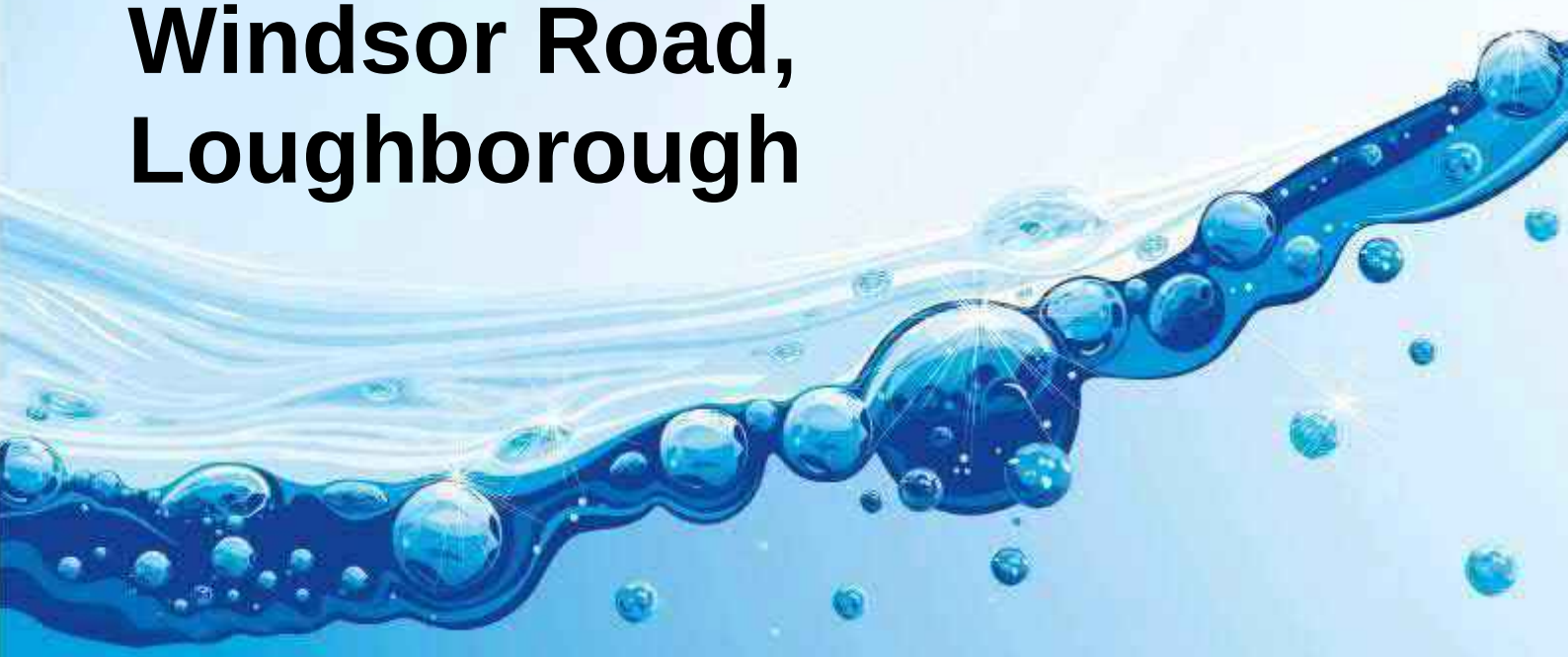
Leicestershire County Council

Windsor Road, Loughborough



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

Limitations

The attached Report (the "Report") has been prepared by AECOM Infrastructure & Environment UK Limited ("AECOM") for the benefit of the Leicestershire County Council ("Client") in accordance with the agreement between AECOM and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations and conclusions contained in the Report (collectively, the "Information"):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations");
- represents AECOM's professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to AECOM which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time.

AECOM shall be entitled to rely upon the accuracy and completeness of information that was provided to it and has no obligation to update such information. AECOM accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time.

AECOM agrees that the Report represents its professional judgement as described above and that the Information has been prepared for the specific purpose and use described in the Report and the Agreement, but AECOM makes no other representations, or any guarantees or warranties whatsoever, whether express or implied, with respect to the Report, the Information or any part thereof.

Without in any way limiting the generality of the foregoing, any estimates or opinions regarding probable construction costs or construction schedule provided by AECOM represent AECOM's professional judgement in light of its experience and the knowledge and information available to it at the time of preparation. Since AECOM has no control over market or economic conditions, prices for construction labour, equipment or materials or bidding procedures, AECOM, its directors, officers and employees are not able to, nor do they, make any representations, warranties or guarantees whatsoever, whether express or implied, with respect to such estimates or opinions, or their variance from actual construction costs or schedules, and accept no responsibility for any loss or damage arising therefrom or in any way related thereto. Persons relying on such estimates or opinions do so at their own risk.

Except (1) as agreed to in writing by AECOM and Client; (2) as required by-law; or (3) to the extent used by governmental reviewing agencies for the purpose of obtaining permits or approvals, the Report and the Information may be used and relied upon only by Client.

AECOM accepts no responsibility, and denies any liability whatsoever, to parties other than Client who may obtain access to the Report or the Information for any injury, loss or damage suffered by such parties arising from their use of, reliance upon, or decisions or actions based on the Report or any of the Information ("improper use of the Report"), except to the extent those parties have obtained the prior written consent of AECOM to use and rely upon the Report and the Information. Any injury, loss or damages arising from improper use of the Report shall be borne by the party making such use.

