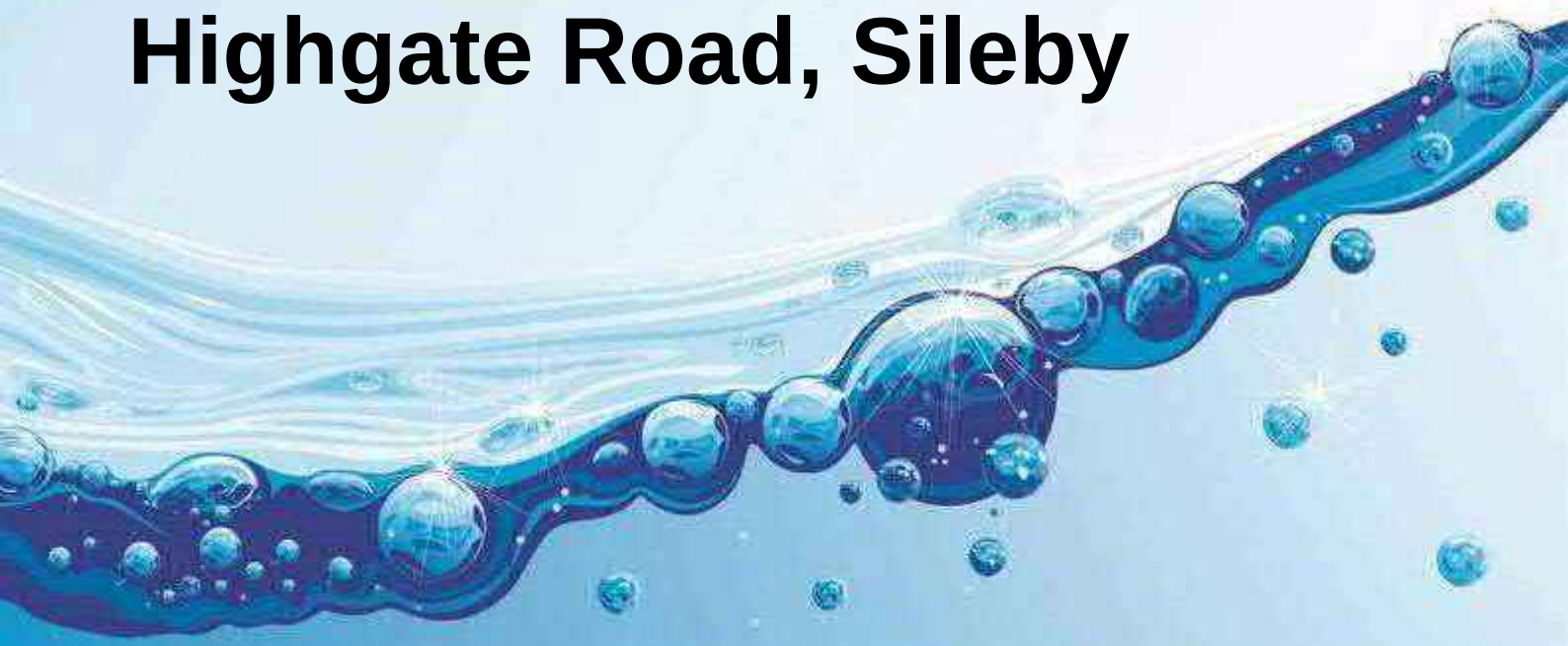
Leicestershire County Council

Highgate Road, Sileby



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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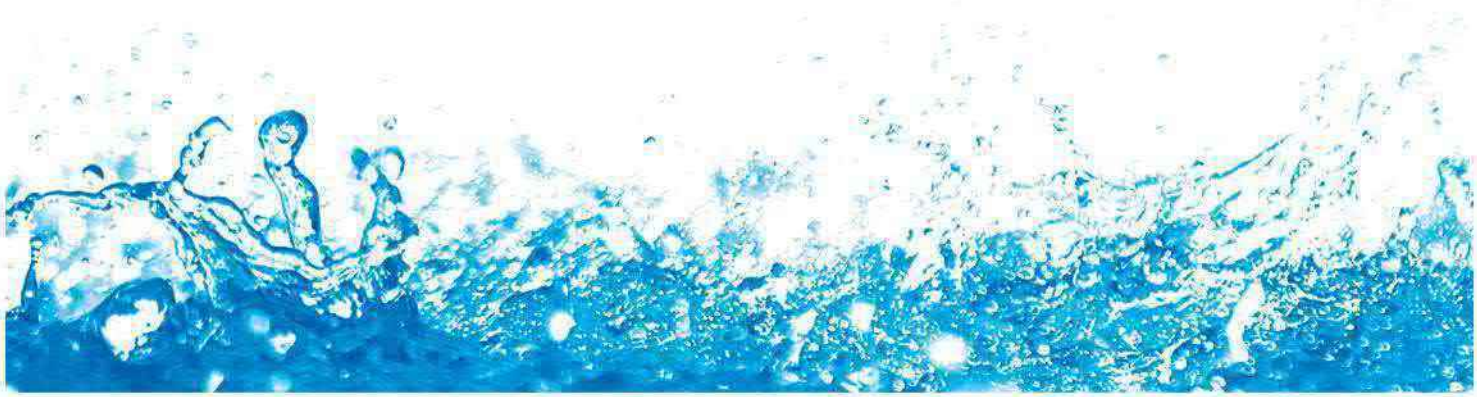

DETAILED FLOOD INVESTIGATION

County Council Investigation Ref.:	**2016-INV-187**
Investigation:	**Highgate Road Sileby**
Date of Flooding:	**10th June 2016**
Revision	**Final**

Officer:	Alannah Bolton	Graduate Water Consultant	14/03/2019
Checker:	Ken Lo	Principal Engineer	14/03/2019
Approver:	Steve Edwards	Associate Director	14/03/2019
Leicestershire County Council Approver:	Mohamed Admani	Senior Engineer	16/04/2019

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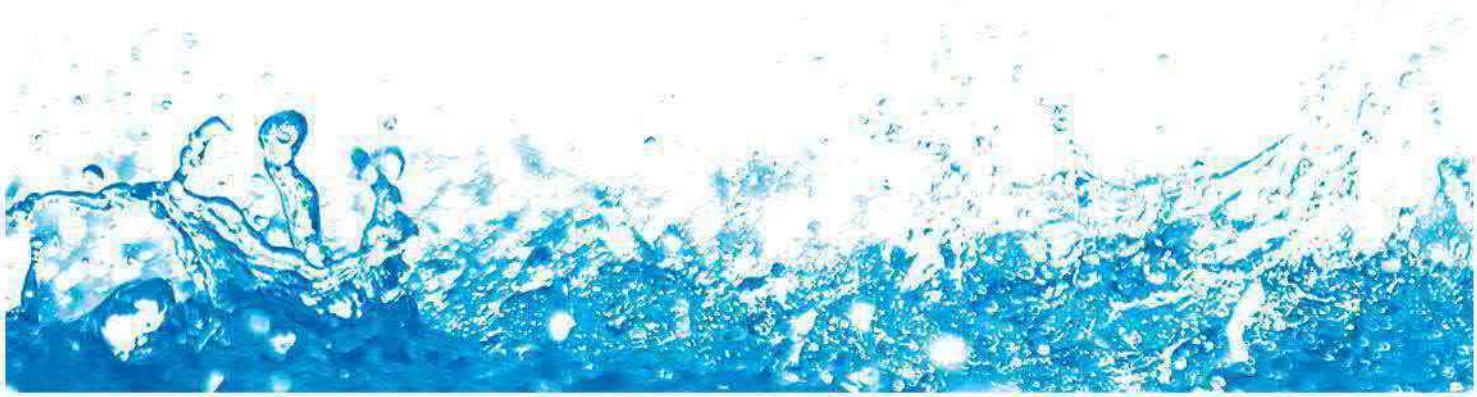


CONTENTS **PAGE NO.**

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), Leicestershire County Council (LCC) 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 the flooding incident that occurred on Highgate Road, Sileby as it was reported (via a Flood Reporting Form submitted to LCC) that one residential dwelling suffered from internal flooding on the 10th of June 2016. The Flood Reporting Form stated that another two residential properties experienced flooding to gardens which interfered with access.

