduce flood risk to properties.

Birmingham City Council (LLFA) has undertaken a review of the property level resilience installed at Overdale Road.

### *What next?*

The following table outlines the recommended actions for this area to be undertaken by the appropriately identified RMA.

Recommended Actions	Identified Party / RMA
<b>Assess the condition and capacity of the sewer network in the catchment area</b>	Severn Trent Water
<b>Assess the condition and capacity of the culverted Quinton Brook</b>	Birmingham City Council (Housing)
<b>Review maintenance regime to ensure gullies are free from debris</b>	Birmingham City Council (Highways)
<b>Develop catchment options across the upper Bourne Brook catchment to manage flooding from all sources</b>	Birmingham City Council (LLFA), Severn Trent Water and Environment Agency
<b>Review property level resilience scheme in Overdale Road</b>	Birmingham City Council (LLFA)



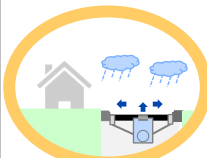

## 4.19 ROUGHLEY

### What happened?

Eight properties in Roughley, Sutton Coldfield reported internal flooding during the June 2016 storms. Flooding was reported across Willmott Road, Marlpit Lane and Slade Road to varying depths. Flooding was also reported elsewhere to the external areas near Weaver Court.

### Why did it happen?

The flooding in this area has been identified to be surface water flooding, flooding from sewers and flooding from highway drainage.

Identified Flooding Type(s)	
	
	
No. of flooded properties: 8	

Due to the magnitude of the storm, surface water runoff followed the topography of the area, flowing south on Willmott Road before accumulating in the low point in the highway. The underlying sewer infrastructure and highway drainage was unable to cope with the volume of water in this area, resulting in ponding within the highway. Water levels rose in this area, overtopping kerbs and flowing into the curtilage of properties where it flowed down the hill, through rear gardens and entered properties in Marlpit Lane and on through properties in Slade Road. This is indicated in the public surface water flood risk mapping; as shown in Figure 4-28.

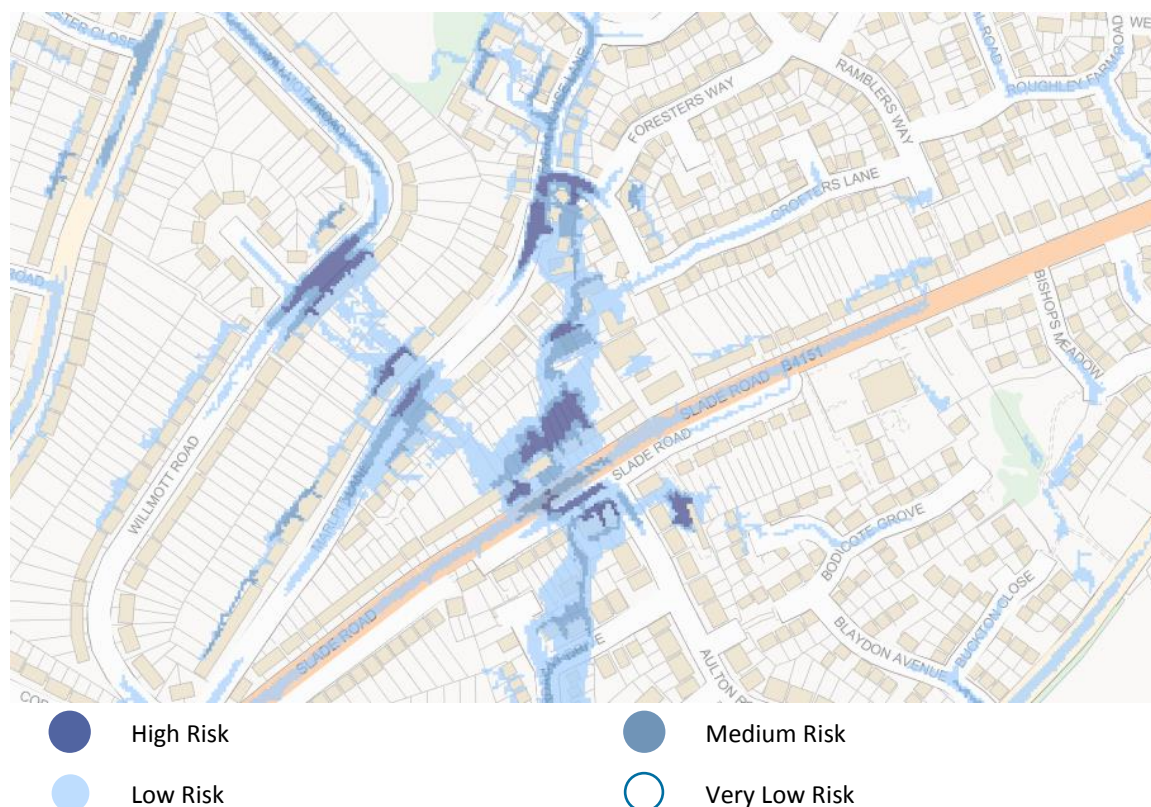


Figure 4-28 Flood Risk from Surface Water map

A second flow path was also observed with flows accumulating in Farmhouse Lane before following the topography of the area, through multiple properties, before accumulating in Slade Road. The flooding in Slade Road was further exacerbated, as the capacity of the sewer infrastructure was overwhelmed and began to surcharge from the underground system onto the highway. It is also understood that electrical components and pumps failed during the storm.

Following the storm event, flood waters receded with water draining through gullies as capacity became available in the highway drainage and sewer infrastructure.