This Statement of Qualifications and Limitations is attached to and forms part of the Report and any use of the Report is subject to the terms hereof.

AECOM: 2015-04-13

DETAILED FLOOD INVESTIGATION

County Council Investigation Ref.:	**2016-INV-143**
Investigation:	**Windsor Road, Loughborough**
Date of Flooding:	**15th June 2016**
Revision	**Final**

Officer:	Anupriya Prabhuswamy	Senior Engineer	14/03/2019
Checked:	Ken Lo	Principal Engineer, AECOM	14/03/2019
Approved:	Steve Edwards	Associate Director, AECOM	14/03/2019
Leicestershire County Council Approved	Mohamed Admani	Senior Engineer	16/04/2019

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

CONTENTS **PAGE NO.**

1.	Executive summary	1
2.	Introduction	3
3.	Site background	4
4.	Flooding incident	6
5.	Summary of impacts and findings	9
6.	Responsibilities	11
7.	Agreed/Recommended actions	13
8.	Acknowledgements	14
9.	Abbreviations	14

Appendix A – Site Location Plan

Appendix B – 1884 Historic Map

Appendix C – Risk of Flooding from Rivers and Sea Map

Appendix D – Lidar Plan

Appendix E – Site Visit Notes

Appendix F – Hydrological Study

Appendix F-1 – Site Specific Hydrology Notes

Appendix G – Risk of Flooding from Surface Water (RoFSW) Map

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. The flooding of grounds at a multi-occupant residential property (flats) located on Windsor Road, Loughborough, that house a number of elderly residents, was reported to Leicestershire County Council (LCC) via a Flood Reporting Form.

Even though a formal investigation into the flooding incident within Windsor Road, Loughborough on the 15th June 2016 is not required as it does not trigger one of the three locally agreed criteria, based on the nature of the affected residents (vulnerable/elderly residents), LCC has decided to further investigate the source, mechanism and impact of the flood event.

The properties affected are flats within Hanover Court which house a number of elderly and vulnerable people to the west of Windsor Road, as well as flats within Sir Robert Martin Court, located to the east of Windsor Road also housing elderly and/or vulnerable residents. Information provided on the Flood Reporting Form suggests that flooding has been an issue at the Hanover Court property for more than 15 years. No evidence has been provided to suggest Sir Robert Martin Court has experienced the issue for any length of time.

1.2. CAUSE OF FLOODING

Over the course of the investigation it became clear that the flooding was caused by intense rainfall that occurred within the catchment on the morning of June 15th 2016. The description of the flooding suggested that surface water on the road was unable to drain into the highway drainage system because the capacity was exceeded. It is also likely that the flooding situation was exacerbated by the state of disrepair of a pipe connecting a gully located on Windsor Road to the surface water drainage network. As a result, surface water ponded on the road surface eventually overtopping the low kerb and entering the low-lying car parks of the two flats that are located across the road from one another on Windsor Road. It is also suspected that the private drainage located in the car parks of the two properties was overwhelmed. However, this private drainage was not included in this investigation.

1.3. MAIN FINDINGS

Based on the hydrological analysis undertaken for this site using data from two gauging stations, it appears that the rainfall event on the 15th June 2016 was very localised and fast moving across the area, such that the majority of the rainfall during this event was recorded by the Mount St Bernards Gauge. The hydrologic analysis estimated that the rainfall event that fell on Windsor Road had intensity greater than a 10% Annual Exceedance Probability (AEP). However, as two rain gauges were used neither directly at the location of interest, an element of uncertainty is to be expected in the interpolation. Therefore it is worth noting that the rainfall event recorded by the Mount St Bernards Gauge had an intensity of 1 in 40 years (2.5% AEP)[1]. In general, highway drainage is not designed to accommodate events of this magnitude.

Severn Trent Water sewer plans indicate the surface water runoff from Windsor Road is collected by a 225mm diameter pipe that joins a 300mm diameter pipe that carries the water along Lewis Road in a north-easterly direction.

A CCTV survey of the surface water drainage network on Windsor Road undertaken by LCC in November 2016 following clearance of the highway drainage network did not find any issues in the main branch of the surface water sewer located on Windsor Road. However, further investigation by LCC revealed that one of the pipes that connected a gully to the surface water network was in a state of disrepair and is likely to have restricted the amount of floodwater that reached the surface water sewer network. It is thought that this may have exacerbated the flooding situation.

During a site visit undertaken in August 2108, it was observed that the gully in the Sir Robert Martin Court's car park is at a local low point. Any surcharges in the surface water sewerage network during the rainfall events could result in flooding at this location.

LCC also reported that the private drainage network within Sir Robert Martin Court property had also been cleared, but not the drains within Hanover Court. There is no evidence as to whether these drainage networks had been blocked and consequently causing the flooding in question.

Thus, it can be concluded that the flooding of Hanover Court and Sir Robert Martin Court car parks was caused due to a combination of the low kerb, overwhelmed surface water drainage system, and restriction of flow by the broken pipe at the highway drainage system connecting a gully to the surface water sewerage network.

[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).