1.2. CAUSE OF FLOODING

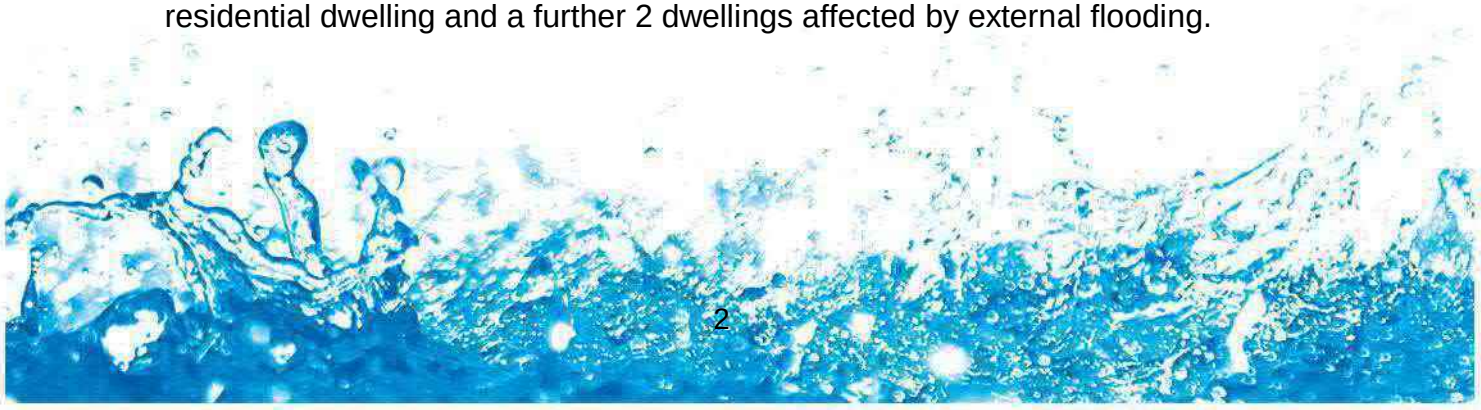
Over the course of the investigation it became clear that the flooding was caused by a period of intense rainfall that occurred within the catchment. The description of the flooding suggested that surface water was unable to drain into the highway drainage system due to the capacity being exceeded and due to possible issues relating to the type of gully located at the site. As a result, surface water followed the natural topography of the land, resulting in ponding to a depth of approximately 380mm at a low point close to the junction of Highgate Road and Wellbrook Avenue.

1.3. MAIN FINDINGS

During the site investigation undertaken in 2016, anecdotal reports were gathered that suggested that the flooding was not an isolated event, reported to occur following any period of intense rainfall. The flooding experienced along Highgate Road on the 10th of June 2016, is believed to be the result of several contributing factors as described in the paragraphs below.

The bucket drain gullies along the highways have small openings, which have a greater potential to become overwhelmed during intense rainfall and become blocked. Anecdotal reports found that the gully connections were 100mm in diameter and the conveyance of the drain may have been reduced due to the siltation in the system.

Therefore, for the event on the 10th of June 2016 it seems that the very high volume of rainfall combined with the topography of the land, nature of the existing highway gully types and potentially insufficient number of gullies resulted in the internal flooding of one residential dwelling and a further 2 dwellings affected by external flooding.



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

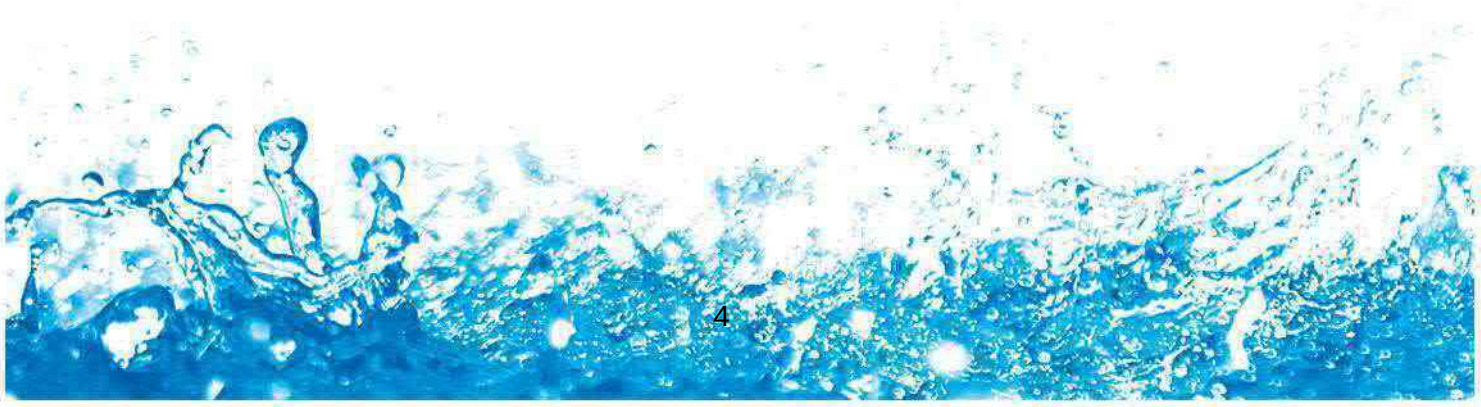
The following risk management authorities were identified as relevant to the flooding within Highgate Road, Sileby:

- Leicestershire County Council – Local Highway Authority
- Leicestershire County Council – Lead Local Flood Authority

- Severn Trent Water Ltd
- Environment Agency

2.4. FLOODING INCIDENT

It was deemed necessary to complete a formal investigation into the flooding incident within Highgate Road, Sileby, on the 10th June 2016 as internal flooding of one residential dwelling on Highgate Road from an unknown source was reported to the LLFA, via a Flood Reporting Form.



3. SITE BACKGROUND

3.1. LOCATION

The site is located within the village of Sileby, in the Charnwood Borough of Leicestershire. Sileby lies approximately 10 kilometres north of Leicester and 7 kilometres south of Loughborough, in the Soar Valley (Site Location Plan, Appendix A).

Flooding was reported on the north east side of the village, along Highgate Road, in the vicinity of the junction with Wellbrook Avenue. The likely catchment for this site consists of medium density 20th Century housing and associated roads.

LiDAR[1] data provided by LCC (found in Appendix B) identifies the junction of Highgate Road and Wellbrook Avenue is at a similar level above ordnance datum to the watercourse flowing parallel north of Highgate Road. Sileby slopes south-east to west, with its lowest point being at the junction. Sileby Brook is an Environment Agency designated Main River which is a tributary of the River Soar.

LiDAR data (found in Appendix B) also identifies the junction of Highgate Road and Wellbrook Avenue to be at a low point. Once water reaches a depth greater than the height of the highway kerbs, it flows down through the driveways and garages of several residential dwellings; finding the easiest route to Sileby Brook.

The Environment Agency Long Term Flood Risk Map[2], (Appendix E), identifies the area to be located within Flood Zone 2, which has a 0.1% Annual Exceedance Probability (1 in 1000 year return period) and Flood Zone 3, which has a 1% Annual Exceedance Probability (1 in 100 year return period).

3.2. DRAINAGE SYSTEMS

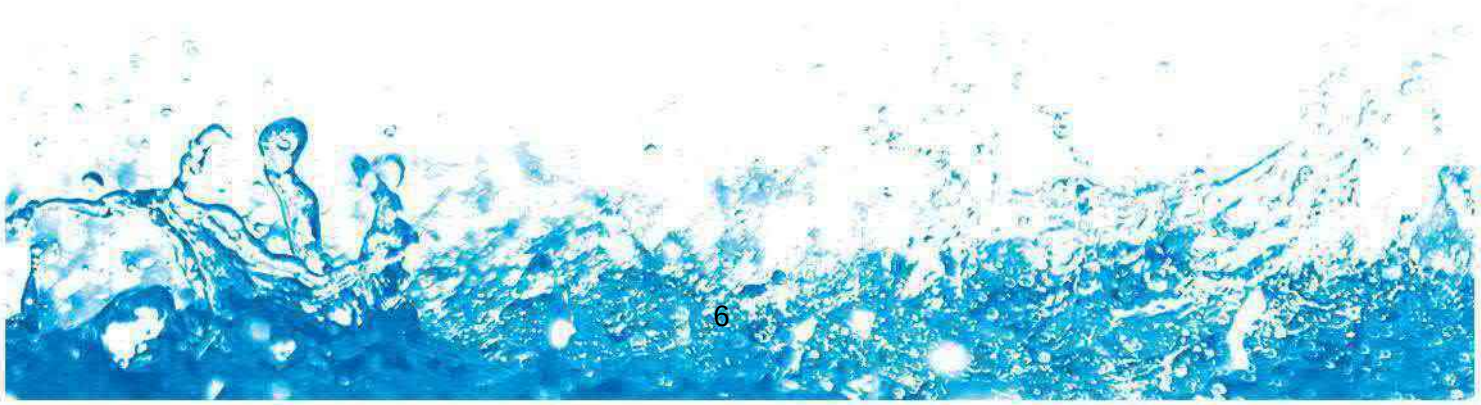
Severn Trent Water (STW) plans show the junction of Highgate Road and Wellbrook Avenue to be the head of two drainage systems, as runoff water is conveyed in surface water sewerage networks in both an easterly and westerly direction at this point. However, the LiDAR suggests a decline in gradient on the eastern approach to the junction (Appendix B). Site observation also suggested the junction to be the lowest point in the local area. If the sewers have been designed to a gradient that is too flat this might result in the manholes becoming surcharged frequently, due to a slowed conveyance as a result of the gradient and build-up of sediment.