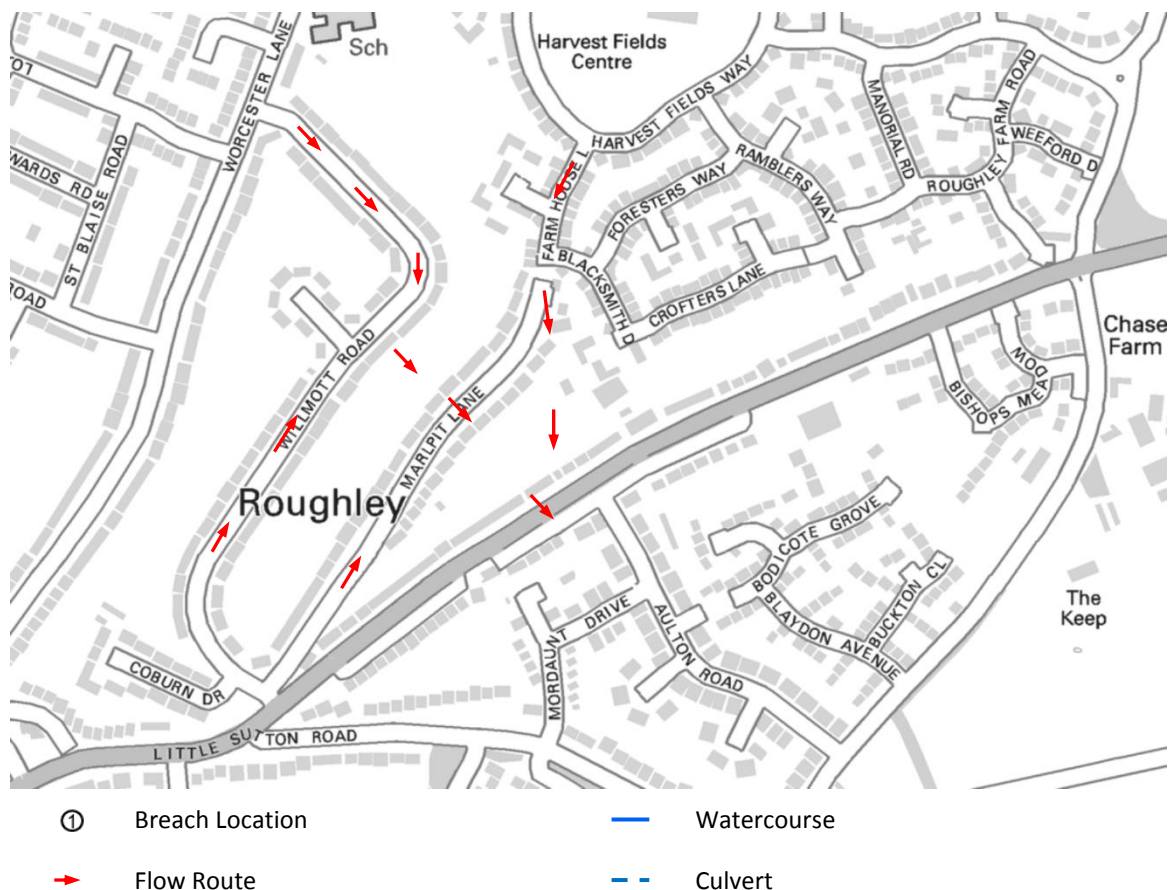


Figure 4-29 Potential overland flow routes

### What has been done?

While there are no historic records of flooding in Willmott Road, Farmhouse Lane or Marlpit Lane, there have been incidents of flooding previously reported in the vicinity of Slade Road. In 2002, a scheme was implemented to increase the capacity of the sewer infrastructure in this area. While this scheme may be considered to be effective, it is likely that the magnitude of the event(s) in June 2016 exceeded the increased capacity in this area.

Property level resilience measures were installed to properties within Slade Road by Severn Trent Water prior to the events in June 2016. Following these events, further investigation into the operation and effectiveness of these measures has been undertaken by Severn Trent Water, with appropriate remediation measures completed, where required.

Following the June 2016 storms, Birmingham City Council (Highways) has cleared the gullies of any debris.

### *What next?*

The following table outlines the recommended actions for this area to be undertaken by the appropriately identified RMA.

Recommended Actions	Identified Party / RMA
<b>Assess the condition and capacity of the sewer network in the vicinity of Slade Road and Willmott Road</b>	Severn Trent Water
<b>Assess the condition and capacity of the highway drainage network to establish if additional gullies are required</b>	Birmingham City Council (Highways)
<b>Review of maintenance schedule of highway assets (e.g. gullies)</b>	Birmingham City Council (Highways)
<b>Explore the potential for flood mitigation measures</b>	Severn Trent Water
<b>Assess the effectiveness of the installed property level resilience measures</b>	Severn Trent Water

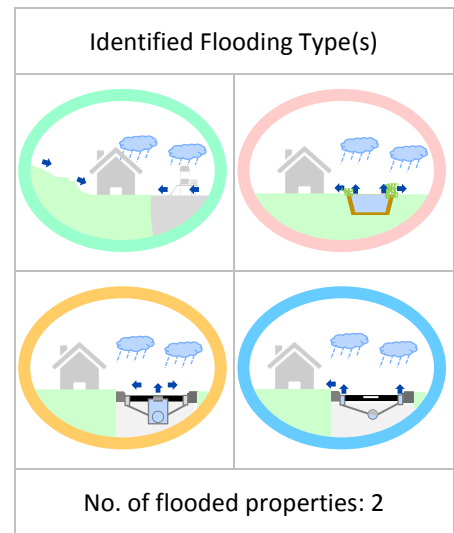
## 4.20 SELLY OAK – WOOD BROOK

### What happened?

Following the storm event on 16<sup>th</sup> June, two properties on the north-western side of the Bristol Road (A38), adjacent to the Wood Brook, experienced internal property flooding. In addition, the parkland to the rear of the properties on Witherford Way and Middle Park Road also flooded together with the highway in Bristol Road.

### Why did it happen?

The flooding in this area have been identified to be a combination of surface water flooding, river flooding, flooding from sewer infrastructure and flooding from highway drainage.



The Wood Brook, an Environment Agency Main River, runs adjacent to the boundaries of the affected properties, flowing in a south-easterly direction. Water is discharged from the pond adjacent to Shenley Fields Road into the Wood Brook and this flows south-eastwards through the park area. This watercourse is culverted as it passes under a number of roads which include Weoley Hill, Fox Hill and the Bristol Road. Downstream of the Bristol Road the Wood Brook is joined by Giffin’s Brook and becomes The Bourn, ultimately discharging into the River Rea in Stirchley.