2. INTRODUCTION

2.1. LEAD LOCAL FLOOD AUTHORITY (LCC) INVESTIGATION

Section 19 of the Flood Water Management Act 2010 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 at Windsor Road, Loughborough:

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

2.4. FLOODING INCIDENT

Based on the nature of the affected residents (vulnerable/elderly residents), LCC has decided to further investigate the source, mechanism and impact of the flood event on the 15th of June 2016.

3. SITE BACKGROUND

3.1. LOCATION

The site study area is located in the Thorpe Acre area of north-western Loughborough as shown in Appendix A.

The affected residential dwellings are located at the northern end of Windsor Road, close to its junction with Sandringham Drive. Hanover Court lies to the west of Windsor Road, whilst Sir Robert Martin Court is located to the east.

Historic mapping from 1884 is provided in Appendix B and shows that the site used to be a greenfield area and has developed since into residential housing. Online resources also identify the site to have been greenfield until as late as the 1960's.

3.2. PROXIMITY TO WATERCOURSES

To the north west of the affected properties is Black Brook, an Environment Agency designated Main River[2]. Main Rivers are maintained and under the responsibility of the Environment Agency. Black Brook flows in a north-north east direction and has raised embankments on both sides, passing through the area of interest. The Environment Agency Risk of Flooding from Rivers and Sea map (reproduced in Appendix C) shows the affected properties at Windsor Court to be located within defended Flood Zone 2. Properties located in Flood Zone 2 are at 'Medium Risk' of flooding from the brook. Medium risk means that each year this area has a chance of flooding of between 0.1% and 1% if there is a failure of the defences. These defences reduce but do not completely eliminate the chance of flooding as they can be overtopped, or fail.

It appears that the brook is independent to the surface water system and therefore the flood mechanisms can be treated separately during smaller flood events. During the larger events, it is possible for flood water from the brook to enter the system, adding additional demand for both the highway drainage as well as the Severn Trent Water (STW) surface water sewer capacity.

3.3. TOPOGRAPHY

There is a ridge of higher land along Stewart Drive to the northwest of the site and higher land to the southeast along Knightthorpe Road. Between these areas, the ground slopes

[2] Source: https://www.charnwood.gov.uk/pages/watercoursemanagement

north, down towards Black Brook. Windsor Road lies on the southern slope of this depression, running southeast to northwest, perpendicular to the prevailing slope.

The likely catchments of the surface water system are made up of medium and high density housing (see Appendix D for Lidar[3] map of site and surrounding catchment).

A review of the Lidar data (Appendix D) suggests that the area to the south of Hanover Court and Sir Robert Martin Court is higher and run off from Knightthorpe Road and Stirling Avenue is likely to flow down Windsor Road during large storm events, exacerbating the flooding situation at the low point at the junction of the side road from Hanover Court with the main arm of Windsor Road.

3.4. DRAINAGE SYSTEMS

Severn Trent Water (STW) sewer records suggest the surface water system collects runoff from Windsor Road. From here it is conveyed across Epinal Way and through the housing estate beyond. The surface water sewer continues in a north easterly direction and discharges into a culverted watercourse at the intersection of Derby Road.

The Hanover Court and Sir Robert Martin Court developments have private highway drainage networks that are assumed to connect into the surface water sewer in Windsor Road. Both developments are at a lower elevation than Windsor Road and therefore standing water collects at both sites. It should be noted that Sir Robert Martin Court is the lower of the two residential courts and is thought to experience deeper external flooding.

During the site inspection for this report (site visit notes provided in Appendix E), a council team were seen on site with a drain cleaning contractor. CCTV surveying was scheduled for later that day. Findings of the CCTV survey are outlined in Section **Error! Reference source not found.**.

[3] LIDAR uses 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 area of interest.

4. FLOODING INCIDENT

4.1. PREVIOUS FLOODING INCIDENTS

Anecdotal reports suggest that flooding of the grounds of the Hanover Court development has occurred multiple times a year for over a decade. Residents have reported increasing flooding in recent years, which may be attributed to the effects of climate change. The majority of the residents in the two developments are elderly and/or vulnerable people who rely on regular outside support. This support is negatively impacted when the grounds are flooded. The issue has been raised to the Charnwood Borough Council and LCC as an ongoing matter of concern amongst the residents.

4.2. FLOOD INCIDENT

On Wednesday 15th June 2016, intense rainfall fell over the area over a two hour period. Rainfall data from nearby rainfall gauges (Mount St Bernards and Burton on the Wolds) is shown in Figure 1. This is thought to have exceeded the design capacity of the drainage system in Windsor Road, causing flash flooding to occur. The grounds (car park and garden) of the two developments were inundated, although no internal flooding was experienced. The floodwaters remained for a number of hours after the rain had stopped.

