Leicestershire County Council

Burleigh Avenue, Wigston

Flood Report

To discuss the flood report contact the Flood Risk Management Team by e-mail: flooding@leics.gov.uk or phone 0116 305 0001

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AECOM: 2015-04-13

DETAILED FLOOD INVESTIGATION

County Council Investigation Reference:	**2016-INV-197**
Investigation Location:	**Burleigh Avenue, Wigston**
Date of Flooding:	**27th August 2016**
Revision	**Final**

Officer:	Stacey Johnson	Engineer	28/09/2018
Checked:	Ken Lo	Principal Engineer	16/10/2018
Approved:	Fay Bull	Regional Director	16/10/2018
Leicestershire County Council Approved	Victoria Coombes	Senior Engineer	28/11/2018

Report produced for Leicestershire County Council by AECOM,
Royal Court, Basil Close,
Chesterfield,
Derbyshire.
S41 7SL.

CONTENTS **PAGE NO.**

1. EXECUTIVE SUMMARY

1.1. STATUTORY CONTEXT

Section 19 of the Flood and Water Management Act 2010 (FWMA) states that, on becoming aware of a flood which meets certain predetermined criteria, the Lead Local Flood Authority (LLFA) must undertake a flood investigation in order to determine the relevant flood risk management authorities involved and which flood risk management actions have been (or should be) taken to mitigate future flood risk. Where an authority carries out a formal investigation, it must publish the results and notify the relevant risk management authorities.

It was deemed necessary to complete a formal investigation into a flooding incident that is reported to have occurred on the 27th August 2016 at Burleigh Avenue, Wigston as it was reported (via a Flood Reporting Form submitted to Leicestershire County Council) that at least two residential dwellings on Burleigh Avenue suffered from internal flooding. The Flood Reporting Form stated that one additional property is reported to have experienced water ingress into their cellar and other residents reported external flooding. It also identified the potential cause of flooding to be from both the highway drainage and the surface water network.

1.2. CAUSE OF FLOODING

Over the course of the investigation it became clear that the flooding was caused by two short bursts of intense rainfall that occurred within the catchment. The description of the flooding suggested that surface water was unable to drain into the highway drainage system because the capacity was exceeded as a result of the volume of water that fell during the rainfall event. As a result, surface water flowed over the land surface following the natural topography and ponding at a low point close to the junction between Burleigh Avenue and Barnaby Avenue, to a depth of approximately 150mm.

1.3. MAIN FINDINGS

Anecdotal evidence has highlighted that while flooding has been a recurring problem over the last few decades, it has become a more serious issue for the area in recent years. It is reported that the previous flooding incidents also occurred in the months of June, July and August and have been associated with intense rainfall events. Based on the hydrological analysis undertaken for this site using data from three gauging stations, it appears that the rainfall event on the 27th August 2016 was very localised and fast moving across the area, such that the majority of the rainfall during this event was recorded by the Fleckney Gauge. The rainfall event recorded by the Fleckney Gauge had an intensity of between 1 in 20 (5% AEP) to 1 in 40 years (2.5% AEP)[1]. In general, highway drainage is not

[1] The Annual Exceedance Probability (AEP) refers to the probability of a flood event occurring in any one year. The probability is expressed as a percentage. For example if an event has a magnitude of a 1 in 100 year flood, it would be expressed as having a 1% Annual Exceedance Probability (AEP).

designed to accommodate events of this magnitude. Residents have reported increasing flooding in recent years, which may be attributed to the effects of climate change.

Therefore, for the event on 27th August 2016 it seems that the high volume of rainfall combined with the finite capacity of the highway drainage and subsequent surface water runoff led to the internal flooding of two residential dwellings. There is no evidence to suggest that there was a blockage of the highway drainage network.

To further understand and attempt to mitigate potential future internal property flooding, a CCTV survey is planned to determine the current condition of the highway and public sewer system and review the current nature of the available drainage in the vicinity of the property.

2. INTRODUCTION

2.1. LEAD LOCAL FLOOD AUTHORITY INVESTIGATION

Section 19 of the FWMA states:

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

2.2. FLOOD INVESTIGATION CRITERIA

A formal investigation will be carried out if one or more of the following occurs after a flooding event:

- Loss of life or serious injury
- Critical infrastructure flooded or nearly flooded from unknown or multiple sources
- Internal property flooding from unknown or multiple sources

In the following circumstances, discretion may be used to investigate a flooding incident:

- A number of properties have been flooded or nearly flooded
- Other infrastructure flooded
- Repeated instances
- Investigation requested
- Risk to health (foul water)
- Environmental or ecologically important site affected
- Depth/area/velocity of flooding a cause for concern

2.3. RISK MANAGEMENT AUTHORITIES

The following risk management authorities were identified as relevant to the flooding in Wigston:

- Leicestershire County Council – Lead Local Flood Authority
- Leicestershire County Council – Local Highway Authority
- Severn Trent Water Ltd – Water Utility Company

2.4. FLOODING INCIDENT

It was deemed necessary to complete a formal investigation into the reported flooding incident on the 27th August 2016 at Burleigh Avenue, Wigston as it was reported that at least two residential dwellings suffered from internal flooding one of which is reported to have experienced water ingress into their cellar. Other residents reported external flooding.

3. SITE BACKGROUND

3.1. LOCATION

Wigston is a town approximately 5 miles south of Leicester situated centrally in Leicestershire County, within the Borough of Oadby and Wigston (Appendix A, Site Location Plan). The town consists of a mixture of post-war and 19th Century buildings sandwiched between more modern housing developments, which may indicate drainage infrastructure of varying age, condition and design capacity.

The likely catchment of the surface water system is made up of residential properties (see Appendix E for LiDAR[2] map of site and surrounding catchment). The local area in general slopes from south to north, with Burleigh Avenue running in an east-west direction approximately perpendicular to the gradient of the land.

3.2. DRAINAGE SYSTEMS

Burleigh Avenue and the surrounding residential roads are serviced by a public surface water gravity sewer which outfalls to Saffron Brook. Saffron Brook is a tributary of the River Soar, which is Ordinary Watercourse of Burleigh Avenue and becomes Main River downstream of Palmerston Way. From site inspection and review of Severn Trent Water Sewer Records, it is evident that the area around the junction of Burleigh Avenue and Barnaby Avenue has a small number of road gullies (refer to Appendix B). In the event of a storm, highway runoff may need to flow some distance over the road surface to reach the nearest highway gully. The residential dwellings that reported internal flooding are located at a lower level than Burleigh Avenue, providing an easy flow path for water to pond near properties and potentially flow over the threshold into properties. One homeowner has installed lateral drains in the front garden to combat this, but this measure has not been successful at preventing the flooding, possibly due to the low-lying nature of the property and to the fact that the garden is somewhat enclosed.

The Environment Agency's Risk of Flooding from Surface Water Map (provided in Appendix C) suggests that this localised part of Burleigh Avenue is at moderate risk of flooding from surface water (flooding during a 3.33% Annual Exceedance Probability (AEP) storm (1 in 30 year (return period)[1]).

[2] LiDAR shows the topography of an area and is derived using a laser to measure the distance between a survey aircraft and the ground surface, including buildings and other assets (above ground pipelines, highways, street furniture, power lines, railway tracks). This data is represented in a LiDAR Plan that shows the topography of the surveyed area

4. FLOODING INCIDENT

4.1. PREVIOUS FLOODING INCIDENTS

Anecdotal reports suggest that flooding of the two residential dwellings has been occurring since the 1990s with increasing frequency. Anecdotal reports indicate that past flooding incidents have occurred in July 2013, August 2012, and in August 1997. It is also reported that in recent years flooding has been occurring annually in the months of June, July and August. This correlates with expected patterns of summer rainfall, which typically are shorter and of greater intensity than winter storms of comparable return period[3] and the increasing frequency may be attributed to the effects of climate change.

4.2. FLOOD INCIDENT

On Saturday 27th August 2016, the area in the vicinity of Burleigh Avenue experienced two bursts of intense rainfall between 3pm and 5pm, which led to floodwater approximately 150mm deep entering at least two residential dwellings (Appendix B). Rainfall data from nearby rain gauges is shown in Figure 4-1. The volume of water overwhelmed the existing drainage network, which resulted in the localised flooding. Pooling water in the road eventually overtopped the kerb and spilled into two residential properties.

The internal flooding of the residential dwellings lasted approximately 15-20 minutes. While no road closures were issued, anecdotal evidence suggests that vehicles proceeded slowly through the water.

Although Saffron Brook is the outfall for all nearby drainage networks, anecdotal reports have stated that the Brook was not out of bank during the flood incident on the 27th August. Overtopping of the brook is therefore not considered to be the cause of the flooding issues occurring on Burleigh Avenue. It is possible that levels in the Brook were higher (although still in bank) and caused flows to back up and restrict discharge at the surface water drainage outfall. However, the river is located 800m away from Burleigh Avenue and is unlikely to have a significant impact on surface water drainage. There is no evidence available to indicate river levels in relation to drainage outfalls.

Leicester Road, which is the main road running north-south, perpendicular to Burleigh Avenue and to which Burleigh Avenue joins at its eastern end, has a history of flooding. Analysis of topographic data for the area suggests that if Leicester Road was the source of the flooding on Burleigh Avenue, then flooding would likely have been observed around Leicester Road before any flooding appeared at the affected properties on Burleigh Avenue. Surface water flooding down Leicester Road was not reported during the incident on the 27th of August, suggesting that the flooding of Leicester Road was not linked to the flooding on Burleigh Avenue.