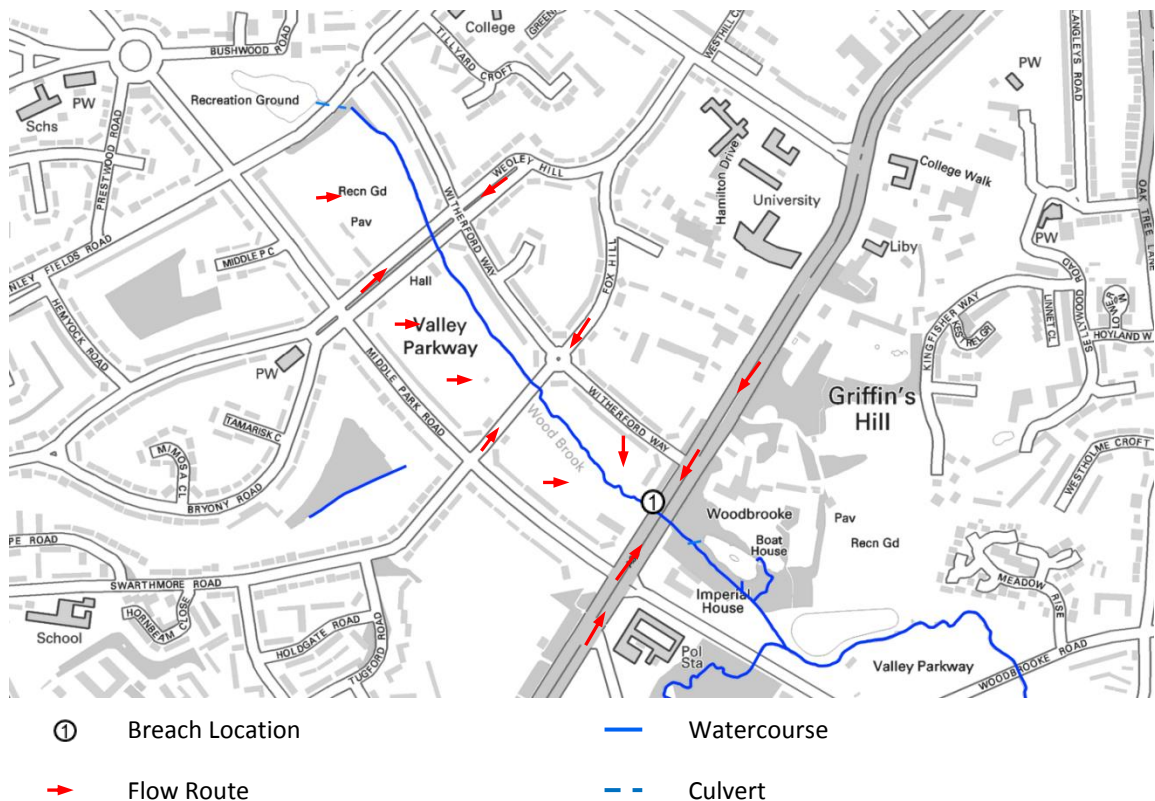


Figure 4-30 Potential watercourse breach and overland flow routes



Due to the magnitude of the event, the Wood Brook came out of channel where the watercourse enters the culvert at Bristol Road, shown as Breach Location 1 in Figure 4-30. The culvert was not blocked, however the capacity of the culvert and the channel were exceeded resulting in flooding.

The affected properties are also located at the bottom of a steep highway catchment. Where roads have a significant gradient, surface water runoff runs down the side of the highway can flow straight over the gully pots due to the speed of the flow. It is therefore likely that, due to the intensity of the storm and the steep nature of the Bristol Road, the highway gullies and Severn Trent Water sewers were unable to capture all surface water runoff. Excess runoff which was not captured by the highway gullies flowed down the hill, within the highway, ponding at the lowest point of Bristol Road, in close proximity to the affected properties.

The Wood Brook is a Main River and the Environment Agency has modelled this brook as part of the wider River Rea catchment. The areas at risk of flooding from the wood brook are shown on the extract of the Flood Risk from Rivers or the Sea map shown in Figure 4-31. The flooding report correlates with the high risk areas in the mapping further emphasising the source of flooding was the watercourse.

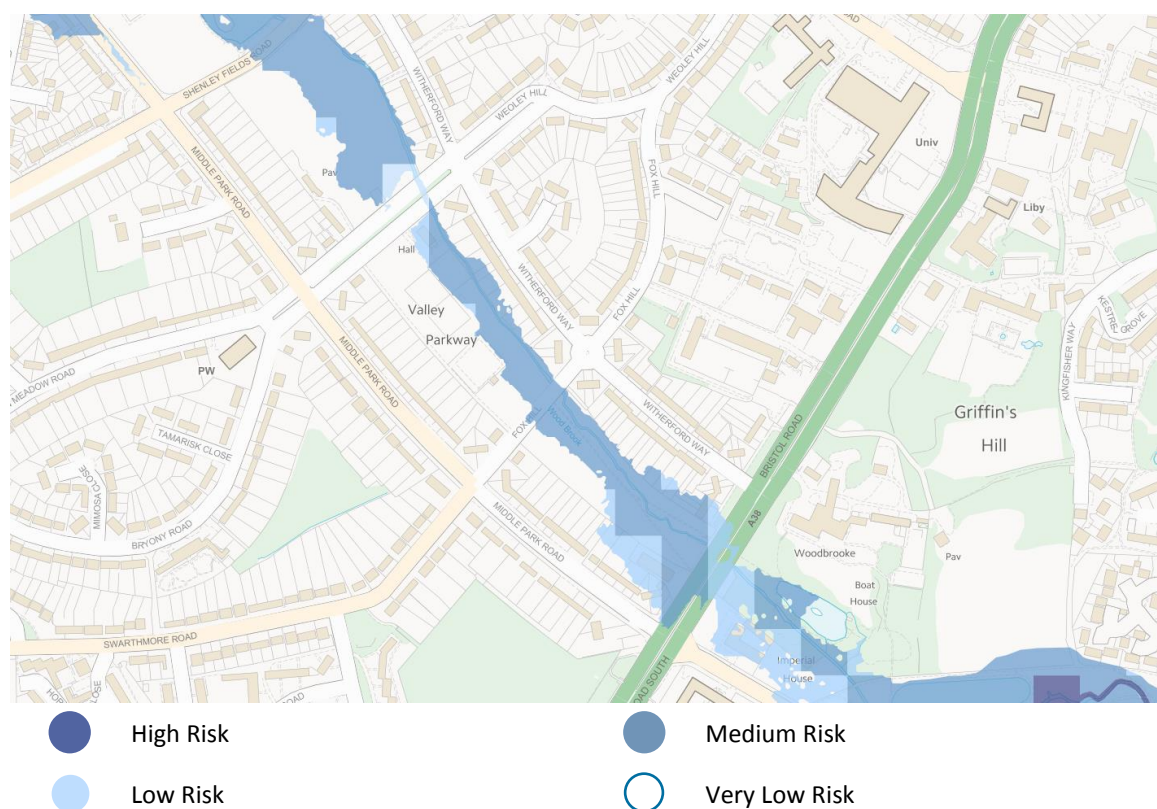


Figure 4-31 Flood Risk from Rivers or the Sea map

### *What has been done?*

Following the June 2016, Birmingham City Council (LLFA) conducted site walkovers of the affected area.

The Environment Agency has been working with its partners through the Rea Catchment Partnership to develop proposals for flood alleviation in the Bourn Catchment. It is likely that measures will include the storage of flood water in the upper reaches of the Bourn, with an initial assessment of potential storage locations being completed. This assessment has identified areas near Manor Park Farm, Valley Parkway and the public open space adjacent to the Wood Brook that may be suitable areas for flood storage, as shown in Figure 4-32. Any areas used for storage may be designed to remain dry under normal conditions

and only be used to store water in extreme events. It should be noted that a significant amount of external funding will be required in order for this scheme to progress further.