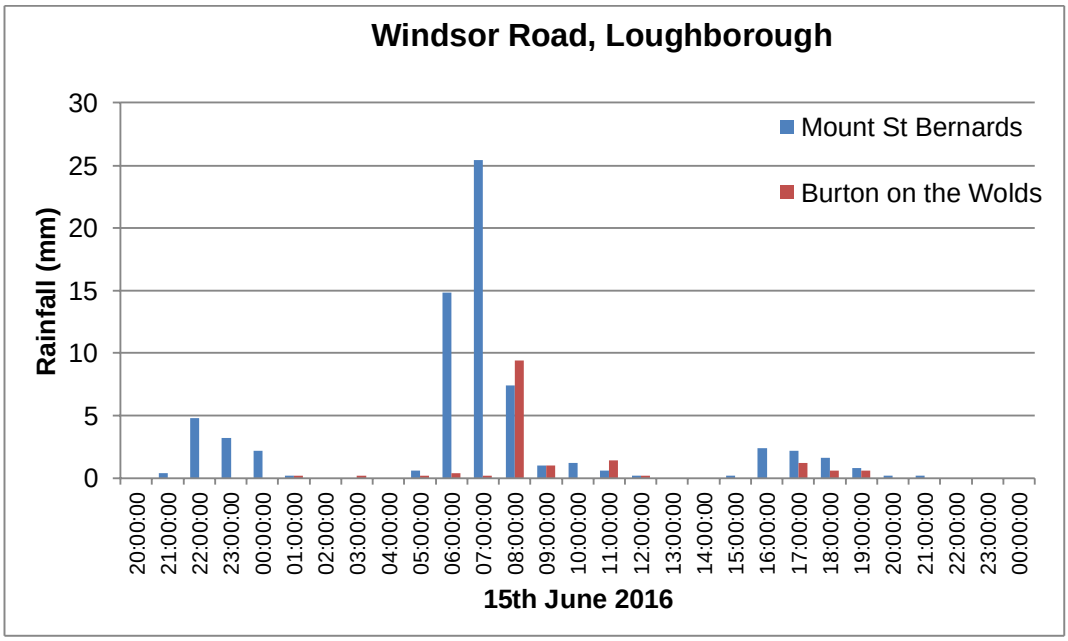


Figure 1 Rainfall data showing rainfall event which resulted in flooding on Windsor Road, Loughborough

4.3. RAINFALL ANALYSIS

The Hydrological Summary produced by the Centre for Ecology and Hydrology for June 2016 stated:

> *"In a period from the 11th to the 16th, convective downpours brought significant rainfall around the UK including50mm at Winterbourne (Midlands) on the 16th; 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…."*

Source: http://nora.nerc.ac.uk/513961/1/HS_201606.pdf

The flooding incident was located between two rainfall gauges (Mount St Bernards and Burton on the Wolds). Therefore an average of the maximum rainfall from the two 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 two rainfall gauges closest to Windsor Road, Loughborough are shown in Figure 2.

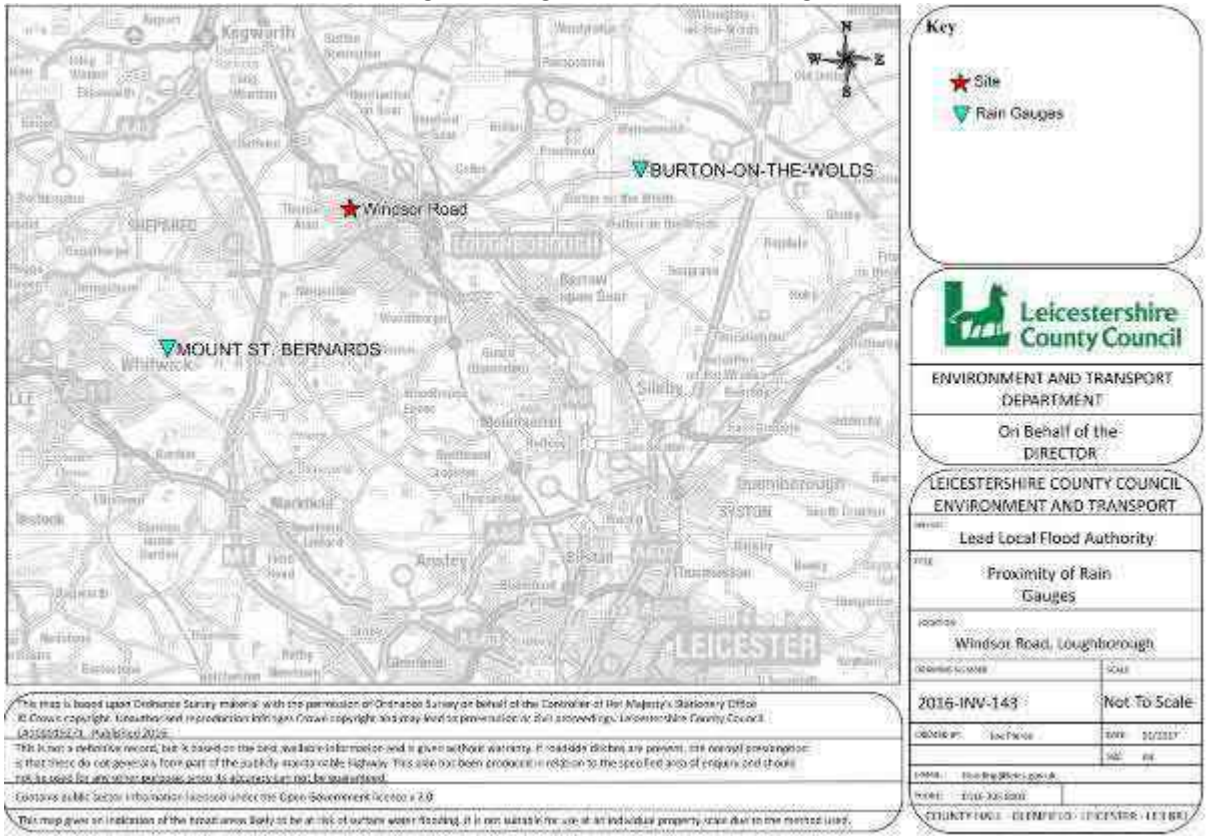


Figure 2 Location of rainfall gauges and flooding incident location

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

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

Name	Time series	Record start year	Record end year
Burton-on-the-Wolds TRB	Hourly	2000	2016
Mount St Bernards TRB	Hourly	1985	2016