[1] 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.
[2] Environment Agency. (2018). Flood Map for Planning. Accessed online: https://www.gov.uk/guidance/flood-risk-and-coastal-change#flood-zone-and-flood-risk-tables

The STW plans show the 225mm dia. sewer conveying water to the east of the junction converging with a 300mm diameter sewer flowing from the east sewer, which drains a much larger catchment to the east end of Highgate Road, before outfalling through a 375mm dia. pipe into Sileby Brook. As the gullies at this pipe junction are situated at a low point in the system, any surcharging of the drainage system would tend to back up and flood out of these gullies first which is reportedly what occurred (Site Visit Notes, Appendix C).

During a site investigation undertaken by LCC, the surface water sewer network outfall into Sileby Brook was observed to be approximately 300mm above ordinary water level. It was also observed that there is no highway drainage on the south-eastern kerb of the junction, where ponding was recorded.

The local highway gullies consists of bucket gullies which connect directly to the STW system via lateral drains.



4. FLOODING INCIDENT

4.1. PREVIOUS FLOODING INCIDENTS

Anecdotal reports suggest that flooding has been recurring annually along Highgate Road for the last 20 years and that flooding frequency has increased such that flooding now occurs whenever there is a period of intense rainfall. Residents have reported increasing flooding in the past 10 years, which may be attributed to the effects of climate change.

4.2. FLOOD INCIDENT

On Friday the 10th of June 2016, a yellow weather warning was issued for the Leicestershire area, as scattered heavy showers fell across the region[3]. This led to excessive surface water flooding in the area of the junction of Highgate Road and Wellbrook Avenue, when the highway gullies became overwhelmed and began to flood the road. Rainfall data from two nearby rainfall gauges is shown in Figure 1 Rainfall data showing rainfall event which resulted in flooding at Highgate Road, Sileby.

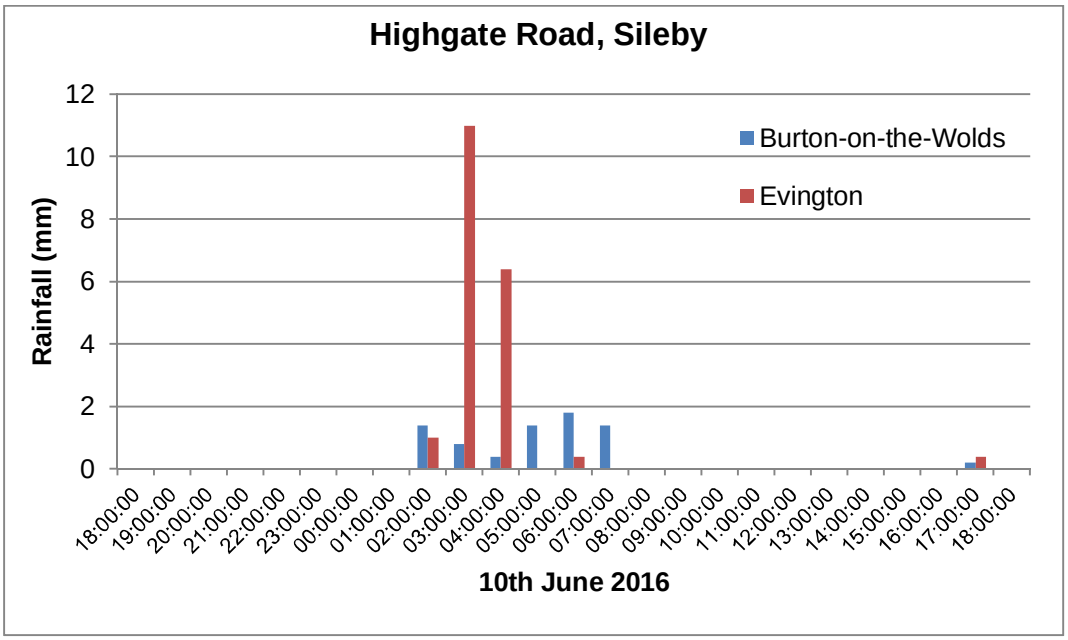


Figure 1 Rainfall data showing rainfall event which resulted in flooding at Highgate Road, Sileby

The water depths in the highway rose until, eventually, it flowed across the footway and into a residential dwelling on the north side of Highgate Road. Other dwellings reported

[3] http://www.bbc.com/news/live/uk-england-leicestershire-36487688

flooding of their driveways up to water depths of approximately 380mm deep in places around the outside of the dwellings.

The rainfall analysis in section 4.3 shows the storm on the 10th of June 2016 to have more than a 50% Annual Exceedance Probability (AEP), meaning flooding of this magnitude is likely to occur more frequently than every two years (1 in 2 Year). This is consistent with the resident's reports of flooding occurring (usually in June) on an annual basis. Highway drainage, which is designed to handle events up to a 3.33% AEP (1 in 30 year storm event), would be expected to cope with a storm of this severity. However, it should be noted that the rainfall event was very localised and may not have been fully recorded by the nearby rain gauges.

4.3. RAINFALL ANALYSIS

The Hydrological Summary produced by the Centre for Ecology and Hydrology[4] for June 2016 stated that:

> *"June started relatively dry and settled, but showers and thunderstorms occurred from the 5th and dominated the rest of June, bringing some intense rainfall. Associated surface water flooding caused a wide range of impacts".*
>
> Generally *"…June rainfall totals were above average (147%) and several regions recorded more than 150%. Due to the localised nature of the rainfall, parts of East Anglia, the Midlands, Wales and Northern Ireland also recorded >200% of average…."*

An average of the maximum rainfall from the two nearest rainfall gauges has been used to estimate the event rarity for the flood event using the Depth-Duration-Frequency (DDF) rainfall model. The two rainfall gauges closest to Sileby are located at Burton-on-the-Wolds (6KM to the north of Sileby) and at Evington (12KM south of Sileby), as shown in Figure 2. Table 1 provides a summary of the relevant Environment Agency rainfall gauges within the study area that were used for data analysis purposes.

Table 1: Rainfall gauges near the site

Name	Time series	Record start	Record end
Burton-on-the-Wolds TRB	Hourly	2000	2016
Evington TRB	Hourly	2008	2016

[4] Centre for Ecology and Hydrology. (2016). http://nora.nerc.ac.uk/513961/1/HS_201606.pdf

A Hydrology Technical Note that describes the hydrological method that was used to undertake probability of occurrence rainfall analysis for the flooding incident has been provided in Appendix D. A site specific hydrology technical note is provided in Appendix D-1.