[3] Source: http://evidence.environment-agency.gov.uk/FCERM/en/FluvialDesignGuide/Chapter2.aspx?pagenum=2

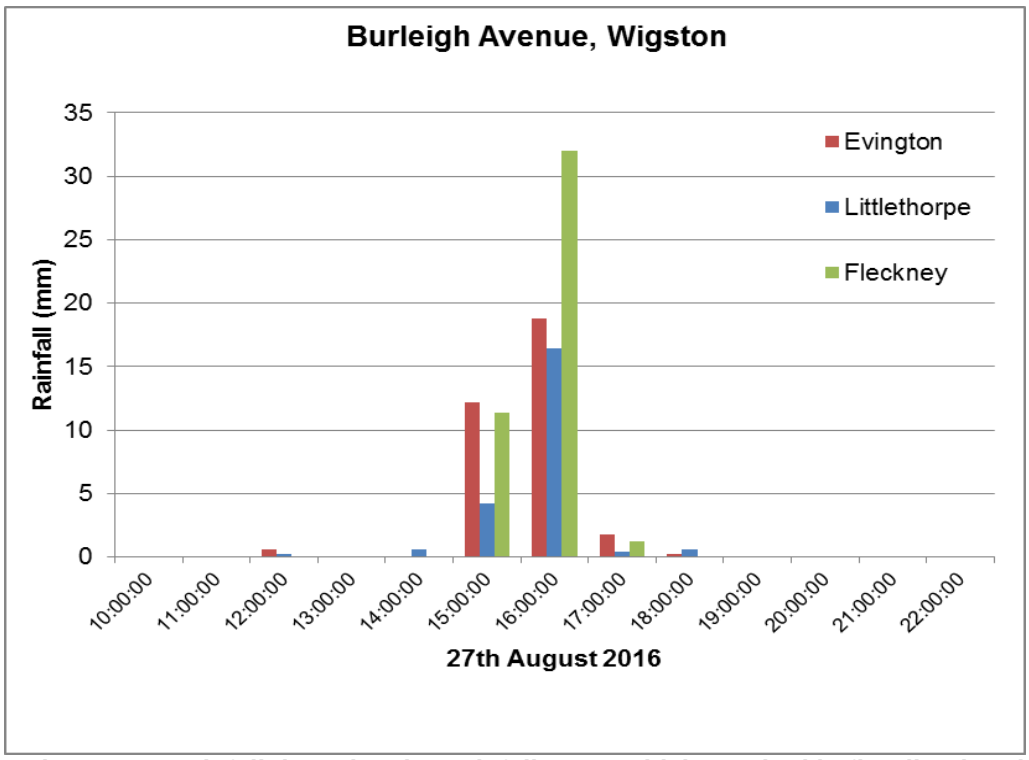


Figure 4-1: Rainfall data showing rainfall event which resulted in flooding in Wigston
Distances to Burleigh Avenue from: Evington (4.8 km), Fleckney (7.8 km), Littlethorpe (6.8 km).

4.3. RAINFALL ANALYSIS

The Hydrological Summary produced by the Centre for Ecology and Hydrology for August 2016 stated that much of the UK experienced a wetter August.

However it also stated that:

'Localised flash flooding occurred in the Midlands on the 27th.'

Source: http://nora.nerc.ac.uk/514505/1/HS_201608.pdf

The flooding incident at Burleigh Avenue, Wigston was located between three rainfall gauges. Therefore an average of the maximum rainfall from the three nearest rainfall gauges has been used to estimate the event rarity for the rainfall event, using the Depth-Duration-Frequency (DDF) rainfall model[4]. The three rainfall gauges closest to Wigston are located at Littlethorpe, Evington and Fleckney, as shown in Figure 4-2.

[4] Flood Estimation Handbook (FEH) CD ROM 3 (1999) Institute of Hydrology.

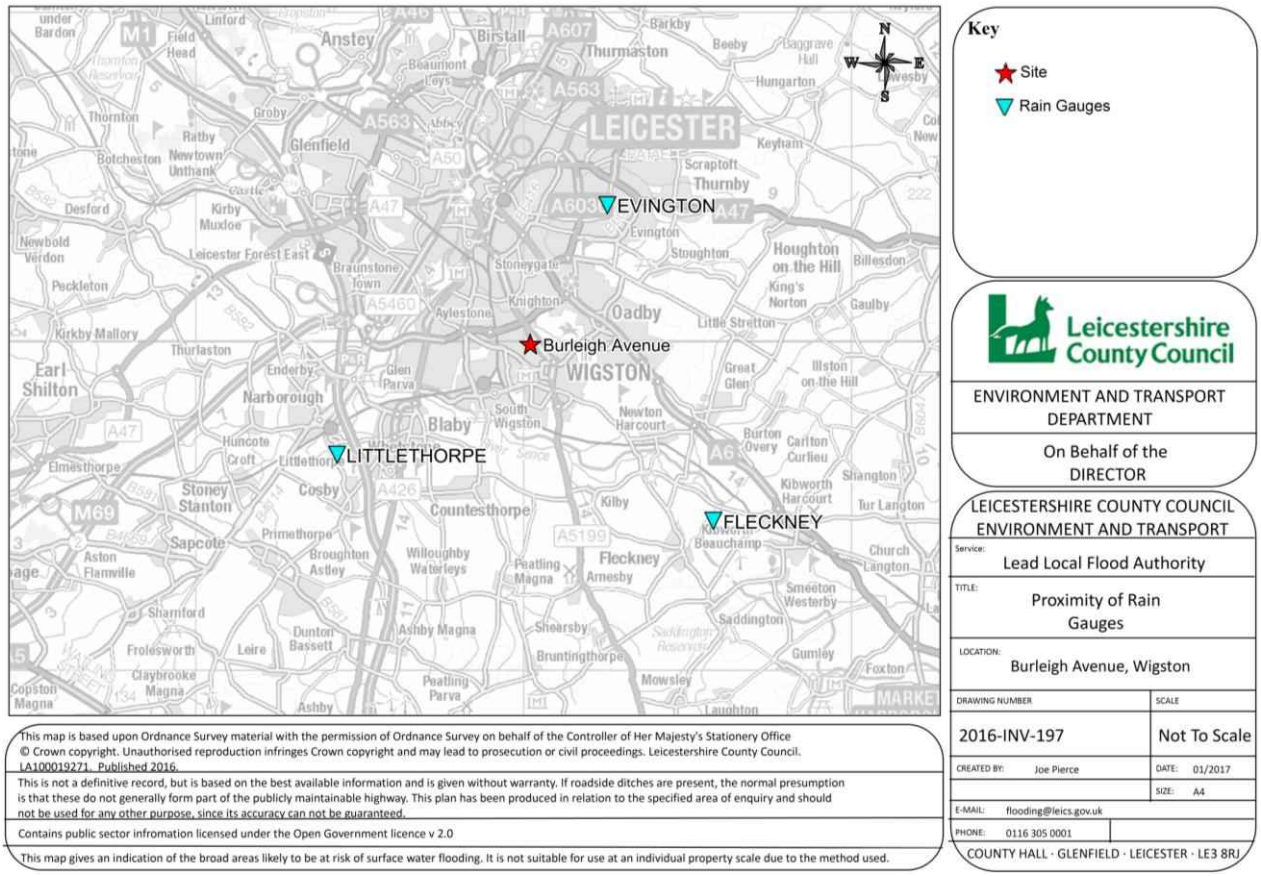


Figure 4-2: Location of rain gauges and site of flooding incident.
Distances to Burleigh Avenue from: Evington (4.8 km), Fleckney (7.8 km), Littlethorpe (6.8 km).

Table 4-1: Rain gauges near the site

Name	Time series	Record start	Record end
Littlethorpe TRB	Hourly	1998	2016
Evington TRB	Hourly	2008	2016
Fleckney TRB	Hourly	1985	2016

Table 4-1 provides a summary of the relevant Environment Agency rain gauges within the study area that were used for data analysis purposes.

A hydrological analysis was undertaken shortly after the 27th August 2016 event to investigate the magnitude of the rainfall event. The resulting Hydrology Technical Note is included in Appendix F. The rainfall that occurred over the Wigston catchment had an equivalent return period of less than 20 years, or a less than 5% Annual Exceedance Probability (AEP)[1]. However, it should be noted that the rainfall event was very localised and may not have been fully recorded by the nearby rain gauges.

5. SUMMARY OF IMPACTS AND FINDINGS

5.1. IMPACTS

The flooding event on the 27th August 2016 led to internal flooding of two residential properties, resulting in a significant emotional impact to the affected residents. The local highway network was also impacted, resulting in disruption and distress to the local community and users of the highway network.

5.2. LOCAL TOPOGRAPHY

Topographic data (Appendix E) suggests that, in the event of a storm, water would flow to the affected site from four main drainage paths and that the properties are located at a natural low point with thresholds lower than the road. There is a crest in the road alignment of Burleigh Avenue, where one side slopes towards the A5199, and the other towards the junction between Burleigh Avenue and Barnaby Avenue. The other two roads leading into the junction also slope towards this low point. Due to the size of the catchment, a large volume of water collects in this region. Overwhelming of the highway gullies (due to the intensity of the storm event) would have led to water beginning to pool in the street, eventually overtopping the pavement and cascading into nearby driveways.

The extent of the reported flooding is consistent with the Risk of Flooding from Surface Water Map (Appendix C). Surface water ponding is more significant on approach to the junction between Burleigh Avenue and Barnaby Avenue, which correlates with gradients seen in the topographic data (Appendix E). However, it does suggest that flooding only occurs during more intense storms, correlates with reports from residents who claim the flooding is occurring at least annually during summer months, which is when short sharp rainfall events are more common.

5.3. HIGHWAY DRAINAGE

The highway drainage along Burleigh Avenue consists of traditional road gullies. There are gullies outside of the two houses that have reported flooding. These gullies are upstream of the public surface water sewer and it is likely that that there is a highway drain linking gullies to the surface water sewer. It is unclear what condition the gullies were in before the flooding incident. Flooding has been recurring in this location since the 1990's, with increasing frequency in recent years.