Table 1 Rainfall gauges near to the site

The Leicestershire Section 19 Flood Investigations Hydrology Technical Note produced by AECOM (2017) describes the hydrological method that was used to undertake probability of occurrence analysis for the flooding incident in the Windsor Road area, and has been provided in Appendix F. Site specific hydrology details are provided in Appendix F-1.

The Depth-Duration-Frequency (DDF) model demonstrates that the rainfall events that occurred over the Windsor Road catchment had return periods of between 5 and 10 years, or more than a 10% Annual Exceedance Probability (AEP). However, as two rain gauges were used, neither directly at the location of interest, a certain amount of error is to be expected in the interpolation. Therefore it is worth noting from Appendix F-1 that the 2 hour duration rain event at the Mount Saint Bernards rain gauge has a 1 in 40 year return period and hence, dependent on the extent and track of the rain storm, the Windsor Road event could have been as much as a 1 in 40 year return period. In general, highway drainage is not designed to accommodate events of this magnitude.

5. SUMMARY OF IMPACTS AND FINDINGS

5.1. IMPACTS

The flooding event on the 15th June 2016 was identified to be of a similar nature to what is regularly reported to be experienced at Windsor Road. While no internal flooding was experienced, the access/exit routes from the residential dwellings for the elderly and vulnerable residents were described to be temporarily restricted due to flooding. It also meant that support services could not easily access the residents while the flood waters remained.

Residents report that water gathers at the low point in the property (car park). The flood waters then rise and deepen as rainfall continues. At the Sir Robert Martin Court development, anecdotal sources report the waters rose to a level just below the ground floor doorway thresholds.

5.2. HIGHWAY DRAINS

The highway drainage along Windsor Road consists of traditional road gullies that connect to a STW surface water drainage network. There are gullies located on either side of Windsor Road adjacent to either side of the driveways leading into Hanover Court and Sir Robert Martin Court.

A CCTV survey of the surface water drainage network on Windsor Road undertaken by the LCC Highway Team in November 2016 following clearance of the highway drainage network did not find any issues in the main branch of the STW surface water sewer located on Windsor Road. However, further investigation by the LCC Highway Team revealed that one of the pipes that connected a gully to the surface water network was in a state of disrepair and is likely to have restricted the amount of runoff that was able to enter the surface water sewer network, and thus exacerbating the flooding of Windsor Road and the car parks of the effected properties. LCC Highway Team has reported that this pipe has since been repaired and that gullies and drains have been cleared.

5.3. PUBLIC SEWER

A STW foul sewer (225 mm diameter) flows north along Windsor Road and join a main branch running along Lewis Road which heads towards the east. This foul line is independent of the surface water system. There was no suggestion that the foul system contributed to the flood event, either by receiving excess water or from being overwhelmed.

A STW surface water sewer (225mm diameter) flows south along Windsor Road before heading east via the footpath south of Sir Robert Martin Court. It is possible that the capacity of the surface water network was exceeded by the storm event. However during

the course of this investigation, STW reported that there are no known issues with the surface water sewer network in the area.

5.4. WATERCOURSES

Black Brook is an Environment Agency designated Main River which has been augmented with a number of informal flood defence structures. However the findings have identified that it is not thought to be the source of the flooding in question because Black Brook is not reported to have overtopped its banks on June 15th 2016. Based on observations from the site visit, Black Brook is at a much lower level compared to Windsor Road.

5.5. EXTENT OF FLOODING

Environment Agency Long Term Flood Risk - Surface Water Flood mapping (Appendix G) suggests that Sir Robert Martin Court and a few places in the Hanover Court car park have a high risk of flooding from surface water. High risk means that each year this area has a chance of flooding of greater than 3.3%. The same mapping shows that Windsor Road and portions of the Hanover Court cark park are at a low risk of flooding. Low risk means that each year this area has a chance of flooding of between 0.1% and 1%.

The extent of the reported flooding is larger than that suggested by the Environment Agency Long Term Flood Risk - Surface Water Flood mapping[5]. The maps suggest that flooding occurs throughout most of the Hanover Court car park during extreme rainfall events which is not supported by anecdotal evidence where the flooding is described to occur frequently during smaller less intense events. At Sir Robert Martin Court the map show flooding during less intense storm events, but the extent of flooding that occurred on June 15th 2016 is larger than that suggested by the Environment Agency Long Term Flood Risk - Surface Water Flood mapping.