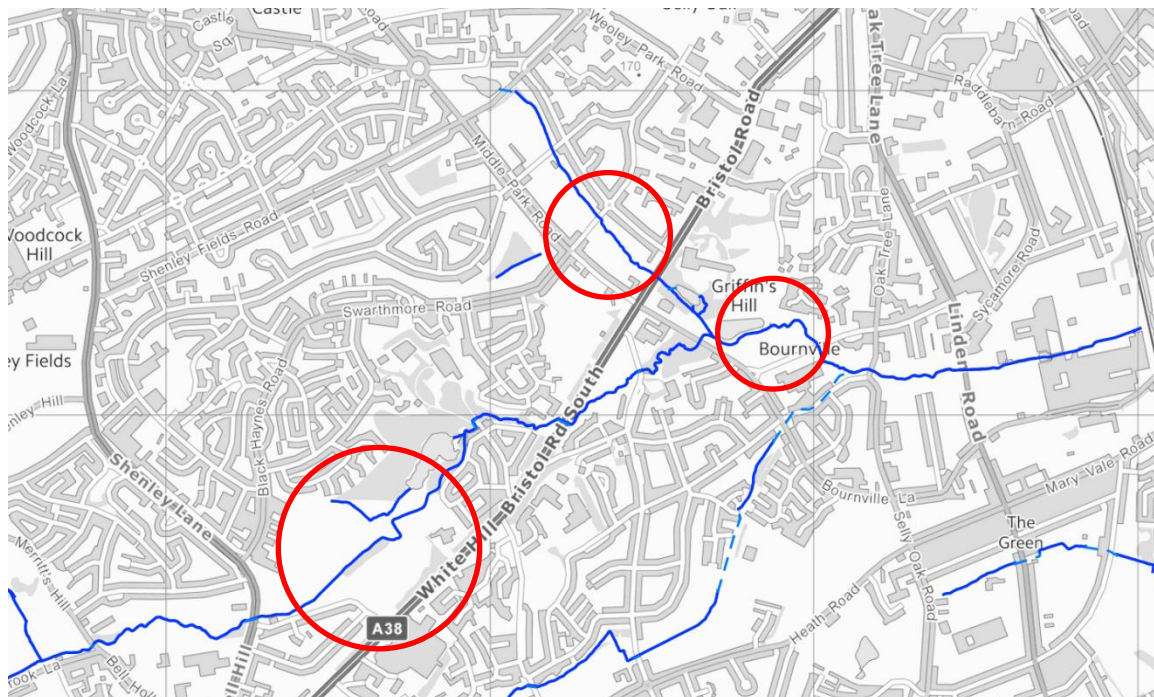


Figure 4-32 Potential Flood Storage Areas

### What next?

The following table outlines the recommended actions for this area to be undertaken by the appropriately identified RMA.

Recommended Actions	Identified Party / RMA
<b>Continue to explore options for funding contributions towards Bourn Brook scheme</b>	Environment Agency
<b>Assess the condition and capacity of the sewer network in the Bristol Road</b>	Severn Trent Water
<b>Assess the condition and capacity of the highway drainage network to establish if additional gullies are required</b>	Birmingham City Council (Highways)
<b>Review of maintenance schedule of highway assets (e.g. gullies)</b>	Birmingham City Council (Highways)

## 4.21 SELLY OAK – EASTERN ROAD





### *What happened?*

Following the storm event on 16<sup>th</sup> June, two properties in Eastern Road reported internal flooding with further flooding to gardens.

### *Why did it happen?*

The flooding in this area has been identified to be surface water flooding.

The flooding to the properties in Eastern Road was as a result of uncontrolled runoff from the King Edwards School playing fields to the rear of the properties. It is likely that due to the intensity of the storms, rain fell onto the playing field at a rate that exceeded the rate that it could soak into the ground and therefore resulted in significant overland flows. These flows, shown in Figure 4-33, followed the slope of the existing ground, falling from west to east and entered properties through the rear gardens.

Identified Flooding Type(s)	
	
	
No. of flooded properties: 2	

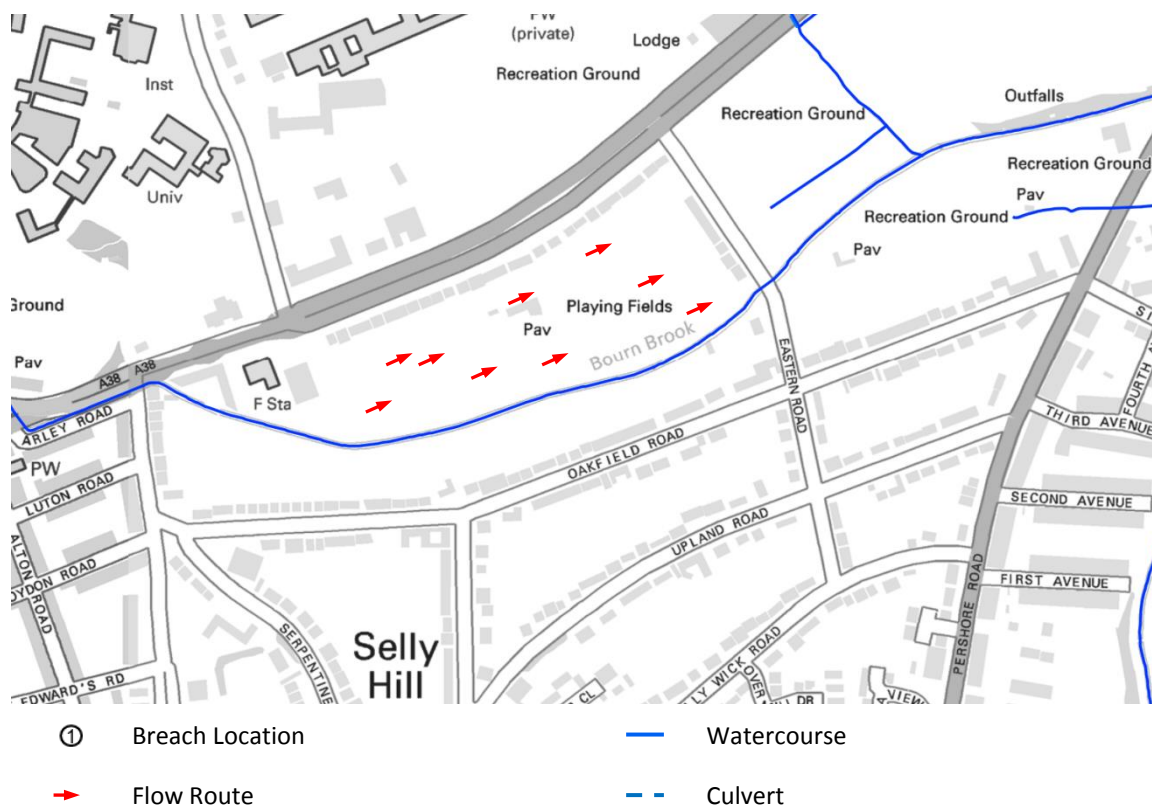


Figure 4-33 Potential overland flow routes

This is indicated in the public surface water mapping; as shown in Figure 4-34 which contains an extract from the 'Risk of Flooding from Surface Water' mapping.