The most probable reason for the flooding is that the capacity of the highway drainage was unable to cope with the rainfall generated by the two intense rainfall events experienced in rapid succession on the 27th of August.

5.4. PUBLIC SEWER

Burleigh Avenue is served by a surface water gravity sewer, which conveys surface water to Saffron Brook, and a gravity combined sewer network that transports sewage in an easterly direction. There has been no evidence to suggest that the foul network contributed to the flood event but it is not clear exactly what the impact of the surface water sewer impacts were if any.

5.5. SAFFRON BROOK

Saffron Brook is located approximately 800m away from the flooding location. There is no evidence to indicate that Saffron Brook was out of bank at the time of flooding on Burleigh Avenue and therefore is not considered to be a source of flooding.

6. RESPONSIBILITIES

6.1. LOCAL HIGHWAY AUTHORITY (LEICESTERSHIRE COUNTY COUNCIL)

Leicestershire County Council are defined as the Local Highways Authority and has a duty to maintain the highway under Section 41 of the Highways Act (1980). The Highway Authority are responsible for maintain a safe and reliable local highway network, including provision for highway drainage.

6.2. LEAD LOCAL FLOOD AUTHORITY (LEICESTERSHIRE COUNTY COUNCIL)

The County Council have the overall responsibility for coordinating the management of local flood risk (namely ordinary watercourses, surface water and groundwater).

As stated within the introduction section, the County Council as the LLFA has a responsibility to investigate flood incidents under Section 19 of the FWMA. Whilst the County Council can suggest possible causes of flooding in Leicestershire and make recommendations to ensure flood risk is mitigated as far as possible, the FWMA does not provide the County Council with the mandate or funding to tackle all identified causes of flooding.

6.3. WATER COMPANY (SEVERN TRENT WATER)

Water and sewerage companies are responsible for managing flood risks related to surface water, foul water and combined sewer systems. Public sewers are designed to protect properties from flood risk in normal wet weather conditions. In extreme weather conditions however there is a risk of these public sewers being overwhelmed, resulting in sewer flooding.

Following the 'Private Sewer Transfer' on 1st July 2011, water companies are now responsible for all pipes systems on private land that serve more than one curtilage and are connected to a public sewer. Under Section 94 of the Water Industry Act (1991) statutory sewerage undertakers have a duty to provide sewers for drainage of buildings and associated paved areas within property boundaries.

Water companies are responsible for all public sewers and lateral drains. Public sewers are a conduit (typically a pipe) assigned to a water and sewerage company that drains two or more properties; conveying foul, surface water, or combined sewerage to a positive outfall. Connection of other drainage sources to public sewers is discretionary, following an application to connect.

Severn Trent Water was consulted for the local sewerage networks performance and has confirmed no known issue related to the network capacity at Burleigh Avenue.

6.4. RESIDENTS AND TENANTS

Local residents and tenants who are aware that they are at risk of flooding should take action to ensure to ensure the resilience of their personal property.

Community resilience is important in providing information and support to each other if flooding is anticipated. Actions taken can include signing up to Flood Warning Direct (if available), nominating a community flood warden, producing a community and / or personal flood plan and moving valuable items to higher ground. More permanent measures to improve property level resilience include installing floodgates, raising electrical sockets and fitting non-return valves on pipes.

7. AGREED/RECOMMENDED ACTIONS

There are a number of agreed/recommended actions for various Risk Management Authorities and individuals (riparian owners) that may reduce the impact of future similar rainfall events. These are outlined below.

7.1. LOCAL HIGHWAY AUTHORITY (LEICESTERSHIRE COUNTY COUNCIL)

A CCTV survey of the highway drainage (and in places public sewer network on behalf of Severn Trent Water) around the junction is to be carried out to confirm the layout and connectivity and assess the condition of the network. The CCTV may lead to remedial maintenance works or further work to investigate mitigation options if appropriate.

The Local Highway Authority will also continue to monitor and maintain their gullies and highway drainage network, keeping them clear from obstruction so they can remain operable.

7.2. SEVERN TRENT WATER

Severn Trent Water has agreed to work with LCC to obtain a CCTV survey of the surface water system as above. This may lead to remedial maintenance works or further work to investigate mitigation options if appropriate.

Severn Trent Water is to continue to monitor and assess any areas of restriction or insufficient capacity within their system as appropriate. Routine maintenance activities will continue to ensure that the sewerage networks have good serviceability.

7.3. LEAD LOCAL FLOOD AUTHORITY (LEICESTERSHIRE COUNTY COUNCIL)

The LLFA will continue to support the community to ensure that they are suitably supported and guided with regards to improving personal resilience as required.

8. ACKNOWLEDGEMENTS:

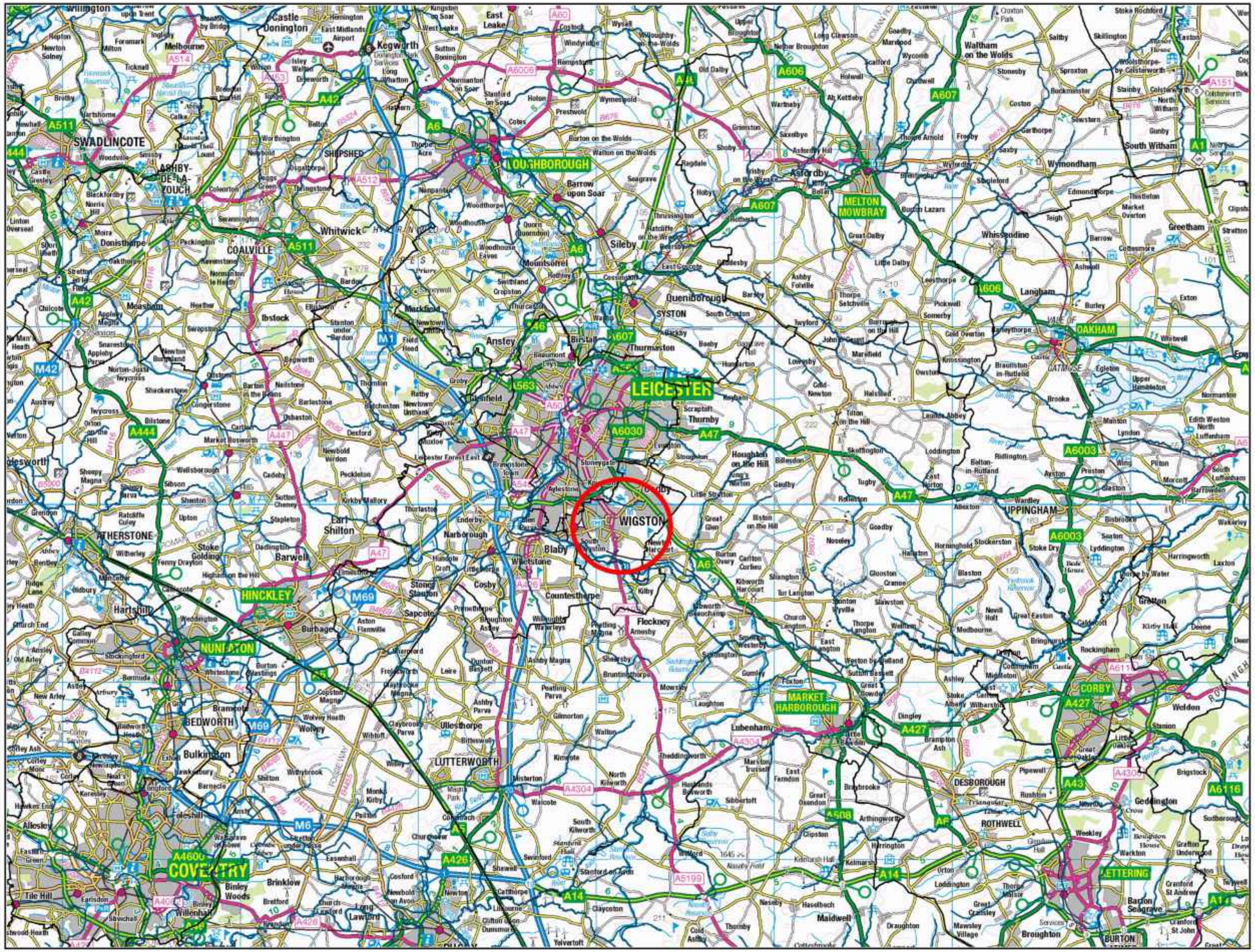
A special mention of thanks should be given to all of those residents of Burleigh Avenue who provided AECOM with knowledge and experience, which has been incorporated into this report and will help to contribute to future flood alleviation and resilience in those affected areas.

9. ABBREVIATIONS:

AEP	Annual Exceedance Probability
LCC	Leicestershire County Council
FIR	Flood Investigation Report
FWMA	Flood and Water Management Act 2010
LDA	Land Drainage Act 1991
LLFA	Lead Local Flood Authority
WRA	Water Resources Act 1991
LiDAR	Light Detection and Ranging
STW	Severn Trent Water Ltd
FMfSW	Flood Map for Surface Water
RMAs	Risk Management Authorities

APPENDIX A

SITE LOCATION PLAN



Key

None.

Leicestershire County Council

ENVIRONMENT AND TRANSPORT DEPARTMENT

On Behalf of the DIRECTOR

LEICESTERSHIRE COUNTY COUNCIL
ENVIRONMENT AND TRANSPORT

Service:	Lead Local Flood Authority
TITLE:	Site Location
LOCATION:	Burleigh Avenue Wigston
DRAWING NUMBER: 2016-INV-197	SCALE: Not To Scale
CREATED BY: Stacey Johnson	DATE: 05/01/2016
	SIZE: A4
E-MAIL: flooding@leics.gov.uk	
PHONE: 0116 305 0001	

COUNTY HALL · GLENFIELD · LEICESTER · LE3 8RJ

This is not a definitive record, but is based on the best available information and is given without warranty. If roadside ditches are present, the normal presumption is that these do not generally form part of the publicly maintainable highway. This plan has been produced in relation to the specified area of enquiry and should not be used for any other purpose, since its accuracy can not be guaranteed.