[5] https://flood-warning-information.service.gov.uk/long-term-flood-risk/map?easting=451746&northing=320262&address=100030467691

6. RESPONSIBILITIES

6.1. LEAD LOCAL FLOOD AUTHORITY (LEICESTERSHIRE COUNTY COUNCIL)

LCC 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 Lead Local Flood Authority, LCC has a responsibility to investigate flood incidents under Section 19 of the Flood and Water Management Act (FWMA) 2010. Whilst LCC 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 LCC with the mandate or funding to tackle all identified causes of flooding.

6.2. LOCAL HIGHWAY AUTHORITY (LCC)

Leicestershire County Council is defined as the local Highway Authority and has a duty to maintain the highway under Section 41 of the Highways Act (1980). The Highway Authority is responsible for maintaining a safe a reliable local highway network. Refer to the Useful Links section of the report for further information on the Highways Act (1980).

6.3. 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.

6.4. RESIDENTS AND TENNANTS

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. More permanent measures are also possible, such as; installing floodgates, raising electrical sockets, and fitting non-return valves on pipes.

7. AGREED/RECOMMENDED ACTIONS

There are a number of recommendations for various risk management authorities and individuals (riparian owners) that may reduce the impact of future similar events. These are outlined below.

7.1. LEAD LOCAL FLOOD AUTHORITY (LCC)

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.

7.2. LOCAL HIGHWAY AUTHORITY (LCC)

LCC Highway Team is to confirm whether remedial works have been undertaken since the CCTV survey. The remedial works believed to have been carried out includes the raising of kerbs, implementation of additional gullies and repair of broken gully pipe.

It is recommended that the LCC Highway Team increases the frequency of inspection and maintenance on Windsor Road.

7.3. SEVERN TRENT WATER

During the course of the investigation Severn Trent Water advised that the area is not known to have experienced sewer flooding from their assets. Severn Trent Water is to monitor and assess any areas of restriction or insufficient capacity within their system, upgrading them and refining the hydraulic model as appropriate. Routine maintenance activities will continue to ensure that the sewerage networks have good serviceability.

7.4. RESIDENTS AND LAND OWNERS

It was observed that the gully in the Sir Robert Martin Court's car park is at a low level and could easily be surcharged during intense rainfall events.

It is recommended that the private drainage networks within Hanover Court and Sir Robert Martin Courts be regularly maintained by the owners and kept clear of blockage.

Property Level Resilience measures could also be explored to be implemented in the area if the remedial measures implemented do not resolve the flooding.

8. ACKNOWLEDGEMENTS:

A special mention of thanks should be given to all residents of the local area who provided AECOM with knowledge and experience. We have incorporated that knowledge into this report which will help to contribute to future flood alleviation within the area.