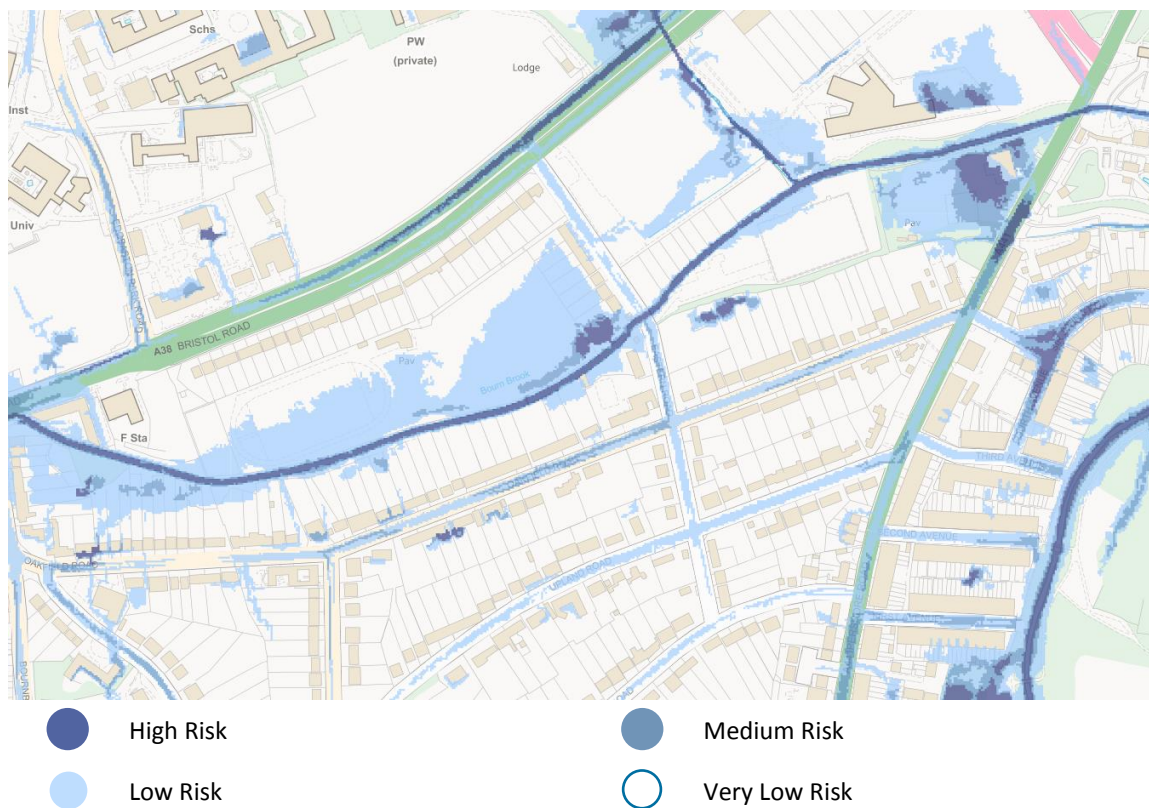


Figure 4-34 Flood Risk from Surface Water map

### What has been done?

Following an initial walkover of the affected areas, Birmingham City Council (LLFA) has undertaken an initial review of the affected area.

### What next?

The following table outlines the recommended actions for this area to be undertaken by the appropriately identified RMA.

Recommended Actions	Identified Party / RMA
Explore the potential for flood mitigation measures	Birmingham City Council (LLFA) and King Edwards School
Develop catchment options across the upper Bourn Brook catchment to manage flooding from all sources	Birmingham City Council (LLFA), Severn Trent Water and Environment Agency

## 4.22 SELLY PARK NORTH

### What happened?

Following the storms on 16<sup>th</sup> June 2016, 33 properties in Selly Park North reported internal flooding along with flooding to, highways, footpaths and gardens. Properties were affected in Pershore Road, Riverside Drive, St John’s Road, Third Avenue and Fourth Avenue.

### Why did it happen?

The flooding in this area has been identified to be surface water flooding, flooding from rivers and flooding from sewer infrastructure.

Identified Flooding Type(s)	
No. of flooded properties: 33	

The capacity of the Bourn Brook was overwhelmed and it is understood to have breached as it flowed adjacent to Birmingham Dental Hospital, shown as Breach Location 1 in Figure 4-35, and flowed southwards through the Recreation Ground. This was then exacerbated by a further breach in another unnamed watercourse upstream of Pershore Road, shown as Breach Location 2, resulting in surface water flowing across Pershore Road into the front of properties fronting onto Riverside Drive. The topography and highway channels directed surface water runoff into St John’s Road, via Pershore Road, and from there into Fourth Avenue and Third Avenue.

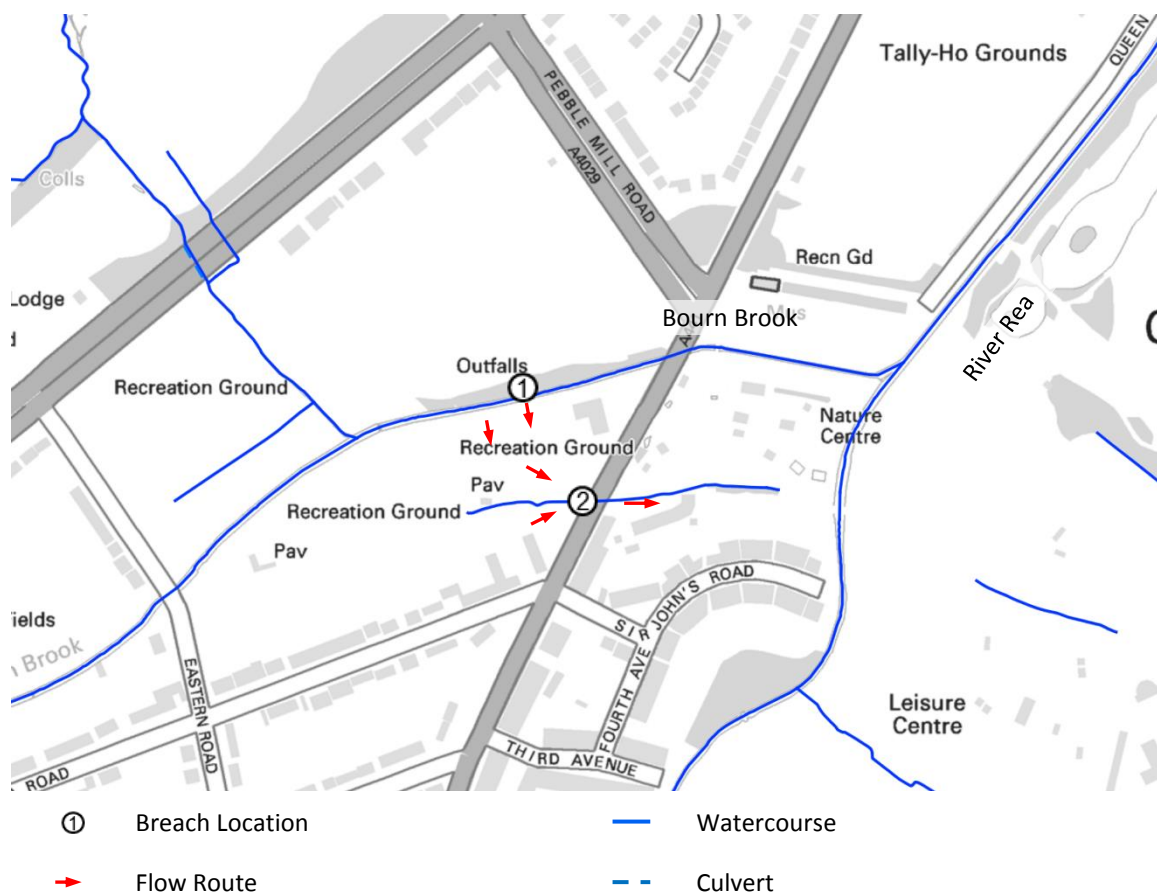


Figure 4-35 Potential overland flow routes

The Flood Risk from Rivers or the Sea map, shown in Figure 4-36, indicates that the area in the vicinity of the affected properties is identified to be within a high risk area. This suggests that when flood waters exceed the capacity of the Bourn Brook, they will spill south-eastwards, flowing overland towards the River Rea. It is highly likely that this was experienced during the June 2016 storms.