This map gives an indication of the location of the site. It is not suitable for use at an individual property scale due to the method used.

APPENDIX B

SITE VISIT NOTES

Leicestershire County Council – Section 19 Reports
Site Visit Data Sheet

1. Detail of Area/Properties/People Affected						
Location/Ward Area:	Burleigh Avenue Wigston					
Team:	SE & SAJ					
Property Type(s) at flood risk Incl. Number:	Residential:	2+	Industrial:		Office:	
	Educational:		Religious:		Recreational:	
Other (e.g infrastructure)	Junction between Barnaby & Burleigh Avenue					
Comments:	Reports that ponding occurs typically in June / July / August after flash storm events. Flood water gathers from the recently developed hardstanding South of Burleigh Avenue, and from the surrounding roads. The resident reported that there were two intense rainfall events, and that it was only following the second event that the system became overwhelmed.					

2. Details of Flooding							
Flood damage incurred? :	Internal flooding experienced		Through doors:	Ponding in houses.			
			Through windows:				
			Through floors:				
			Through airbricks:	Ponding in basement / cellar			
			Through drainage:	Ponding in road			
Source of flooding (if known):	Main River	Other Water Course	Road	Overland	Public Sewer	Private Drain	Other e.g. blocked culvert, gully etc,
			Y	Y			Y
Comments (include estimate of flow path and sketch where possible):	It is thought that the source of flood water is the surface water from the storm. The junction seems to be the lowest point in the area, and as such water collects from all approaching roads to this point. Water drains through the system fine, until the gully begins to overflow. Once this takes place the road fills and eventually spills through the garage and front driveway. Where water has previously entered the home, this time they were able to prevent it from entering their ground floor. Water did entre their cellar and garage. It has also been reported that flooding occurring at these 2 houses is mainly due to the bow waves created by vehicles on the road.						
Water Depth Inside property (m)	Unknown						

Leicestershire County Council – Section 19 Reports
Site Visit Data Sheet

Water Depth Outside property (m)	15/16cm									
3. Effects of Flooding										
Damage to Props. (residential and commercial/retail):	Internal flooding of (at least) two houses, along with complete submersion of the road at the junction – causing significant distress to the owners.									
Damage to infrastructure:	No visible damage.									
Were/are properties Vacated?	No		If Yes, for how long?		If Yes, relocated to where?					
Utilities Affected?	Electricity		Water		Gas		Phone		Other	
Flood Report/Grant application Refs?	Unknown									
4. Existing Flood Defences										
Is there an existing defence? Type and details:	One house has lateral drains installed at the front of the property.									
Condition	N/A									
5. **Potential Flood Alleviation Measures**										
Proposed Measure(s) Details incl. length, height, Constructability/Access	Flood Wall									
	Flood Embankment									
	Upstream storage									
	Storm Water Drainage System	Possible improvements to system								
	Cleaning/Maintenance	Regular maintenance of the system								
	SUDS									
	PLP									
Location Details and sketch (Public or Private Property, Provide Details (e.g. river embankment, field, main road, residential street)	Public street; Burleigh Avenue.									
Further Comments										

Leicestershire County Council – Section 19 Reports
Site Visit Data Sheet

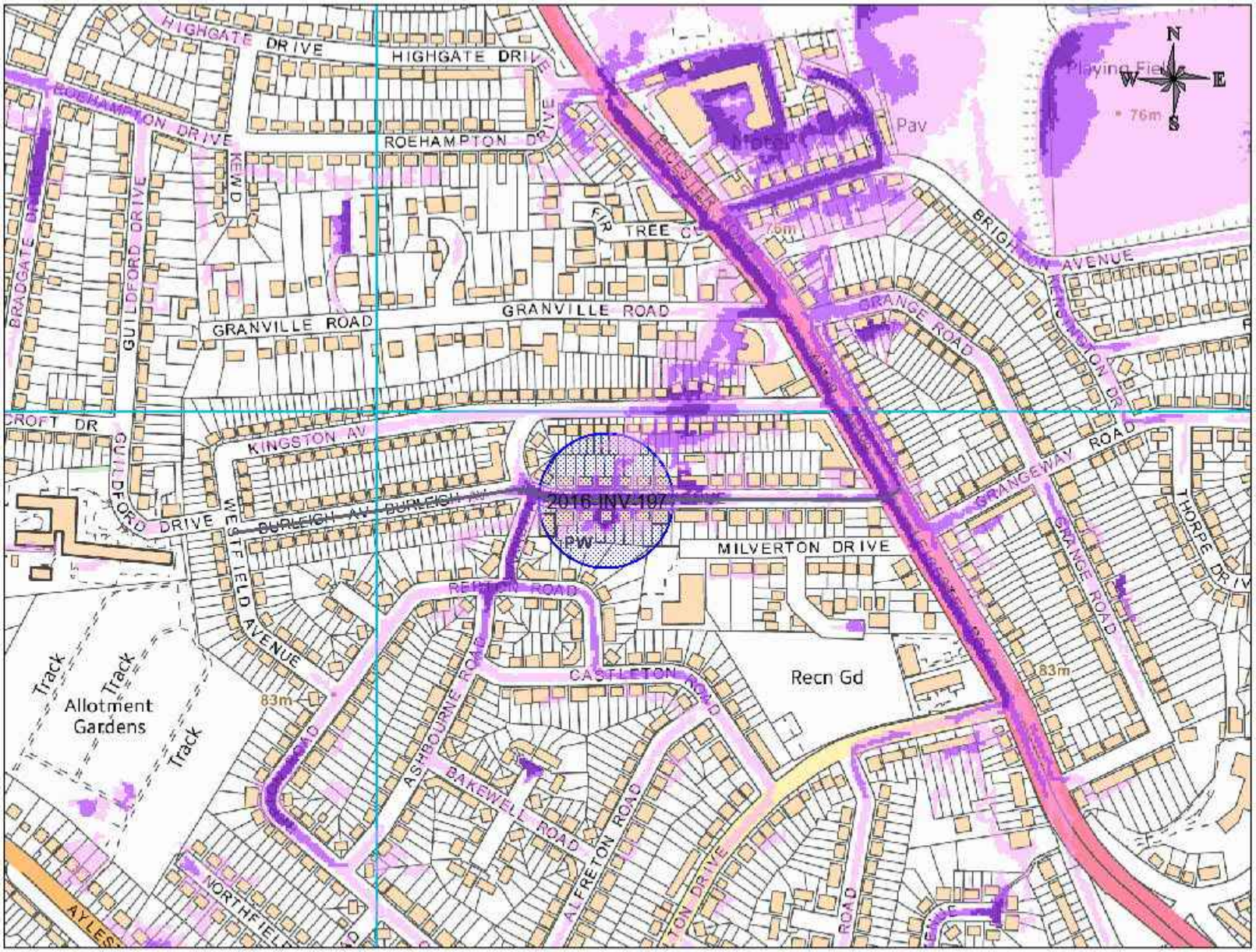
Add further comments, details, sketches here:

Signature:

Name of Collator:	**Date:**	**Time:**
Stacey Johnson	**29 /11 /2016**	**1.00 pm**

APPENDIX C

RISK OF FLOODING FROM SURFACE WATER (RoFSW)



Location Map

updated Flood Map for Surface Water

- 3.33 % AEP (1 in 30 Years)
- 1% AEP (1 in 100 Years)
- 0.1% AEP (1 in 1000 Years)