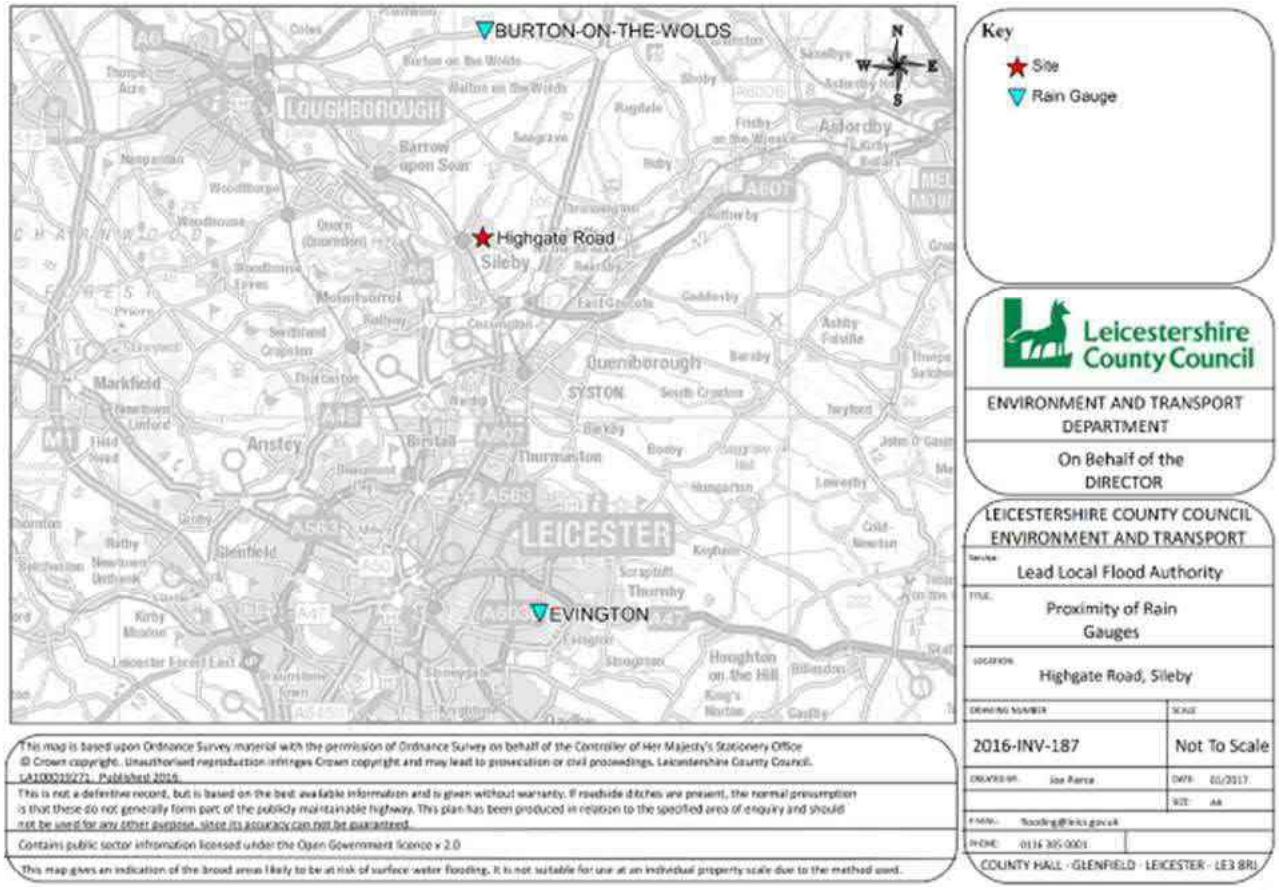


Figure 2: Location of rainfall gauges and site of flooding incident

5. SUMMARY OF IMPACTS AND FINDINGS

5.1. IMPACTS

The event which occurred on the 10th of June 2016 led to internal flooding of one property and access issues with two others. Multiple residents in the area undertook mitigation measures to prevent inundation of their properties, which were successful despite water levels rising to approximately 380mm. The local highway network was impacted, resulting in disruption to the local community and to highway users of the highway network.

Not only was the water level significantly high, it was observed by residents that the bow waves created by the cars driving through the flood water were large enough to damage the fence bordering dwellings on the highway. It was said that this fence (shown in Photo no.1) was relatively new, having been replaced due to the damaged caused by previous flooding incidents.

Residents have reported increasing flooding in the past 10 years, which may be attributed to the effects of climate change.

Photo 1 & 2: The junction where flooding regularly occurs, Highgate Road on approach (from north east end) to the junction.

5.2. DRAINAGE SYSTEMS

The highway drainage network consists of bucket gullies, which are pictured in Photo 3 below.

Photo 3: A pictured 'bucket' gully located on Wellbrook Avenue, Sileby

The bucket gullies along the highway have small openings, which could easily become overwhelmed during intense rainfall and are susceptible to blockages. Anecdotal reports suggested that at the time of the flooding in June 2016 the bucket gullies were potentially silted. During a site walkover in September 2018 it was identified that the gully connections were approximately 100mm in diameter and conveyance capacity was reduced due to siltation in the system. This could have possibly contributed to the cause of the flooding. Following the incident in June 2016, LCC reported that these gullies were jetted. It was identified during a site walkover in September 2018 that maintenance of the bucket gullies were required as they had begun to silt up.

Other possible reasons for the surface water drainage system becoming overwhelmed during the June 2016 event could be due to the lack of gully capacity (bucket gullies), sewer capacity or else poor condition e.g. blockages within the system.

A foul sewer line flows south west along Highgate Road, which is independent of the surface water system. There is no suggestion that the foul system contributed in any way to the flood event.

STW was unaware of flooding in this area and has not received any reports of flooding as a result of their sewers in this area.

5.3. MAIN RIVER

Sileby Brook is a Main River - meaning it is managed by the Environment Agency rather than the LLFA - and flows in a generally south-westerly direction parallel to Highgate Road. Residents report that during recent flood events, the brook has been at a relatively low level and not near its banks. One resident claims the river has only burst its banks twice over 24 years, flooding that residents garden.

Appendix E shows the Environment Agency Long Term Flood Risk mapping which identifies locations at risk from fluvial flooding. Although the village of Sileby has pockets of land (mainly along the profile of the river) located within fluvial Flood Zones 2 and 3

(medium and high risk), considering the sequence of events described by residents, fluvial flooding is not thought to be the cause of the flooding on 10th June 2016.

5.4. EXTENT OF FLOODING

As identified in Appendices E and F, the flooding shown along Highgate Road is fairly consistent with what the residents have reported. The incident on the 10th of June 2016 has been calculated as a >50% AEP (1 in 2 year) event suggesting that flooding is occurring in the predicted locations, but during much less significant rainfall events. However, it should be noted that the rainfall event was very localised and may not have been fully recorded by the nearby rain gauges; as such the rainfall may have greatly exceed the 1 in 2 year intensity.

6. RESPONSIBILITIES

6.1. HIGHWAY AUTHORITY (LEICESTERSHIRE COUNTY COUNCIL)

LCC are designated as the local Highways Authority and have a duty to maintain the highway under Section 41 of the Highways Act (1980). The Highway Authority are responsible for maintain a safe a reliable local highway network. Refer to the Useful Links section of the report for further information on the Highways Act (1980).

6.2. LEAD LOCAL FLOOD AUTHORITY (LEICESTERSHIRE COUNTY COUNCIL)

LCC has the overall responsibility for coordinating the management of local flood risk (namely ordinary watercourses, surface water and groundwater).

As stated within the introduction section, LCC as the Lead Local Flood Authority has a responsibility to investigate flood incidents under Section 19 of the Flood and Water Management Act (FWMA) 2010. 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.

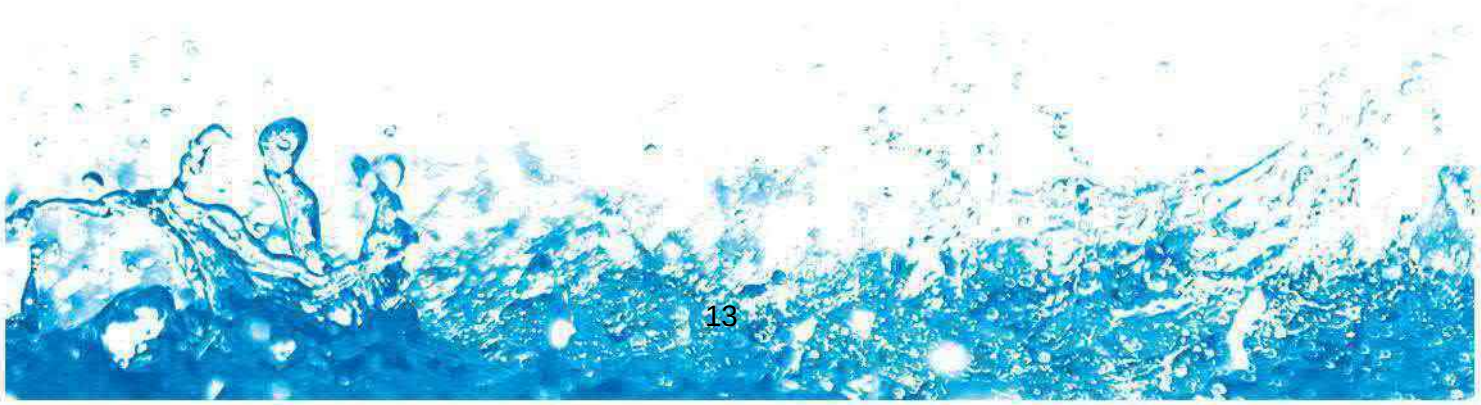
The LLFA also has a responsibility to maintain a register of assets which have a significant effect on flooding, whether from surface runoff, groundwater or ordinary watercourses. This is detailed within Section 21 of the FWMA. The register must contain a record about each structure or feature, including the ownership and state of repair.

6.3. ENVIRONMENT AGENCY

The Environment Agency has a strategic overview responsibility under the FWMA as well as permissive powers to carry out maintenance work on Main Rivers under Section 165 of the Water Resources Act (WRA). Main River means all watercourses shown on the statutory Main River maps held by the Environment Agency and the Department of Environment, Food and Rural Affairs, and can include any structure or appliance for controlling or regulating the flow of water into, in or out of the channel. Sileby Brook is included as a Main River.

The Environment Agency has permissive powers to carry out works of maintenance and improvement on these rivers. These powers can be used to undertake works to reduce flood risk where landowners fail to undertake their responsibilities under the WRA.

The Environment Agency can undertake enforcement action where third party asset owners fail to maintain their property/land in appropriate condition. They may consider undertaking maintenance or repair of third party assets in order to safeguard the public interest and where other options are not appropriate.



6.4. 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, however in extreme weather conditions there is a risk of these public sewers being overwhelmed, resulting in 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.

During a meeting on the 1st of August 2018, between AECOM, LCC and STW, it was discovered that STW were unaware of any flooding to properties in this area. Recommendations have been provided to STW to ensure they are aware of their sewer performance.