A boundary wall at the end of St John's Road, between the highway and the River Rea prevented surface water flows draining into the River Rea which is likely to have exacerbated flooding and resulted in increased flood depths than that which may have been experienced should this wall not have been present. Such a wall is not in place at the end of Third Avenue and therefore surface water runoff drained into the River Rea which prevented surface ponding and minimised the flood depths experienced here. As a result, flood depths experienced were higher in St John's Road than Third Avenue.

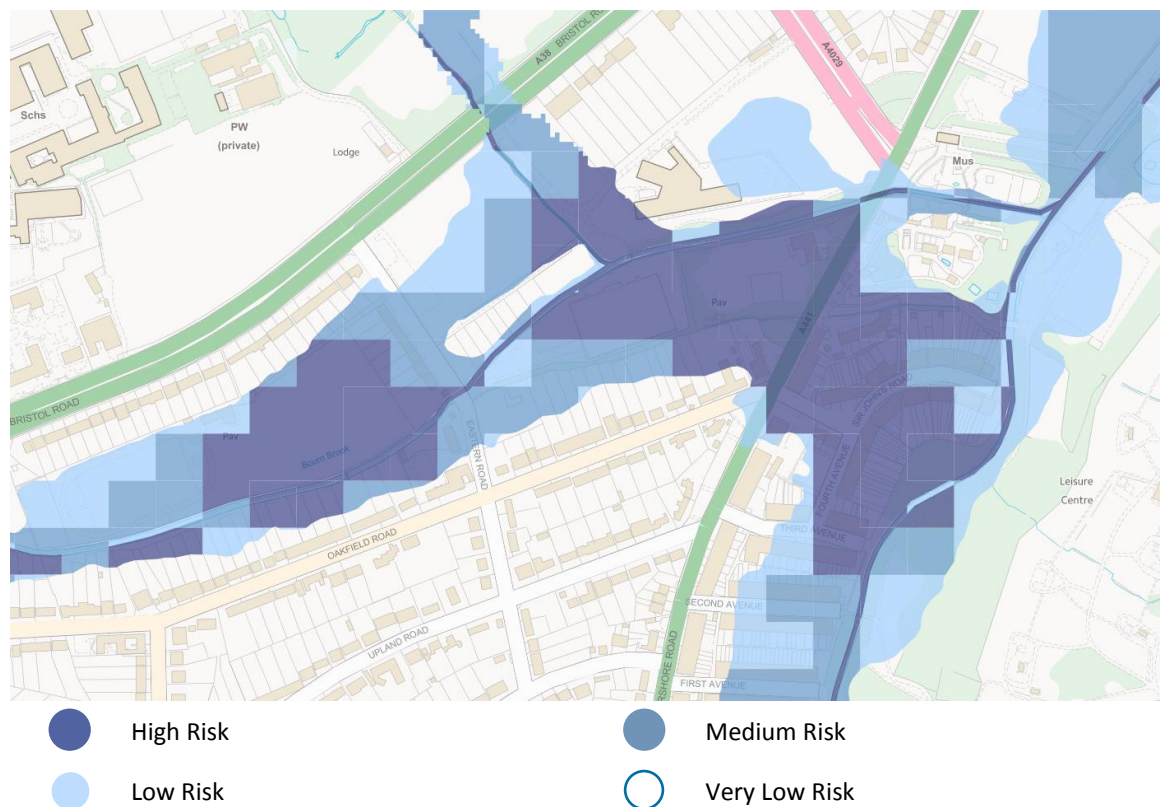


Figure 4-36 Flood Risk from Rivers or the Sea map

### *What has been done?*

Following an initial walkover of the affected areas, Birmingham City Council (LLFA) has conducted a further review of the highway drainage, sewer infrastructure and watercourses in the area.

Following this review, the boundary wall at St John's Road has been reduced and modified with an open fence panel to allow overland flows to discharge into the River Rea rather than being contained within the street. Additional gullies have also been constructed in Third Avenue to allow surface water runoff to discharge into the River Rea easier.

Plans have also been submitted for a flood alleviation scheme on the south side of the Bourn Brook, opposite the Birmingham Dental Hospital which have since been approved. The scheme includes a flood relief channel and culvert which connects the Bourn Brook to the River Rea, running parallel to Riverside Drive.

*What next?*

The following table outlines the recommended actions for this area to be undertaken by the appropriately identified RMA.

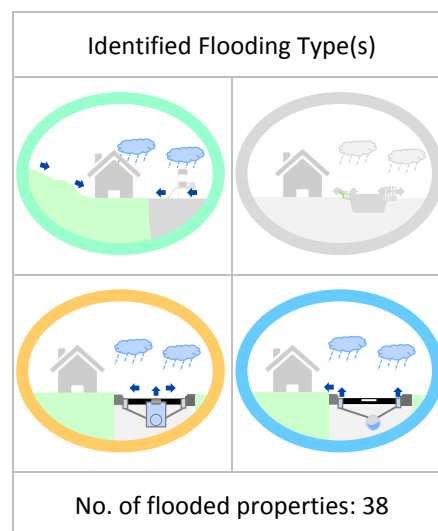
Recommended Actions	Identified Party / RMA
<b>Modification of the private boundary wall and review of maintenance regime in Riverside Drive to accommodate surface water flows</b>	Birmingham City Council (LLFA and Leisure Services) and Homeowners
<b>Implementation of the flood alleviation scheme</b>	Environment Agency, Birmingham City Council (LLFA) and Severn Trent Water
<b>Assess the condition and capacity of the sewer network in catchment area</b>	Severn Trent Water

## 4.23 WOODGATE VALLEY

### What happened?

Approximately 38 properties reported internal flooding across Woodgate Valley as a result of the heavy rainstorms on 16<sup>th</sup> June 2016. This flooding occurred across Woodgate Valley, and may be categorised in three areas:

- **West:** Plough Avenue, Bean Croft, Square Close and Tibbats Close
- **Central:** Ox Leaslow, Warston Avenue, County Close and Sommerfield Road
- **East:** Rushy Piece and Gravel Bank



### Why did it happen?

The flooding in this area has been identified to be surface water flooding, flooding from sewer infrastructure and flooding from highway drainage.

Woodgate Valley is a residential development that has been constructed on a steep slope, with many properties constructed in a tiered fashion. A number of these properties are situated at the same level or lower than the adjacent highways and properties. During the extreme event in June 2016, rain fell at such a rate that the property drainage and highway drainage was unable to absorb it and it ponded in the highways and green areas. Due to the topography of Woodgate Valley, and the magnitude of the event the rainfall generated significant runoff from the adjacent park, rooftops, paths and highways where it ponded in the highways before overtopping kerbs and flowing into properties.

Figure 4-37 shows the primary overland flow paths experienced across Woodgate Valley, which illustrate the flooding that occurred during the events in June 2016. In the **West**, this shows the primary flow route whereby runoff from the Country Park passes through the residential area on route to the Bourn Brook to the north. Along part of the western boundary there is a heavily silted and poorly maintained unnamed watercourse which did not have the capacity to convey any flows.