Site Location

- Site boundary

source_protection_zones_50k Legend

- Region

Leicestershire County Council

ENVIRONMENT AND TRANSPORT DEPARTMENT

ON BEHALF OF THE DIRECTOR

LEICESTERSHIRE COUNTY COUNCIL
ENVIRONMENT AND TRANSPORT

SERVICE: LEAD LOCAL FLOOD AUTHORITY

TITLE: updated Flood Map for Surface Water

LOCATION: BULEIGH AVE

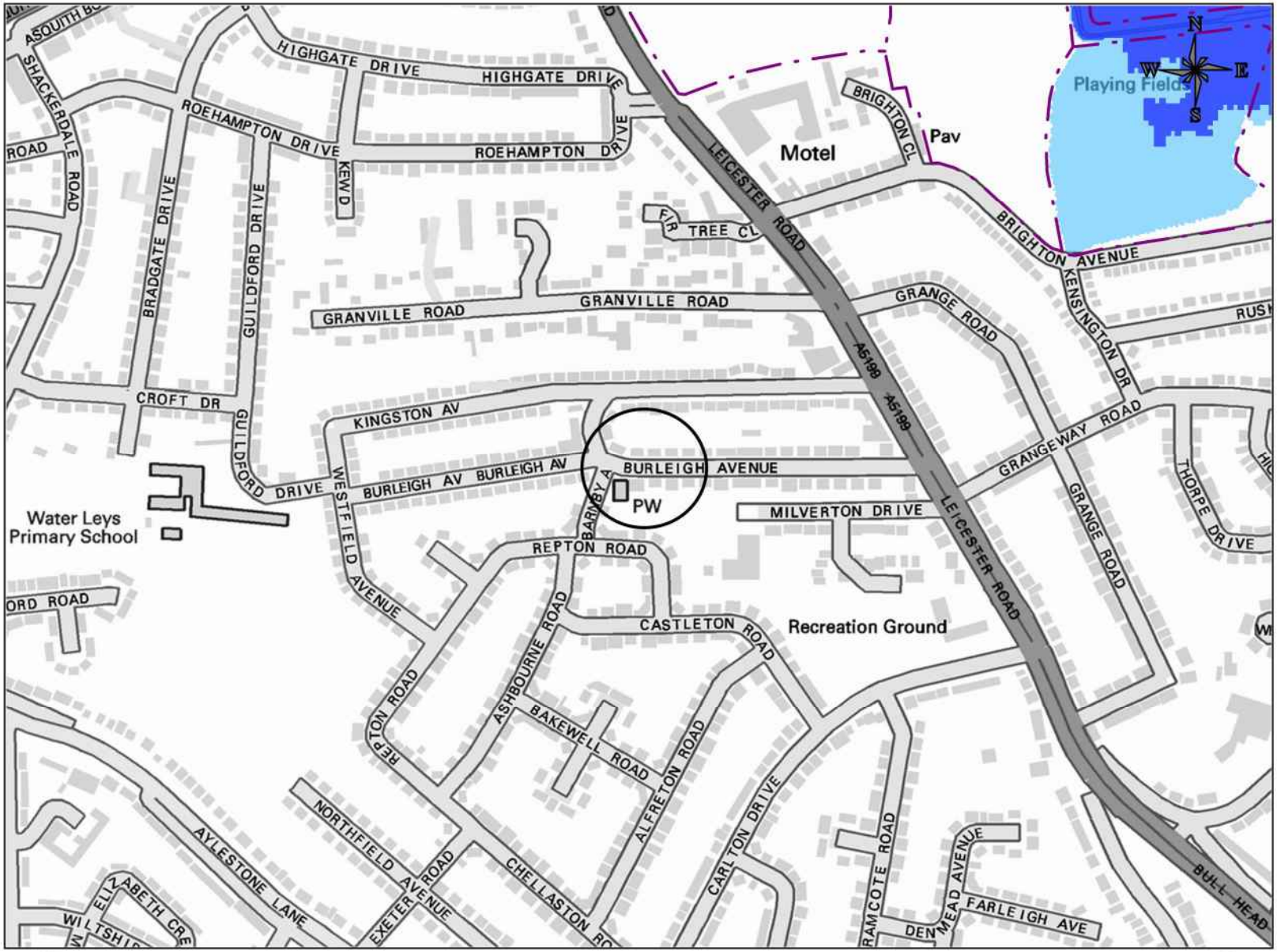
DRAWING NUMBER	SCALE
2016-INV-197	Not To Scale
CREATED BY: Chris Cant	DATE: 27-10-2016
	SIZE: A4

E-MAIL: flooding@leics.gov.uk
PHONE: 0116 305 0001
COUNTY HALL · GLENFIELD · LEICESTER · LE3 8RJ

This map gives an indication of the broad areas likely to be at risk of surface water flooding. It is not suitable for use at an individual property scale due to the method used.

APPENDIX D

FLOOD ZONES MAP



Key

Flood Defences

Flood Zone 3

1% AEP (1 in 100)

Flood Zone 2

0.1% AEP (1 in 1000)

Leicestershire County Council

ENVIRONMENT AND TRANSPORT DEPARTMENT

On Behalf of the DIRECTOR

LEICESTERSHIRE COUNTY COUNCIL
ENVIRONMENT AND TRANSPORT

Service: Lead Local Flood Authority

TITLE: Flood Zones 2 & 3

LOCATION: Burleigh Avenue Wigston

DRAWING NUMBER	SCALE
2016-INV-197	Not To Scale
CREATED BY: Stacey Johnson	DATE: 05/01/2016
	SIZE: A4

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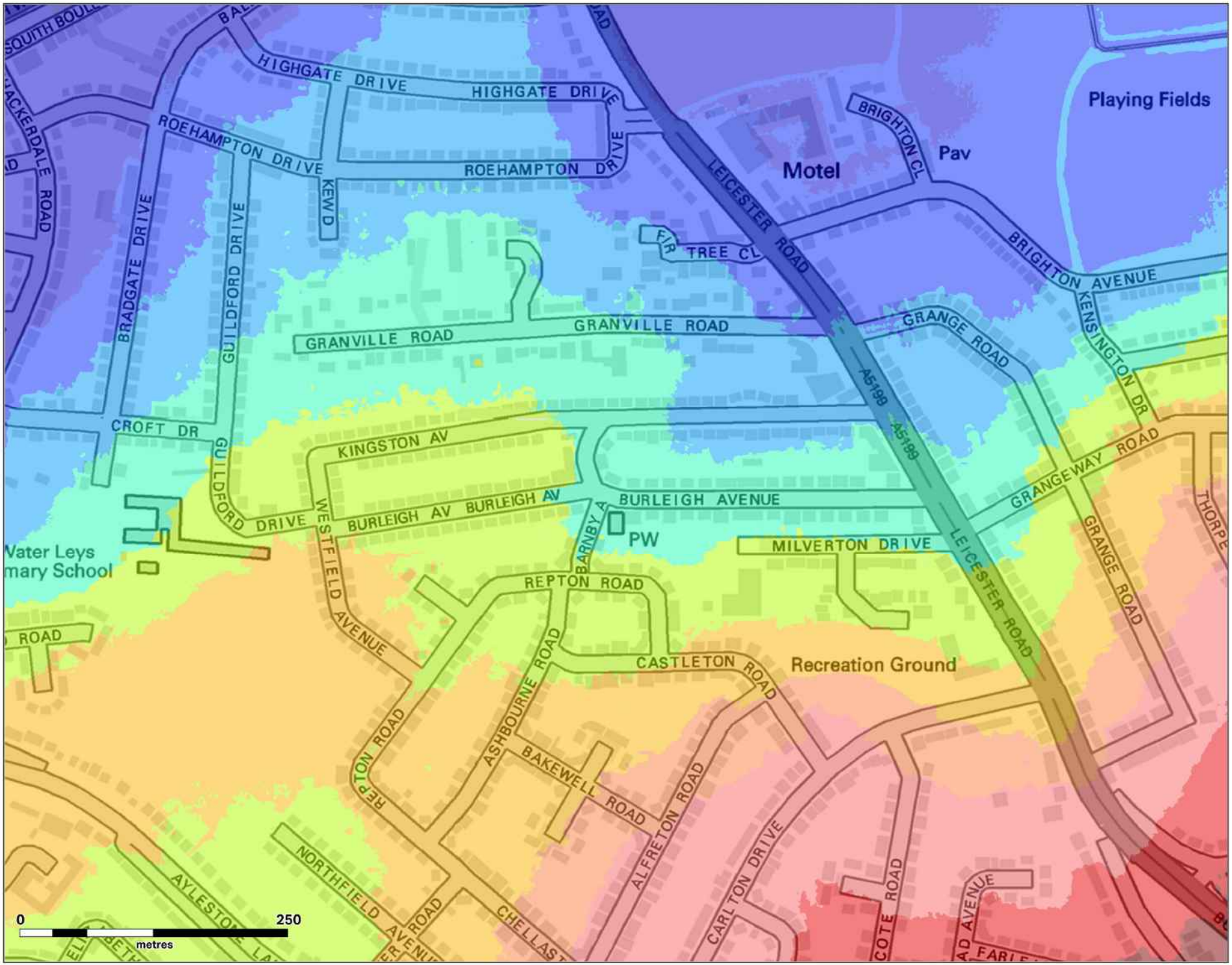
COUNTY HALL · GLENFIELD · LEICESTER · LE3 8RJ

This map gives an indication of the broad areas likely to be at risk of surface water flooding. It is not suitable for use at an individual property scale due to the method used.

APPENDIX E

LiDAR PLAN



Job Title

60527961

Legend

LiDAR Elevation mAOD (m)

67-71	98-102
71-75	102-107
75-77	
77-79	
79-81	
81-83	
83-85	
85-87	
87-91	
91-94	
94-98	

Notes

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

V1	SAJ / NM	15/12/2016	??

Drawing Status

AS BUILT

Drawing Title

2016 INV 197 - LiDAR

Client

Leicestershire County Council

Scale at A3: AS SHOWN

Drawn	Approved
SAJ	SE

Stage 1 Check	Stage 2 Check	Originated	Date
NM	AP	CHFD	12-2016

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Drawing Number: 2016 INV 197 - 02

Rev: 1-1

APPENDIX F

HYDROLOGICAL STUDY NOTES

Leicestershire Section 19 Flood Investigations

Hydrology Technical Note

Leicestershire County Council

Project Number: 60527961

January 2017

Quality information

Prepared by	Checked by	Approved by
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Revision History

Revision	Revision date	Details	Authorized	Name	Position
V1	24/01/2017	Check	KP	Katie Pearson	Associate

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Table of Contents

Figures

Tables

1. Introduction

AECOM have been commissioned by Leicestershire County Council (LCC) to deliver S19 flood investigations for 13 sites across Leicestershire which experienced property and road flooding during 2016. This Hydrology Technical Note describes the hydrological method that was used to undertake probability of occurrence analysis for each flooding incident / each location. Table 1-1 lists the location and date of each flooding incident investigated.

Table 1-1: Location and date of each flooding incident

Flooding location	Easting	Northing	Date of flooding
Wellsic Lane Rothley	458088	312541	09/03/2016
Highgate Road Sileby	460841	315409	10/06/2016
Dunton Road Broughton Astley	453689	291755	09/03/2016
Walnut Leys Cosby	454887	294791	19/04/2016
Leicester Road Loughborough	454322	318656	07/05/2016
Windsor Road Loughborough	451746	320322	15/06/2016
Abbey Close Shepshed	447417	318085	15/06/2016
Blackwood Coalville	444852	314380	08/07/2016
Bishopdale Coalville	442990	317308	15/06/2016
Burleigh Avenue Wigston	460188	299926	27/08/2016
Main Street Kilby	461822	295496	25/08/2016
Kilby Road Fleckney	464540	293631	10/03/2016
Lymetree Grove	431094	315422	13/14/15/06/2016

2. Data Collection

AECOM used available Environment Agency, LCC, and Metrological Office rainfall gauge data and publically available hydrological information to estimate the probability of occurrence of each flood event. Data was obtained from rainfall gauges as close to the study sites as possible, where available for the time period between 1st January 2016 and 1st December 2016, which is the time span during which all the flooding incidents occurred at the 13 locations across Leicestershire.