6.5. RIPARIAN LANDOWNERS OF WATERCOURSES

As detailed within the Environment Agency document 'Living on the Edge', riparian landowners have certain rights and responsibilities, including the following:

- They must maintain the bed and banks of their watercourse, and also the trees and shrubs growing on the banks;
- They must clear any debris, even if it did not originate from their land. This debris may be natural or man-made;
- They must keep any structures that they own clear of debris. These structures include culverts, trash screens, weirs and mill gates.

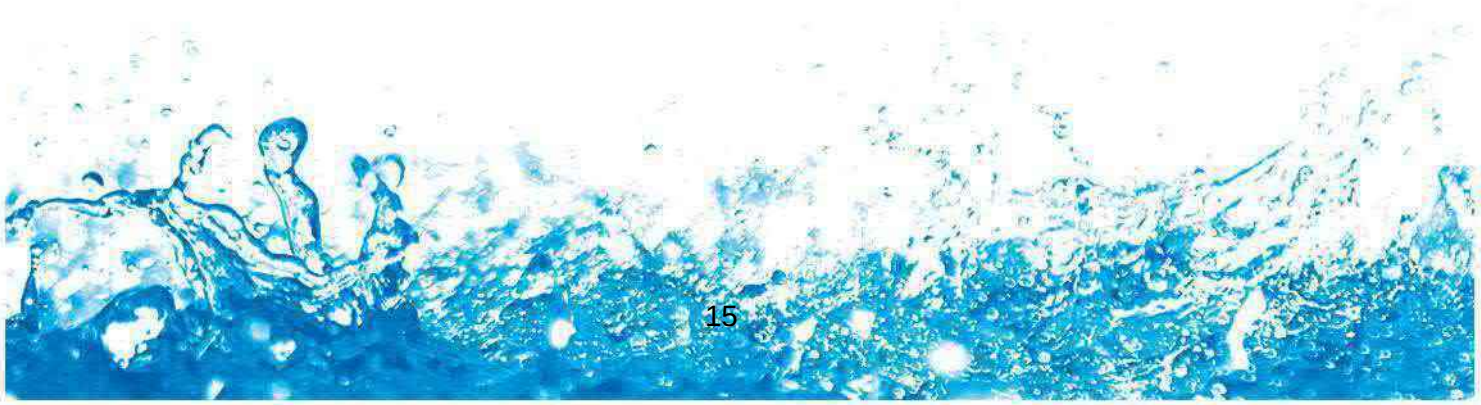
The following link provides further information:
http://www.environment-agency.gov.uk/homeandleisure/floods/31626.aspx.

6.6. RESIDENTS AND TENNANTS

All homeowners have a responsibility to protect their own property from flooding and should take action to become self-resilient.

Local residents and tenants who are aware that they are at risk of flooding should take action to ensure that they and their properties are protected.

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 flood plan implementing property level protection and moving valuable items to higher ground, to more permanent measures such as 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. SEVERN TRENT WATER

STW is to monitor and assess any areas of restriction or insufficient capacity within their system, upgrading them and refine the hydraulic model as appropriate. Routine maintenance activities will continue to ensure that the sewerage networks have good serviceability.

7.2. LOCAL HIGHWAY AUTHORITY (LEICESTERSHIRE COUNTY COUNCIL)

LCC is to investigate the potential to replace the bucket drains with normal gully pots, and examine whether implementing a new gully at the corner between Wellbrook Avenue and Highgate Road would be beneficial. They will also continue to monitor and maintain their gullies as per the Council's current maintenance policy, keeping them clear from obstruction so they can function at full capacity.

7.3. LEAD LOCAL FLOOD AUTHORITY (LEICESTERSHIRE COUNTY COUNCIL)

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

7.4. RIPARIAN OWNERS

The property owners which have experienced flooding should ensure that the drainage systems within their property boundary are well maintained and kept clear of blockage.

The property owners responsible for the banks of Sileby Brook should keep the watercourse clear of vegetation and debris.

Property owners should also consider exploring Property Level Resilience (PLR) measures to better defend their properties from flooding.

8. ACKNOWLEDGEMENTS:

A special mention of thanks should be given to all of the residents of Highgate Road who provided AECOM with knowledge and experience, which has been incorporated into this report.

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
PLR	Property Level Resilience
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: Highgate Road Sileby

DRAWING NUMBER	SCALE
2016-INV-187	Not To Scale

CREATED BY: Stacey Johnson DATE: 05/01/2016

SIZE: A4

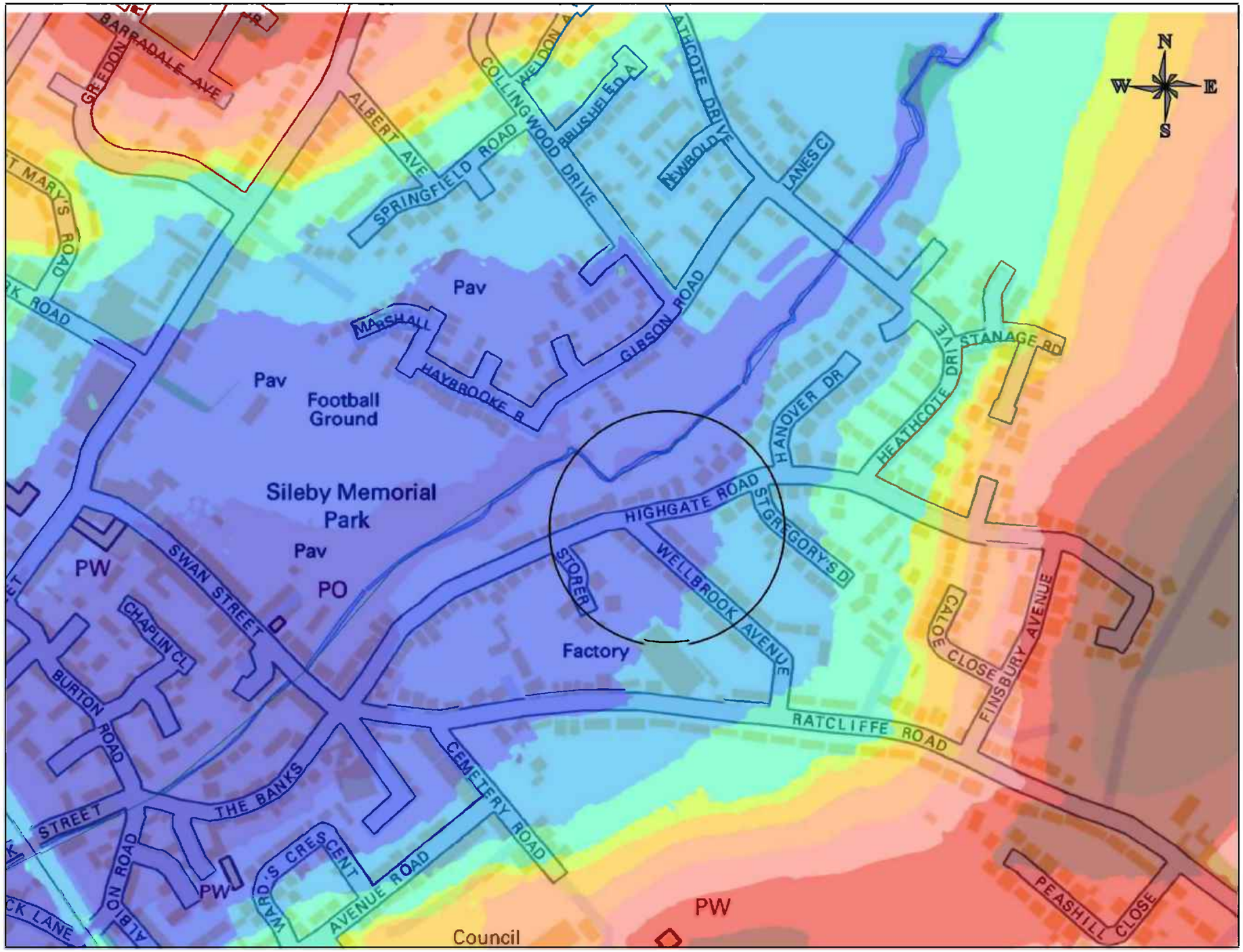
E-MAIL flooding@leics.gov.uk

PHONE: 0116 305 0001

COUNTY HALL · GLENFIELD · LEICESTER · LE3 8RJ

APPENDIX B

LIDAR MAPPING



Key

LiDAR Elevation (mOAD)

43-46	76-79
46-49	79-82
49-52	
52-55	
55-58	
58-61	
61-64	
64-67	
67-70	
70-73	
73-76	

Leicestershire County Council

ENVIRONMENT AND TRANSPORT DEPARTMENT

On Behalf of the DIRECTOR

LEICESTERSHIRE COUNTY COUNCIL
ENVIRONMENT AND TRANSPORT

Service: Lead Local Flood Authority

TITLE: LiDAR Mapping

LOCATION: Highgate Road, Sileby

DRAWING NUMBER	SCALE
2016-INV-187	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

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.