In the **Central** area, overland flow routes originating in Ox Leasow and Warston Avenue, follow the topography of the area and accumulate in Sommerfield Road before entering the Country Park and joining the Bourne Brook. In the **East** the highest point within the local topography is located between Rushy Piece and Gravel Bank. As such, when the property and highway drainage became overwhelmed during the storm water followed the topography of the land, passing through properties and ponding in low lying areas in Rushy Piece, Upper Close and Gravel Bank.

Following the storm event, flood waters receded with water draining through gullies as capacity became available in the highway drainage and sewer infrastructure.

These routes are indicated in the public surface water mapping as shown in Figure 4-38.



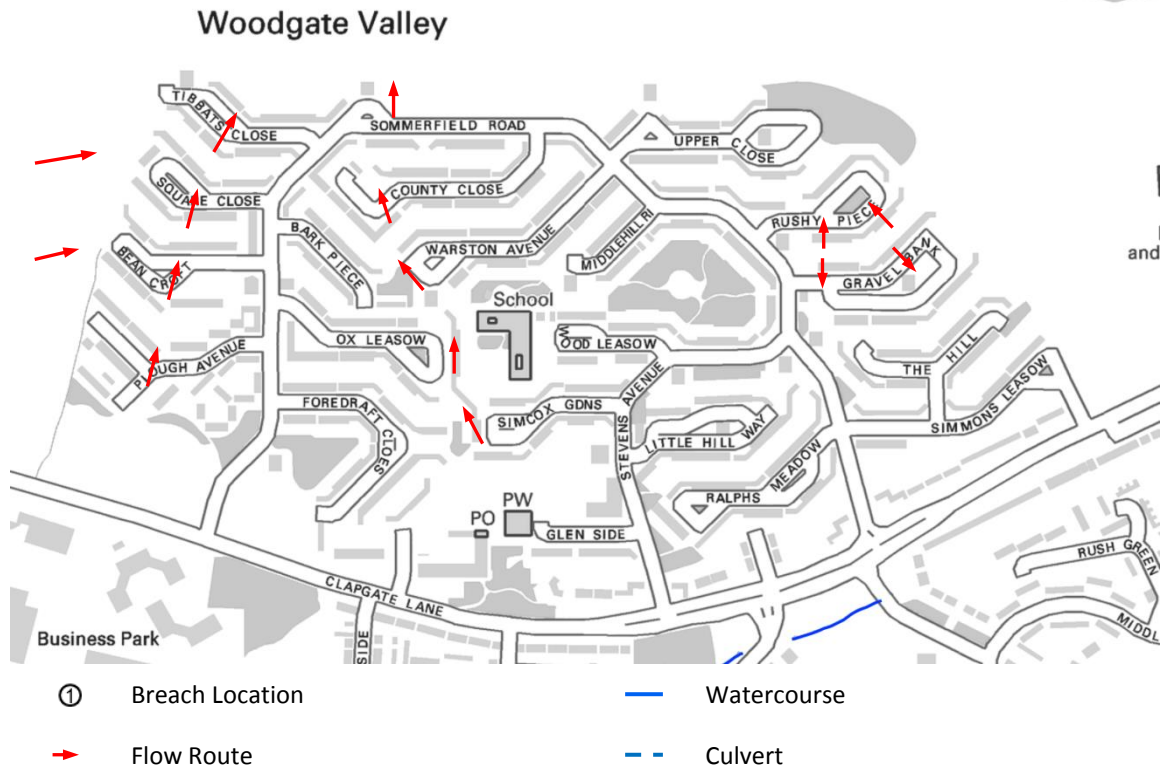


Figure 4-37 Potential overland flow routes

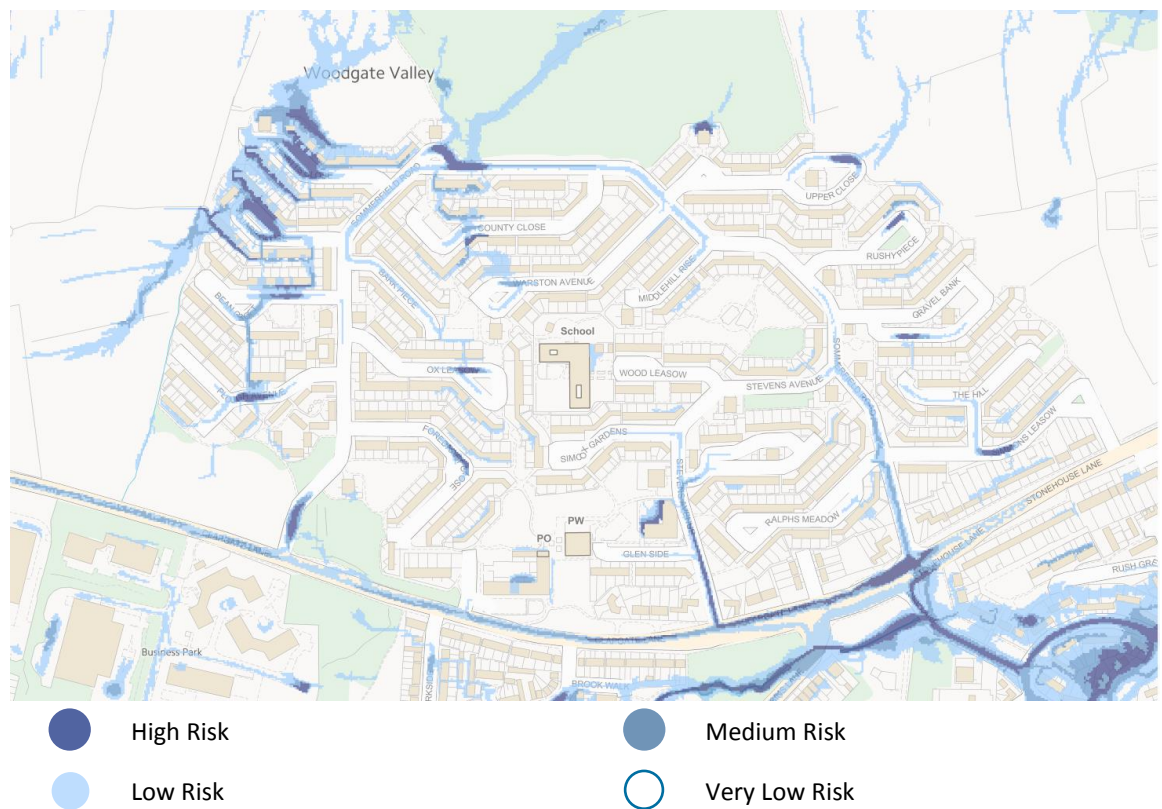


Figure 4-38 Flood Risk from Surface Water map

A property level resilience scheme was installed at some properties in Bean Croft, unfortunately the properties flooded during the event in June 2016.

### *What has been done?*

Birmingham City Council (LLFA) has undertaken a site walkover of the area.

Furthermore, Birmingham City Council (LLFA) has been successful in securing a government grant for funding to carry out a detailed assessment of the cause of flooding in this area and to develop a number of options which, if implemented, could mitigate some or all of the flood risk.

Birmingham City Council (LLFA) has undertaken a review of the property level resilience installed at Bean Croft.