3. Rainfall Analysis Methodology

3.1 Observed Rainfall Data

The Environment Agency provided hourly and daily total rainfall data for 10 rainfall gauges across the study area. However, only six of these rainfall gauges were appropriate to use for data analysis purposes due to the time period of the available data. Figure 3.1 shows the location of rainfall gauges and flooding incidents.

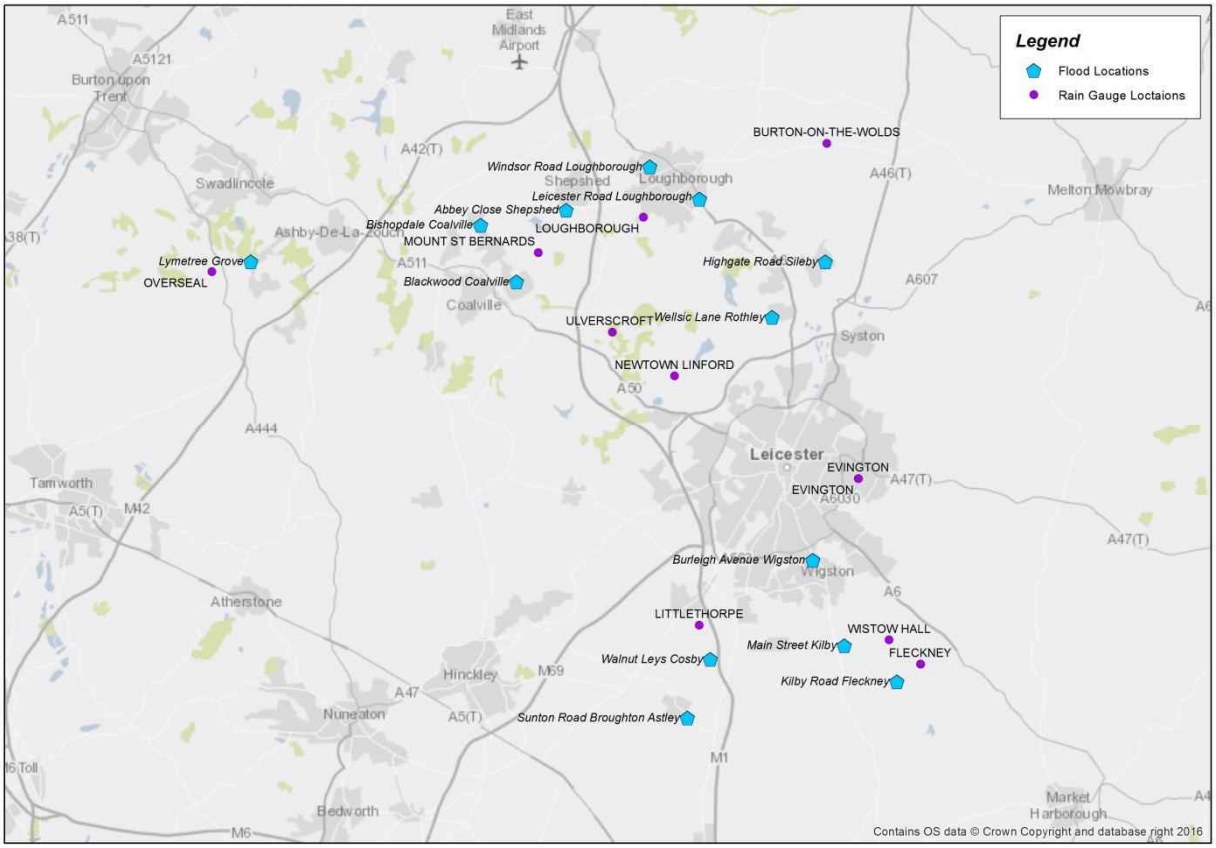

Figure 3-1: Location of flooding incidents and rainfall gauges

Observed rainfall data was analysed from relevant rainfall gauges and used to identify the key rainfall events during the time periods which are known to have caused localised flooding incidents at the 13 locations across Leicestershire.

The rainfall gauge closest to each flooding location was used for data analysis purposes. Where there was no obvious single gauge appropriate for the analysis and where a flooding location falls between two or more rainfall gauges, it is assumed that the rainfall total is an average from the nearest gauges. Table 3-1 indicates which rainfall gauges were used for each flooding location.

A distance weighting approach was considered for rainfall data analysis purposes. However, this was discounted because distance weighting approach is not appropriate for site specific flooding analysis, and is more commonly used for catchment hydrology.

The maximum rainfall depth was calculated for each rainfall event from the observed data, for a one hour, 2 hour and 5 hour storm duration.

Table 3-1: Rainfall gauges used for each flooding location

Flooding location	Rainfall gauge(s) used	Date of flooding	Maximum rainfall in different duration events (mm)		
			1hr	2hr	5hr
Wellsic Lane Rothley	Burton-on-the-Wolds, Evington	09/03/2016	4.40	8.10	16.80
Highgate Road Sileby	Burton-on-the-Wolds, Evington	10/06/2016	6.40	4.50	18.10
Dunton Road Broughton Astley	Littlethorpe	09/03/2016	5.00	8.40	16.80
Walnut Leys Cosby	Littlethorpe	19/04/2016	5.00	8.40	16.80
Leicester Road Loughborough	Burton-on-the-Wolds	07/05/2016	7.00	7.40	8.00
Windsor Road Loughborough	Burton-on-the-Wolds, Mount St Bernards	15/06/2016	17.40	25.30	30.90
Abbey Close Shepshed	Mount St Bernards	15/06/2016	25.40	40.20	49.80
Blackwood Coalville	Mount St Bernards	08/07/2016	8.80	14.4	17.20
Bishopdale Coalville	Mount St Bernards	15/06/2016	25.40	40.20	49.20
Burleigh Avenue Wigston	Littlethorpe, Evington, Fleckney	27/08/2016	22.40	31.67	33.27
Main Street Kilby	Fleckney	25/08/2016	2.60	3.60	3.80
Kilby Road Fleckney	Fleckney	10/03/2016	5.60	9.60	18.40
Lymetree Grove	Overseal	13/14/15/06/2016	14.60	-	-

3.2 Event Rarity

The maximum rainfall depth for these three event durations was then used to estimate the event rarity for each rainfall event using the Depth-Duration-Frequency (DDF) rainfall model. DDF curves describe rainfall depth as a function of duration for given return periods (probabilities) at specified

locations within the UK and can be reproduced using the Flood Estimation Handbook (FEH) CD-ROM 3[1].

For each of the 13 locations, the DDF curve was plotted for each return period, ranging from 2 -100 years, for rainfall events up to a 10 hour duration. The maximum observed rainfall depths were plotted against these DDF curves for the three durations analysed to determine the return period of each rainfall event. This analysis allowed the estimation of probability as, for example, less than a 2 year return period event or between a 5 and 10 year return period event, depending on where the observed rainfall depth plotted compared to the DDF curves. Figure 3-2 shows an example of how the three observed rainfall maximums where plotted against the DDF rainfall curves to assess the probability of occurrence.