9. ABBREVIATIONS

EA	Environment Agency
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

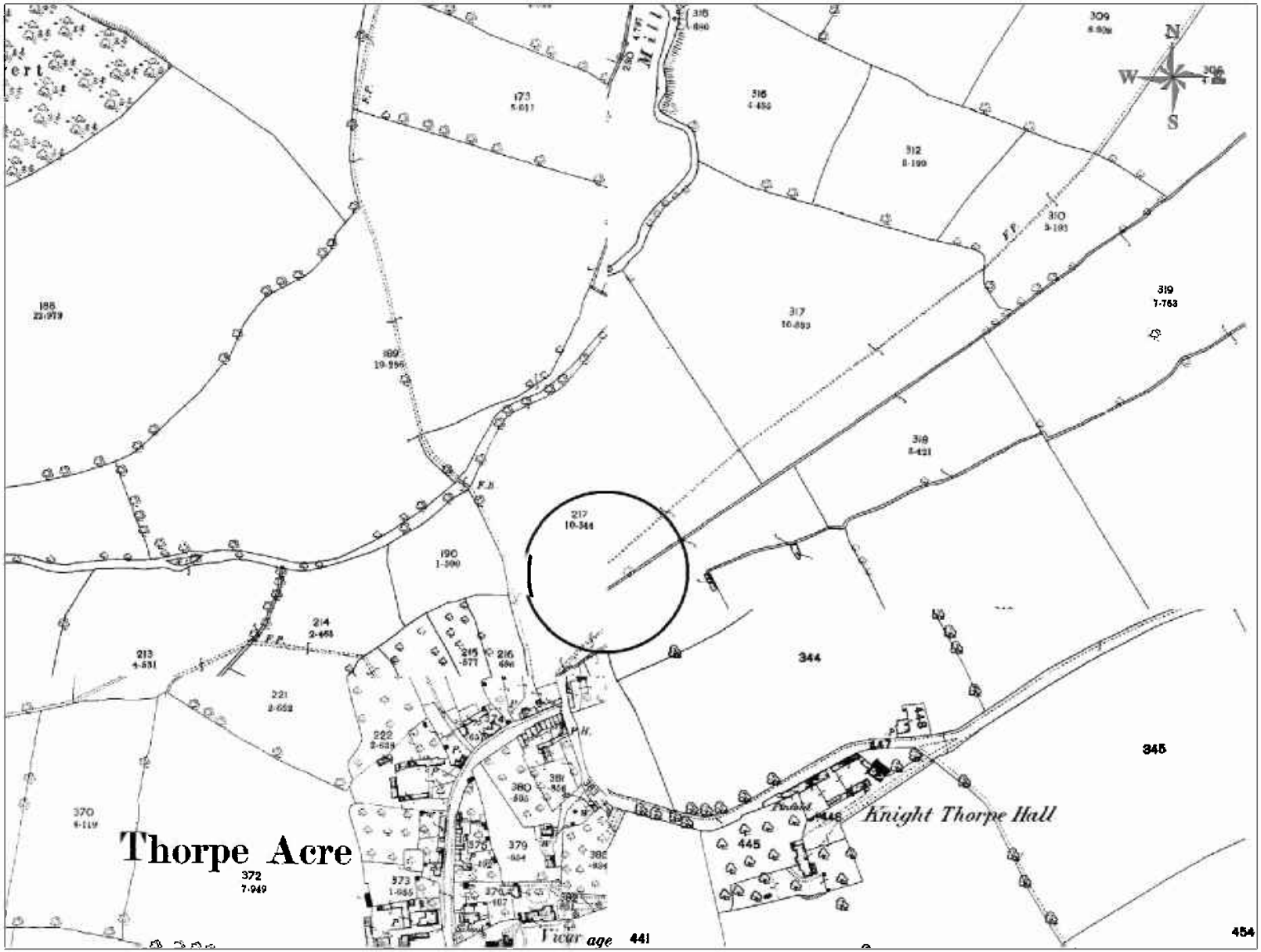
LOCATION: Windsor Road Loughborough

DRAWING NUMBER	SCALE
2016-INV-143	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

1884 HISTORIC MAP



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: Windsor Road Loughborough

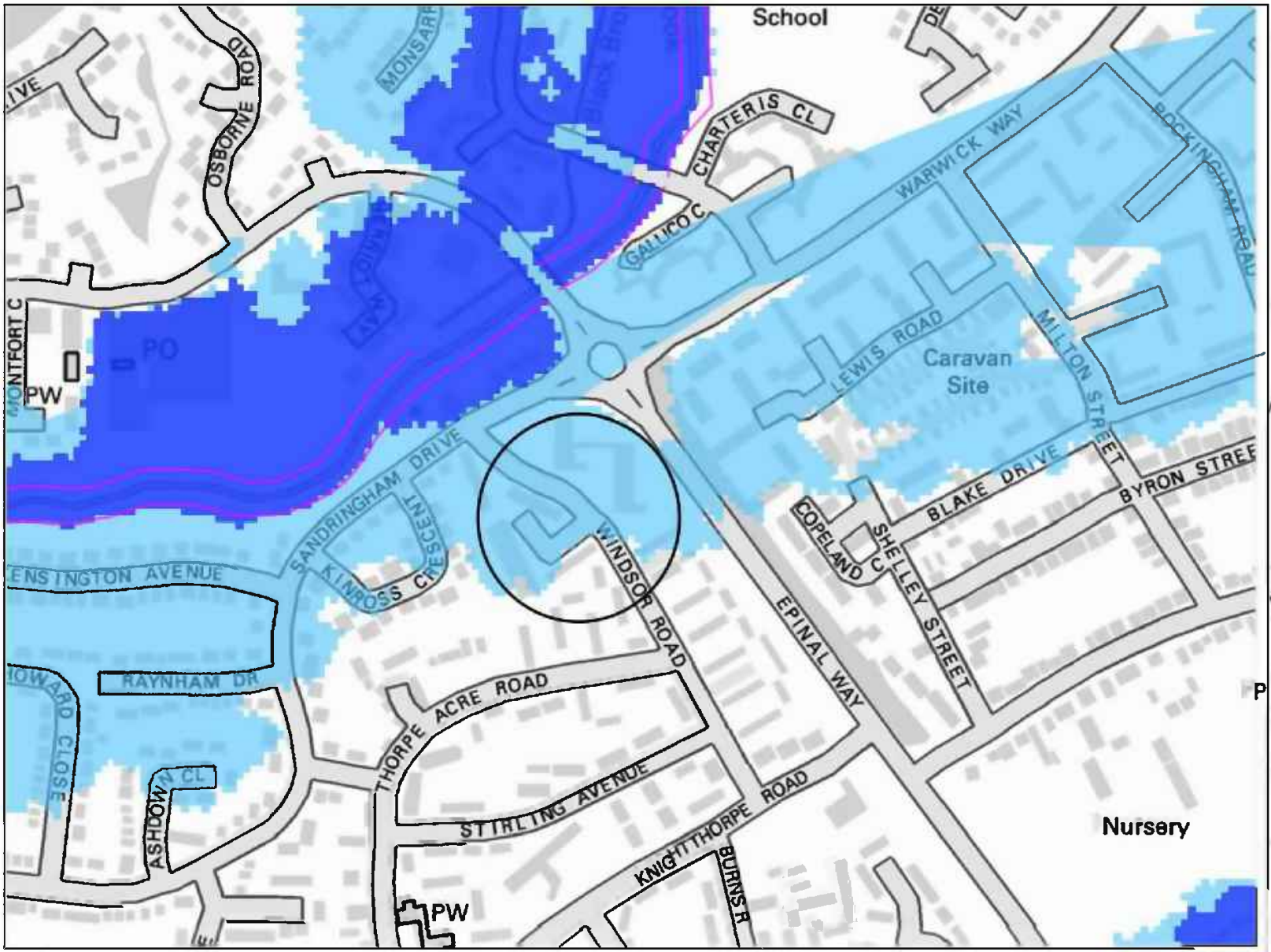
DRAWING NUMBER	SCALE
2016-INV-143	Not To Scale
CREATED BY: Stacey Johnson	DATE: 30/01/2017
	SIZE: A4