### *What's next?*

The following table outlines the recommended actions for this area to be undertaken by the appropriately identified RMA.

Recommended Actions	Identified Party / RMA
<b>Construct a hydraulic model to enhance understanding of flooding mechanisms and develop a set of options to mitigate flooding within the area</b>	Birmingham City Council (LLFA)
<b>Assess the condition and capacity of the sewer network</b>	Severn Trent Water
<b>Assess the condition and capacity of the highway drainage</b>	Birmingham City Council (Highways)
<b>Review of maintenance schedule of highway assets (e.g. gullies)</b>	Birmingham City Council (Highways)
<b>Review property level resilience scheme in Bean Croft</b>	Birmingham City Council (LLFA)
<b>Remove blockages and review maintenance regime of unnamed watercourse</b>	Birmingham City Council (Leisure Services)
<b>Develop catchment options across the upper Bourne Brook catchment to manage flooding from all sources</b>	Birmingham City Council (LLFA), Severn Trent Water and Environment Agency

## 5 RECOMMENDED ACTIONS

### 5.1 ACTIONS

While many of the recommended actions noted above are tailored specifically to the location where the flooding occurred, there are some actions that are applicable in multiple locations. The following section provides a summary of what these actions may entail:

#### *Sewer Infrastructure:*

Assess the condition and capacity of the sewer network

The above recommended actions may incorporate multiple tasks which may include:

- An assessment of the sewer network, ensuring that the existing infrastructure is capable of draining the catchment effectively
- Investigation and survey of existing assets, for example using CCTV and in-person inspections, to ensure blockages and flow restrictions (e.g. silt accumulation) are removed
- Feasibility assessment and optioneering of means to increase capacity of sewer network
- Review existing maintenance schedules and explore opportunities to increase frequency of maintenance and/or incorporation of additional maintenance tasks
- Hydraulic modelling and performance analysis.

#### *Highway Drainage:*

Assess the condition and capacity of the highway drainage network

Review of maintenance schedule of highway assets (e.g. gullies)

The above recommended actions may incorporate multiple tasks which may include:

- Review of the location and condition of existing highway drainage assets, to ensure flows are not impeded and that sufficient gullies are in place to collect flows.
- Assessment of the capacity of the local highway drainage network to explore opportunities to increase capacity
- Review existing maintenance schedules and explore opportunities to increase frequency of maintenance and/or incorporation of additional maintenance tasks

#### *Rivers and Watercourses:*

Assess the condition and capacity of the watercourse

Review of maintenance regime for the watercourse

The above recommended actions may incorporate multiple tasks which may include:

- Site visits and surveys to identify current condition of rivers, watercourses and assets, including culverts, outfalls and structures
- Rehabilitation works including sediment removal, debris removal, clearance of vegetation and restoration of channels where required
- Exploration of opportunities to enhance flow capacity of channels and storage capacity of adjacent floodplains
- Review existing maintenance schedules and explore opportunities to increase frequency of maintenance and/or incorporation of additional maintenance tasks

#### *Property Level Resilience:*

Explore the potential for flood mitigation

The above recommended action may incorporate multiple tasks which may include:

- Site visits and surveys to identify potential flood resilience/mitigation
- Exploration of property level resilience products and vendors to establish if potential resilience measures may be appropriate
- Investigation into previously installed or existing property level resilience measures to assess the effectiveness of the installed measures
- Explore community and catchment wide solutions including, property flood walls and gates, flood defence walls/banks, flood storage areas.

#### *Hydraulic Modelling:*

Construct a hydraulic model

The above recommended action may incorporate multiple tasks which may include:

- Construction of computation models to replicate how watercourses and/or sewers behave when subjected to a significant storm to enhance understanding of flooding mechanisms and properties which are most vulnerable
- Feasibility assessment and optioneering of potential measures that may mitigate flood risk. These measures may be strategic or local scale.

## 5.2 RISK MANAGEMENT AUTHORITIES AND OTHER PARTIES

In addition to the recommended actions, a 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, with regard to their role in flood risk management, is provided below:

### *Birmingham City Council (LLFA)*

<https://www.birmingham.gov.uk/flooding>

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.

### *Birmingham City Council (Highways)*

<https://www.birmingham.gov.uk/roads>

Highways authorities have the lead responsibility for providing and managing highway drainage. In Birmingham this function is undertaken by Amey the Councils Maintenance and Management Partner under a 25 year PFI contract.

### *Birmingham City Council (Leisure Services)*

<https://www.birmingham.gov.uk/parks>

Leisure Services, otherwise known as Parks and Recreation Services, are responsible for the maintenance of public open space. In particular, if this public open space contains or is bound by a watercourse (or feature) Leisure Services hold responsibility for the maintenance and management of this watercourse.

### *Birmingham City Council (Housing)*

<https://www.birmingham.gov.uk/housing>

Housing authorities are county councils or unitary authorities who are required to provide essential housing for the area, and maintain property level drainage systems. In some cases if the properties back onto a watercourse or are constructed above a culverted watercourse, Housing will hold responsibility for the maintenance and management of this feature.

### *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 and they provide advice to LLFAs on how water and sewerage company assets impact on local flood risk.

### *Highways England*

<https://www.gov.uk/government/organisations/highways-england>

Highways England is the highway authority with lead responsibility for maintaining and managing trunk roads and motorways, including drainage.

### *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 river bed and banks within their section of the watercourse to preventing obstruction to the water flow and mitigate flood risk.

## 6

# CONCLUSIONS

Following the storm events in June 2016, 435 incidents of flooding were reported which included internal property flooding, external flooding to gardens and flooding to highways and other areas.

Four types of flooding have been identified as causes for the instances of reported flooding. These include surface water flooding, flooding from rivers, flooding from sewer infrastructure and flooding from highway drainage. The predominant type of flooding was surface water, attributing to 21 of the 23 areas discussed within this report, which is most likely due to the intensity of the storms.

In many locations, surface water runoff was channelled by highways ultimately ponding in low point in the road. Across the reported areas, it was noted the affected properties were usually at or below the level of the adjacent highway. Therefore surface water runoff ponded within the low points of the highway and when the highway could not contain any more surface water, it would spill from the highway into properties.

The surface water flooding was then further exacerbated by the other three types of flooding. In some areas, the flow in watercourses exceeded the available capacity, particularly where watercourses entered a culvert. This resulted in a constriction of flows, causing water to back up, overtopping the river banks and spilling from the river channel.

In some areas, the capacity of the Severn Trent Water sewer infrastructure was overwhelmed causing water to be issued out of the sewer manholes and highway gullies. This has been further exacerbated due to highway gullies being unable to adequately capture the surface water runoff, particularly on steep catchments where the intensity of the rainfall, and volume of runoff, was such that it flowed over or around a gully pot.

For each of the 23 areas, a set of actions have been proposed. The actions that have been proposed are related to the identified cause of the flooding, the severity of the flooding and identified constraints.

Birmingham City Council, in their role as Lead Local Flood Authority, are continuing to work in partnership with all other relevant Risk Management Authorities; such as the Environment Agency, Severn Trent Water and Birmingham City Council (Highways) and other relevant stakeholders to manage and mitigate the flood risk as far as reasonably practicable.