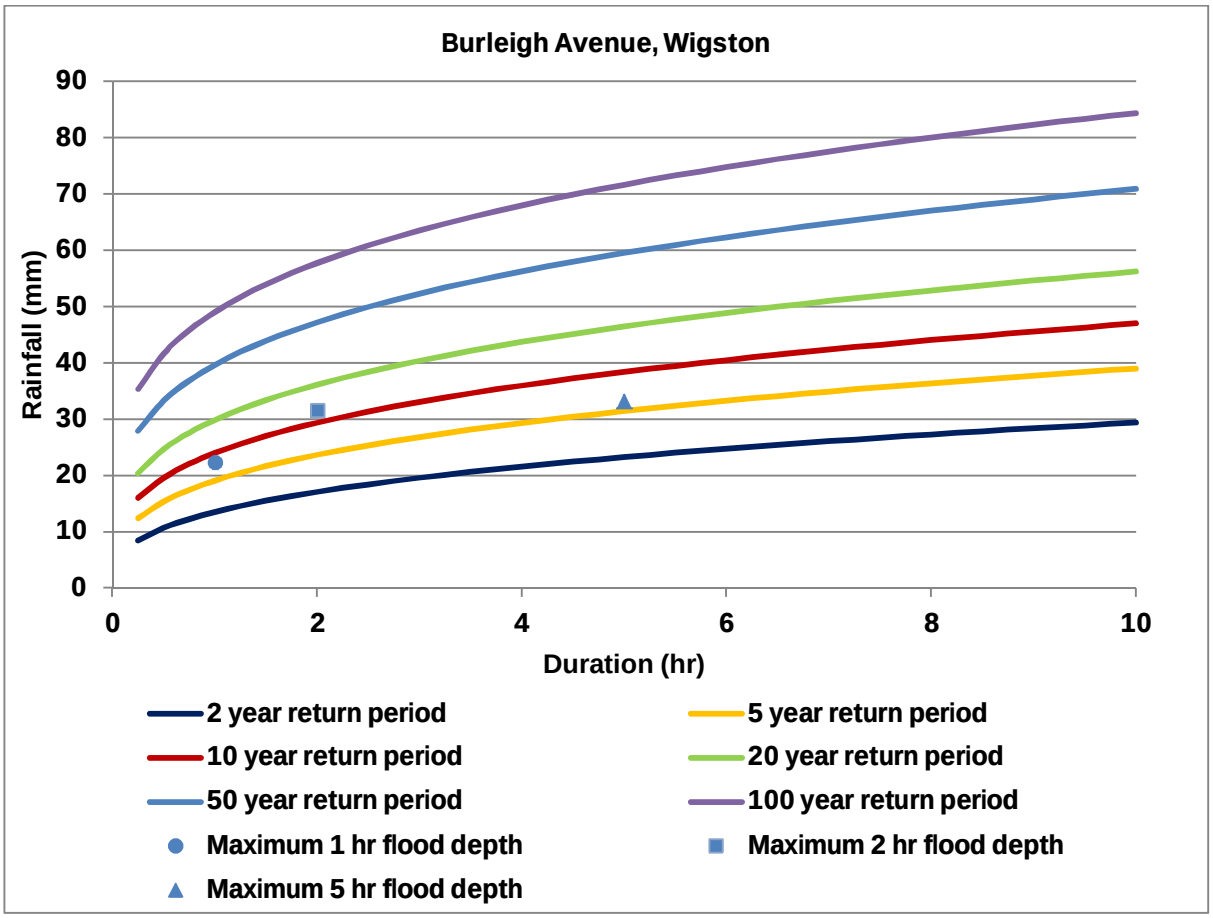

Figure 3-2: Example of rainfall maximums for different durations plotted against DDF rainfall curves to assess probability of occurrence

To verify the above analysis, the 'event rarity' function in the DDF rainfall model was also used to estimate a more specific (e.g. a 3.4 year) return period for each rainfall event. However, it is not considered appropriate to report these more specific return period estimates in the S19 reports as it would provide a false level of confidence in the rainfall analysis which is unrealistic, given the limitations below. It is considered more appropriate to report in terms of less than a 2 year return period event or between a 5 and 10 year etc. Figure 3-3 shows an example of the event rarity function in the DDF rainfall model in the FEH CD ROM 3.

[1]Flood Estimation Handbook, 1999, Institute of Hydrology

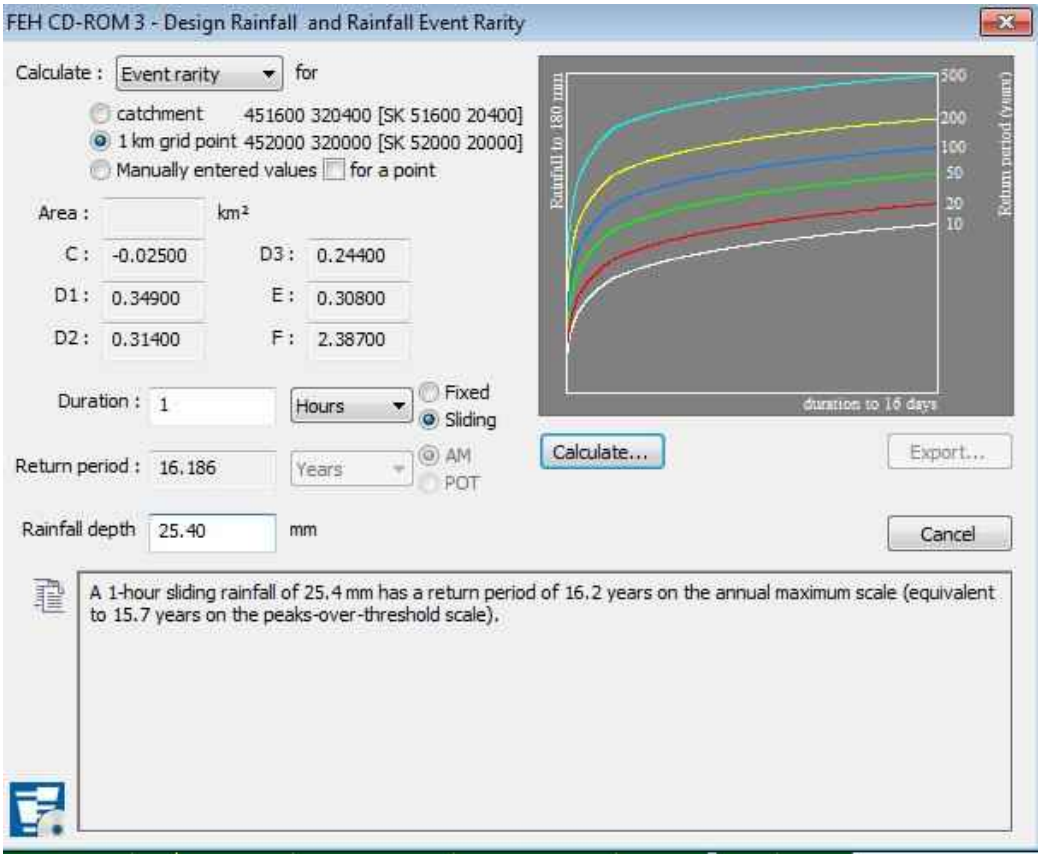

Figure 3-3: Example of the 'event rarity' function in the DDF rainfall model in FEH CD ROM 3

3.3 Limitations

There are some limitations associated with the hydrological methodology which should be considered when reviewing the S19 reports.

These flooding incidents were commonly associated with localised rainfall events which caused localised surface water flooding. Localised rainfall events are commonly characterised by intense fast moving rainfall. Although there is good coverage of rainfall gauges across the entire study area, it is possible that in some cases, the rainfall gauges used in this analysis did not record some of the key rainfall events if the rainfall did not fall directly over the gauge.

The Environment Agency provided hourly and daily total rainfall data for 10 rainfall gauges across the study area. However, only six of these rainfall gauges were appropriate to use for data analysis purposes due to the time period of the available data. Analysis of hourly rainfall data does mean that any particularly intense sub-hourly rainfall bursts are not considered in this analysis. It would have been more accurate to analyse 15 minute data as this would have helped to pinpoint the peak of the rainfall event more specifically. However, the Environment Agency could only provide hourly data within an appropriate timeframe to undertake analysis for this project.

Where more than one rainfall gauge was used for data analysis purposes, averaging the maximum rainfall from more than one gauge has its limitations. The spatial distribution of rainfall varies across an area, especially during intense and fast moving rainfall events that caused these flooding incidents, such that the maximum rainfall may have occurred at one gauge and not others. However the area weighting method is not considered to be appropriate for site specific hydrology so this is the most appropriate option available. The averaging method chosen may have under-estimated maximum rainfall totals in some locations / some events.

4. Conclusion

Observed rainfall data was used to estimate the event rarity of known flooding incidents at 13 locations across Leicestershire. DDF modelling from FEH CD ROM 3 was used to obtain predicted rainfall depths at different durations. Rainfall depths from observed events were plotted against these predicted rainfall depths to estimate the event rarity of historic rainfall events.

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APPENDIX F-1

SITE SPECIFIC HYDROLOGY NOTES

DDF curves describe rainfall depth as a function of duration for given return periods at specified locations within the UK and can be reproduced using the Flood Estimation Handbook (FEH) CD-ROM 3.

The DDF model for the Sileby catchment has been reproduced in Figure 4-3. The rainfall depth values for each duration are the average of the two maximum values for that duration from the two gauge sites. So, for the 1 hour duration, the maximum values are approximately 11mm and 2mm respectively for each of the sites, giving an average maximum depth of 6.5mm. This gives an average maximum 1 hour duration rainfall depth of 6.5mm, giving a return period of less than 2 years, from Figure 4-3.

The DDF model demonstrates that the 1 hour, 2 hour and 5 hour rainfall profiles over the Sileby catchment had an equivalent return period of less than 2 years, or a more than 50% Annual Exceedance Probability (AEP). However, it should be noted that the 2 hour rain event at Evington had a return period of between 2 and 5 years, so the rain event here may have been a little higher than the average value given above.