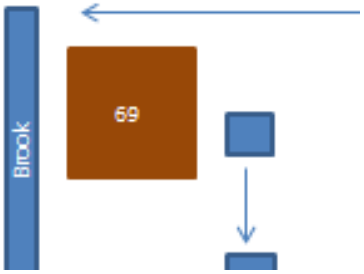
This map gives an indication of the broad areas likely to be at risk of surface water flooding. It is not suitable for use at an individual property scale due to the method used.

APPENDIX C

SITE VISIT NOTES

Leicestershire CC – Section 19 Reports
Site Visit Data Sheet

1. Detail of Area/Properties/People Affected						
Location/Ward Area:	Highgate Road Sileby					
Team:	SE & SAJ					
Property Type(s) at flood risk Incl. Number:	Residential:	3 no. reported	Industrial:		Office:	
	Educational:		Religious:		Recreational:	
Other (e.g infrastructure)	Highgate road					
Comments:	Flooding happens in June every year; however has got worse in recent years. Internal flooding experienced by house 1 house, while the reporting forms states water was up to the front step of house two houses, filling the driveway and back garden.					

2. Details of Flooding							
Flood damage incurred? :	Internal flooding of one house. Driveways flooded of two houses		Through doors:	Water flooded the ground floor of one house			
			Through windows:				
			Through floors:				
			Through airbricks:				
			Through drainage:	Water flowing from the gullies by the Junction, flooding the junction and surrounding driveways.			
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):	The origin of the water is the storm; however it is thought that the drainage network might be the main cause of the flooding experienced. The pipes were recently jetted, where apparently it was determined that water is relayed up hill, which could lead to a build-up of water (if levels are not correctly designed) in the chambers and subsequent flooding. The resident also reported that the pipe diameters are only 4'', which might also be adding to the problem by reducing the rate at which water is relayed. The system shown below was described.  It was also observed that there are only two outlets to the watercourse, which has the capacity to take this storm water. This might have also impacted the						

	flooding event, as a bottle neck situation may be forming.									
Water Depth Inside property (m)	Unknown									
Water Depth Outside property (m)	15 inches									
3. Effects of Flooding										
Damage to Props. (residential and commercial/retail):	The ground floor of one house was flooded, while the other houses experienced flooding to their front door. This led to significant damage and stress to homeowners as they were unable to access / egress the home sufficiently.									
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:	No properties have flood defences.									
Condition	N/A									
5. Potential Flood Alleviation Measures										
Proposed Measure(s) Details incl. length, height, Constructability/Access	Flood Wall									
	Flood Embankment									
	Upstream storage	Improving the holding basin should be considered.								
	Storm Water Drainage System	Extending / improving the network should be considered, including adding outlets to the watercourse.								
	Cleaning/Maintenance	Clearing out the trench and holding basin should also be considered								
	SUDS									
	PLP									

Leicestershire CC – Section 19 Reports
Site Visit Data Sheet

Location Details and sketch (Public or Private Property, Provide Details (e.g. river embankment, field, main road, residential street)	Highgate road: Public Houses: Private
Further Comments	

Leicestershire CC – Section 19 Reports
Site Visit Data Sheet

Add further comments, details, sketches here:

Signature:

Name of Collator:	Date:	Time:
Stacey Johnson	30 /11 /2016	2.00 pm

APPENDIX D

HYDROLOGY TECHNICAL NOTE

Leicestershire Section 19 Flood Investigations

Hydrology Technical Note

Leicestershire County Council

Project Number: 60527961

January 2017

Quality information

Prepared by	Checked by	Approved by
Lucy Rushmer Senior Consultant	Helen Burton Senior Consultant	Katie Pearson Associate

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.

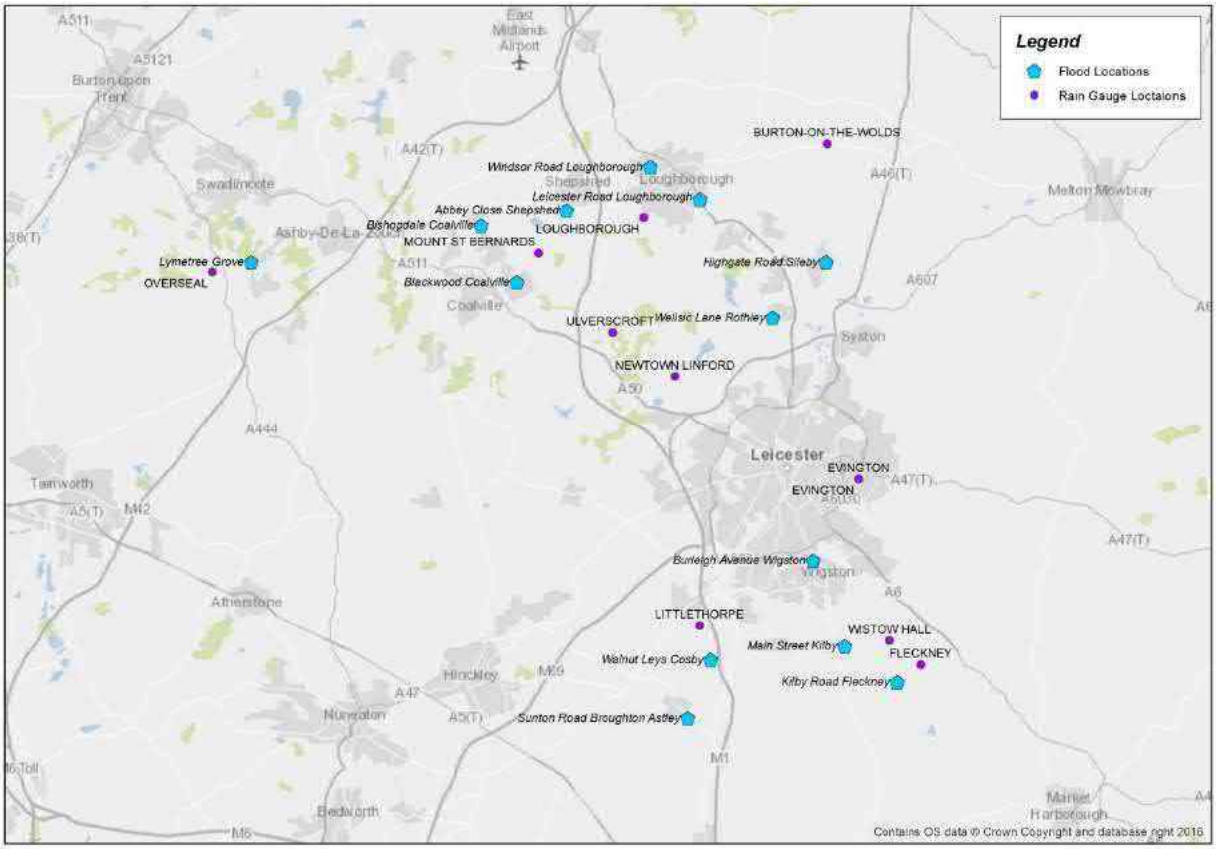

Figure 3-1: Location of flooding incidents and rainfall gauges

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	Mount St Bernards	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.

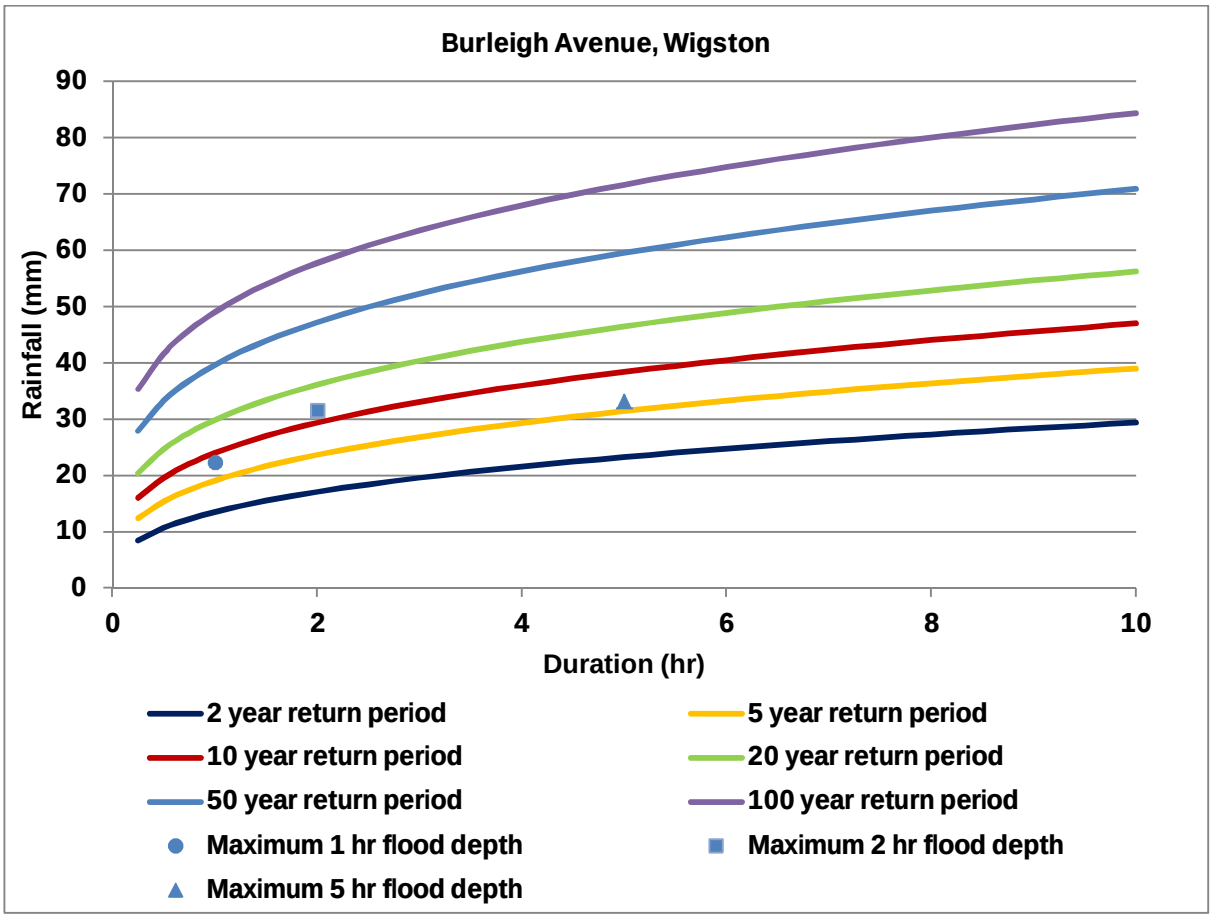

Figure 3-2: Example of rainfall maximums for different durations plotted against DDF rainfall curves to assess probability of occurrence

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

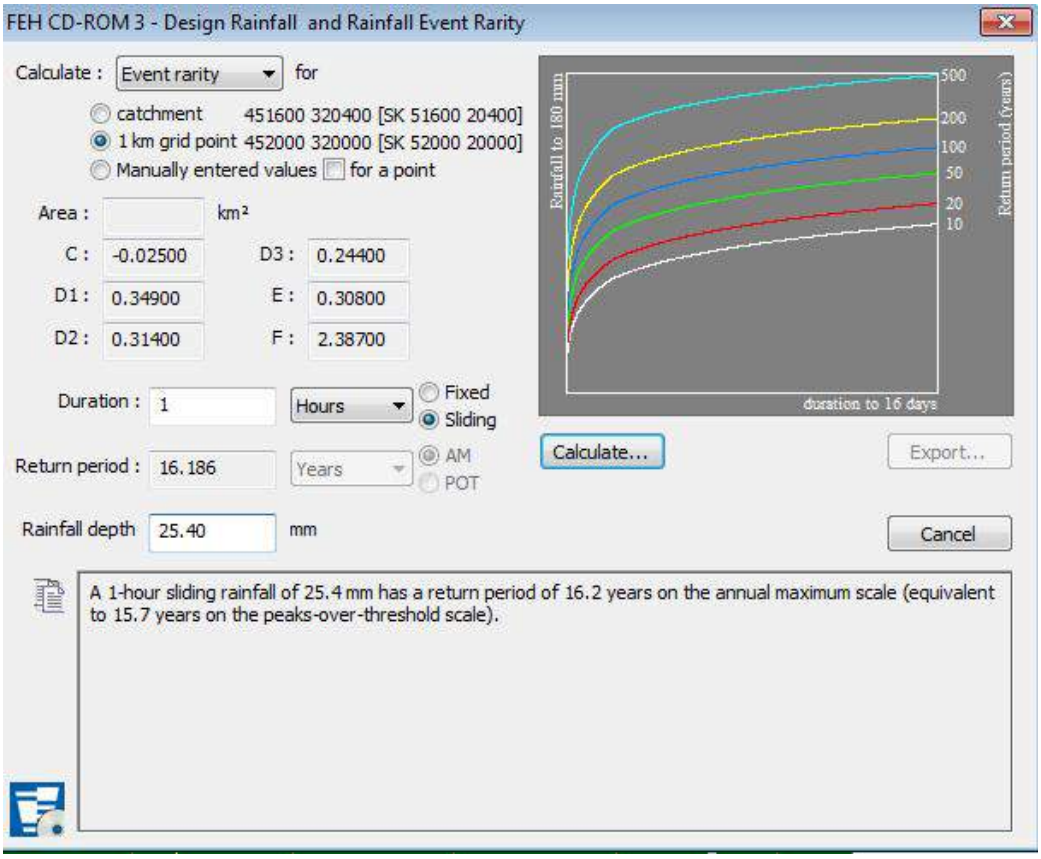

Figure 3-3: Example of the 'event rarity' function in the DDF rainfall model in FEH CD ROM 3

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 D-1

SITE SPECIFIC HYDROLOGICAL STUDY

APPENDIX D-1
SITE SPECIFIC HYDROLOGY

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 1. 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 1.

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.

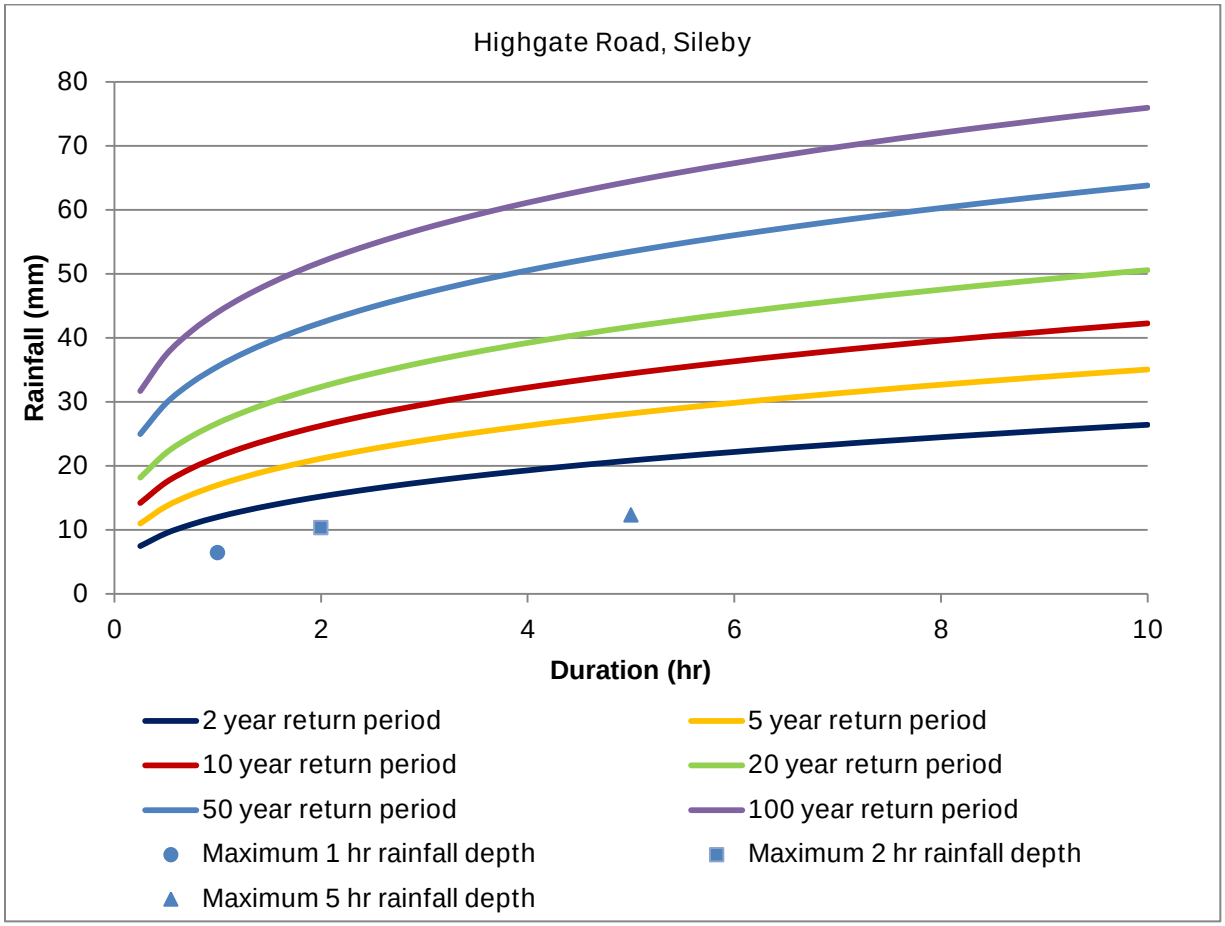


Figure 1: DDF model for Highgate Road, Sileby

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 1 shows the estimated return periods for each rainfall gauge used for data analysis purposes for the flooding incident in Sileby. Table 1 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.