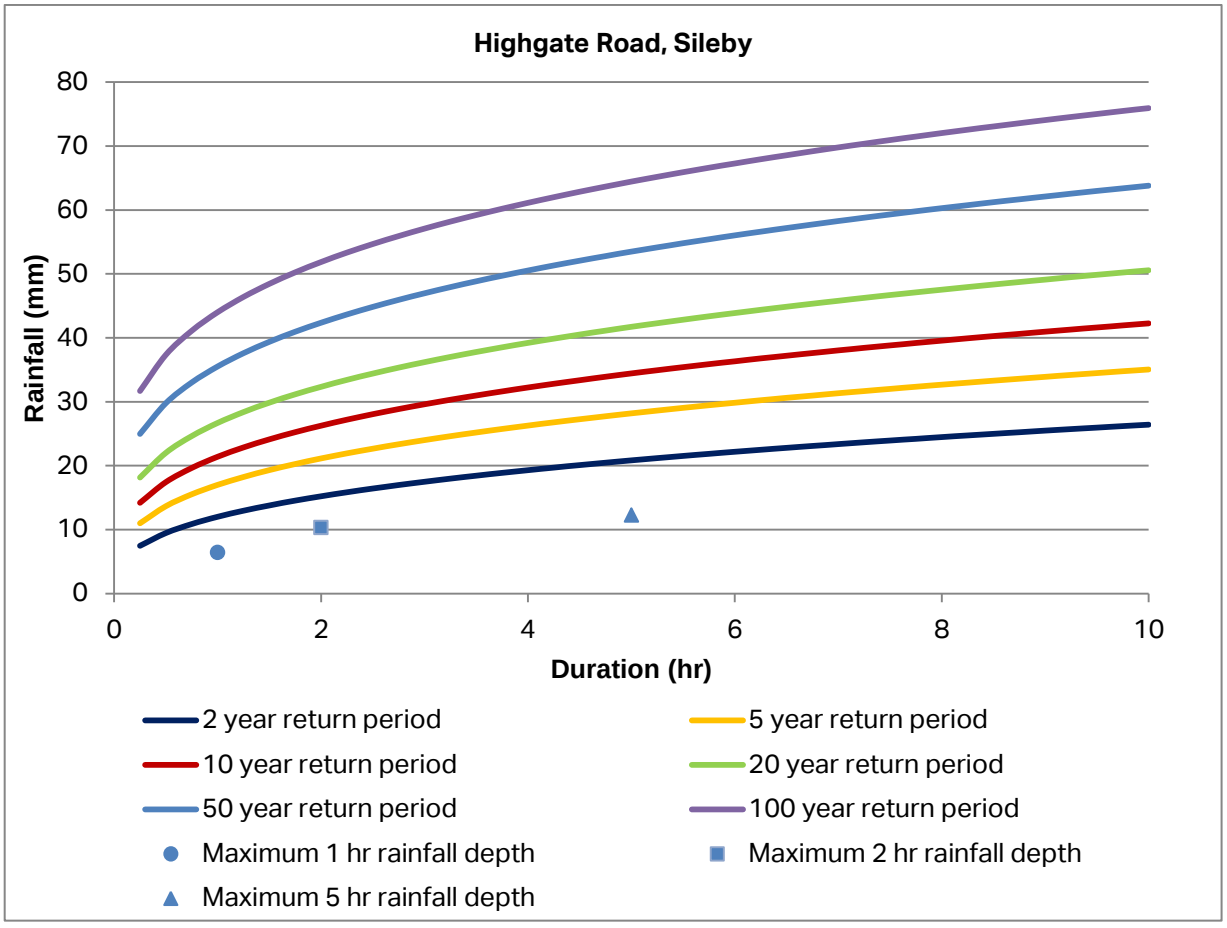


Figure 1: DDF model for Highgate Road, Sileby

The 'event rarity' function in the DDF rainfall model was used to estimate a more specific return period for each rainfall gauge. This approach is especially useful when more than one rainfall gauge was used for data analysis purposes, because it allows the return period to be estimated for each individual gauge.

This allows us to determine whether the event return periods recorded by all the gauges were similar or if the return periods varied significantly across the study area.

Table 4-2 shows the estimated return periods for each rainfall gauge used for data analysis purposes for the flooding incident in Sileby. Table 4-2 shows that the estimated return periods for both rainfall gauges were generally low, with the higher return period event being recorded by the Evington rainfall gauge. This suggests that the rainfall was localised and therefore it was appropriate to use an average of the maximum rainfall observed at both rainfall gauges.

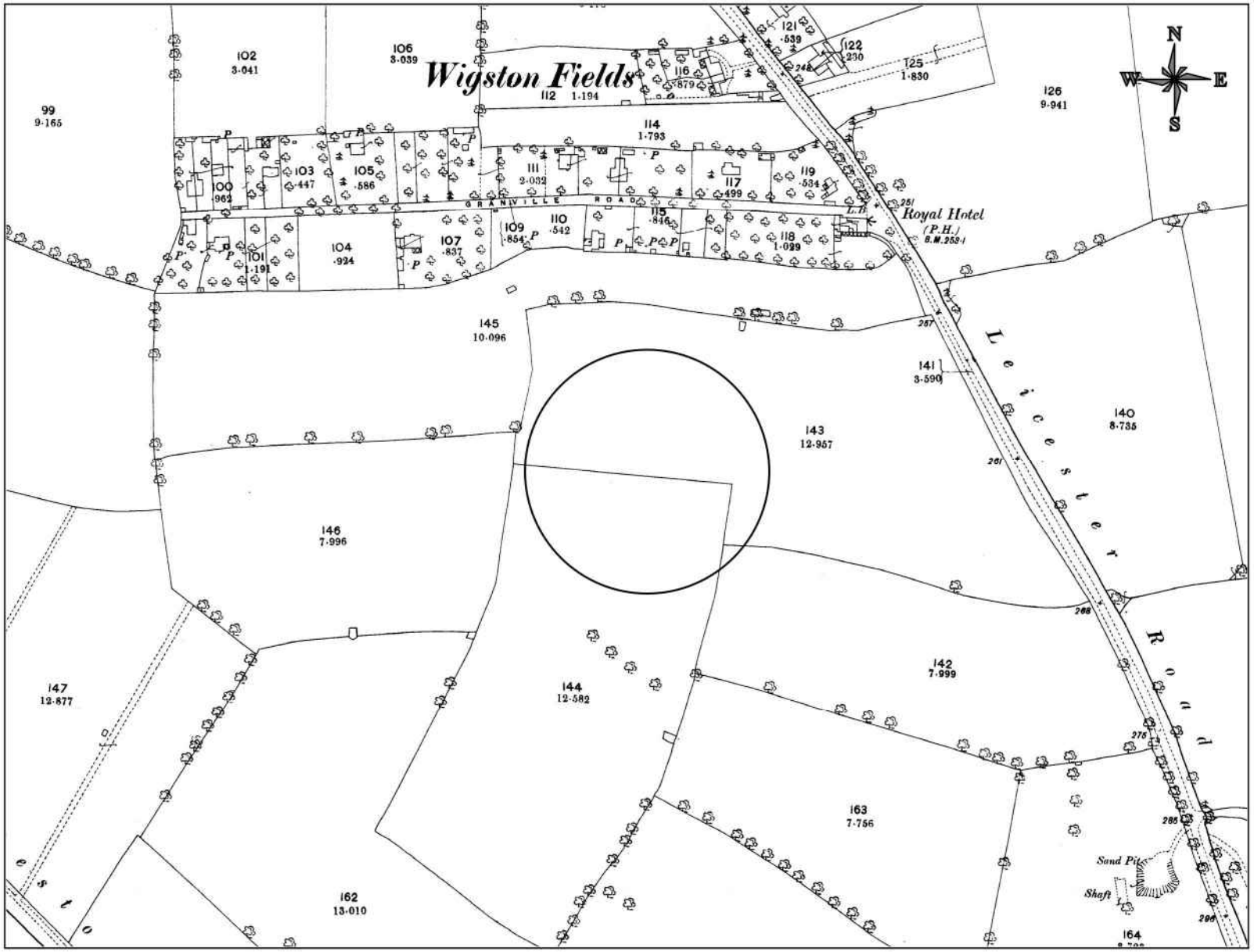
If a rainfall event is considered 'commonplace' this suggests that the rainfall event was very localised and is described by FEH as "having a return period shorter than one month on the peaks-over-threshold scale".

Table 1: Estimated event rarity at a range of durations at both gauges used for data analysis purposes

Gauge	**1 hour (Return period – years)**	**2 hour (Return period – years)**	**5 hour (Return period – years)**
Burton-on-the-Wolds TRB	commonplace	commonplace	commonplace
Evington TRB	2.0	2.8	1.6

APPENDIX G

1884 HISTORIC MAP



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This map gives an indication of the broad areas likely to be at risk of surface water flooding. It is not suitable for use at an individual property scale due to the method used.

Key

Leicestershire County Council

ENVIRONMENT AND TRANSPORT DEPARTMENT

On Behalf of the DIRECTOR

LEICESTERSHIRE COUNTY COUNCIL
ENVIRONMENT AND TRANSPORT

Service: Lead Local Flood Authority

TITLE: Historic Mapping - 1884

LOCATION: Burleigh Avenue, Wigston

DRAWING NUMBER	SCALE
2016-INV-197	Not To Scale
CREATED BY: Joe Pierce	DATE: 01/2017
	SIZE: A4

E-MAIL: flooding@leics.gov.uk
PHONE: 0116 305 0001
COUNTY HALL · GLENFIELD · LEICESTER · LE3 8RJ

STATUS OF THIS REPORT AND DISCLAIMER

This report has been prepared pursuant to the Council's statutory responsibility, under the FWMA, to investigate flood incidents in its area. The statutory duty to investigate is not absolute or exhaustive. Under Section 19 of FWMA, the Council's statutory responsibility is limited to conducting investigations only to the extent the Council deems it necessary.

Where the Council deems it necessary to conduct an investigation, it is required to address two questions under 19(1) of the FWMA. Firstly, the Council is required to identify relevant "Risk Management Authorities"[1]. Secondly the Council is required to investigate whether the Risk Management Authorities have exercised, or are proposing to exercise, flood risk management functions set out under Section 4 of FWMA.

The relevant flood risk management authorities identified by the Council are defined at Section 1.4 of the body of this report. The flood risk management functions which the Risk Management Authorities are proposing are described at Section 6 of the body of this report.

Beyond discharging the specific statutory responsibilities under Section 19(1) of FWMA, the intended purpose of this report is solely as a resource to assist Risk Management Authorities and stakeholders to better understand the relevant flooding incident and to mitigate risks going forward.

Although the Council has commented upon contextual issues related to the flood event, it is not the purpose of this report to determine any private rights arising from the flood event.

Nor is the purpose of this report to reach conclusions as to whether any Risk Management Authority or other stakeholder *(e.g. private land owners, public bodies or government agencies)* has breached any duty of care *(whether statutory or common law)* that they may have held.

The Council has, in good faith, sought to locate and collate relevant primary and secondary evidence to prepare this report. However, the Council accepts no responsibility for assumptions or statements made on the basis of evidence which incomplete, inaccurate or both. As such, this report should not be considered as a definitive assessment of all factors that may have triggered or contributed to the flood event.

The Council expressly disclaims responsibility for any error, omission or negligent misstatement in this report to the fullest extent permissible in law.

Further the Council does not accept any liability for the use of this report or its contents by any third party. Where any party wishes to assert any rights or cause of action related to the flooding event they are requested to rely on their own investigations.

[1] *As defined by Section 6(13) of FWMA*