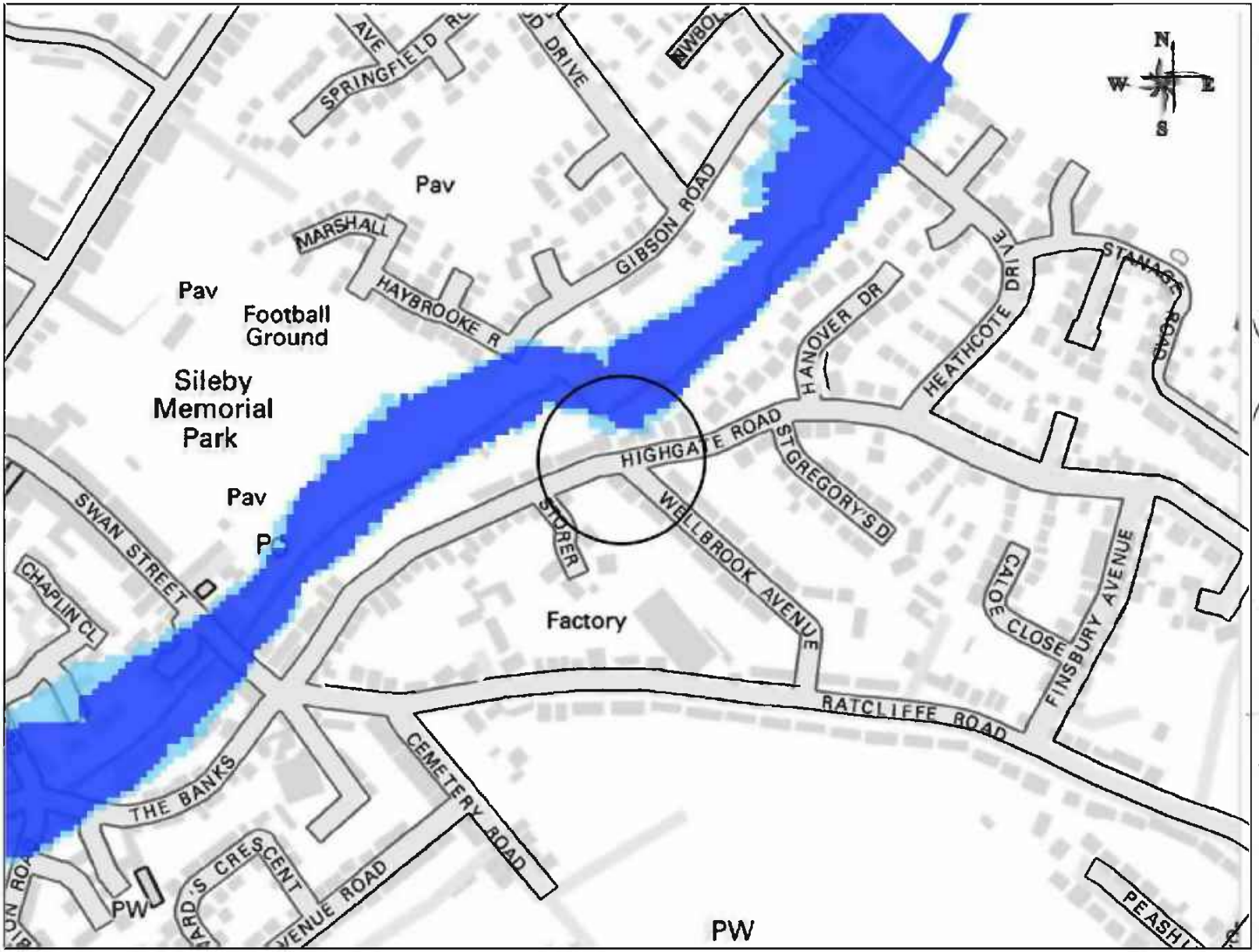
If a rainfall event is considered 'commonplace' this suggests that the rainfall event was very localised and is described by FEH as "having a return period shorter than one month on the peaks-over-threshold scale".

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

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

APPENDIX E

RISK OF FLOODING FROM RIVERS AND SEA MAP



Key

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

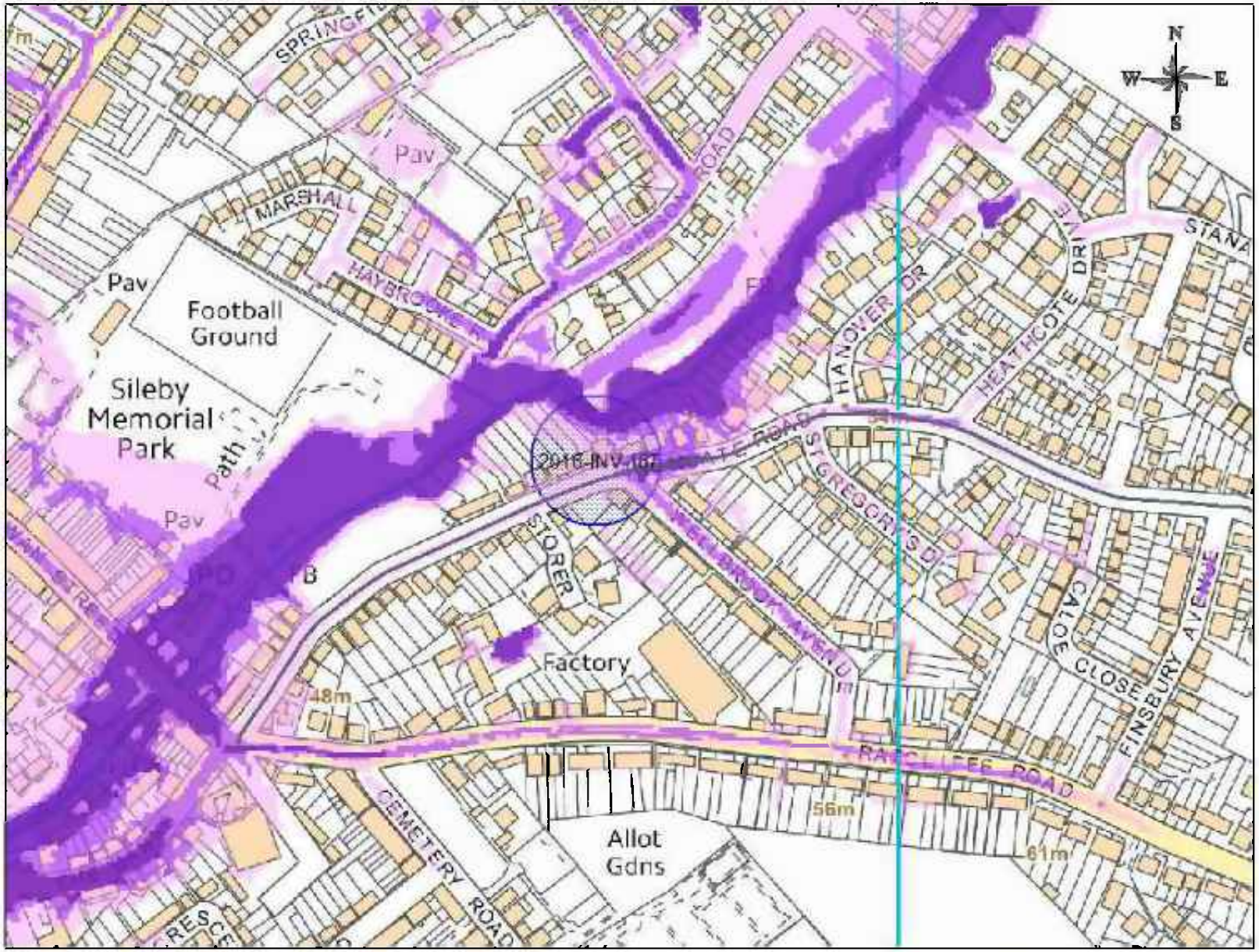
Service: Lead Local Flood Authority	
TITLE: Flood Zones 2 & 3	
LOCATION: Highgate Road Sileby	
DRAWING NUMBER: 2016-INV-187	SCALE: Not To Scale
CREATED BY: Stacey Johnson	DATE: 05/01/2016
	SIZE: A4
E-MAIL: flooding@leics.gov.uk	
PHONE: 0116 305 0001	

COUNTY HALL · GLENFIELD · LEICESTER · LE3 8RJ

This 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 F

Environment Agency Long Term Flood Risk Map to show surface water flood risk



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: HIGHGATE ROAD

DRAWING NUMBER	SCALE
2016-INV-187	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.

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*