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 C

RISK OF FLOODING FROM RIVERS AND SEA 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: Windsor Road Loughborough

DRAWING NUMBER	SCALE
2016-INV-143	Not To Scale
CREATED BY: Stacey Johnson	DATE: 05/01/2016
	SIZE: A4

E-MAIL: flooding@leics.gov.uk

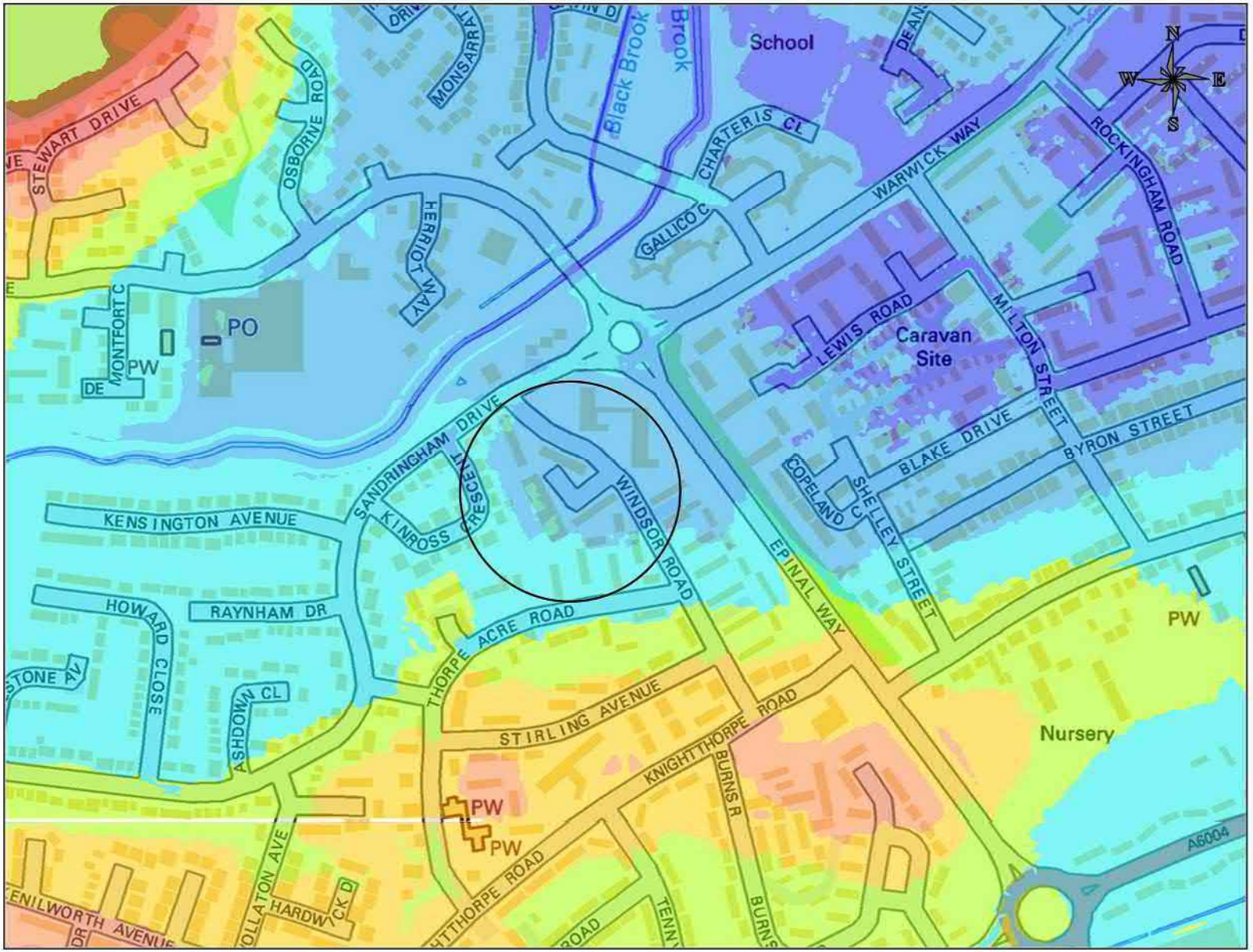
PHONE: 0116 305 0001

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 D

LIDAR MAPPING



Key

LiDAR Elevation (mOAD)

35-37	51-53
37-39	53-55
39-41	
41-43	
43-45	
45-47	
47-49	
49-51	

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: Windsor Road, Loughborough

DRAWING NUMBER	SCALE
2016-INV-143	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 E

SITE VISIT NOTES

Leicestershire CC – Section 19 Reports
Site Visit Data Sheet

1. Detail of Area/Properties/People Affected						
Location/Ward Area:	Windsor Road, Loughborough					
Team:	NM & AP					
Property Type(s) at flood risk Incl. Number:	Residential:	20	Industrial:		Office:	
	Educational:		Religious:		Recreational:	
Other (e.g infrastructure)	Windsor Road					
Comments:	Reports that ponding occurs during most periods of heavy rain. Flood water gathers in the car parks of the Hanover Court and Sir Martin Court flats. This appears to be an extension of ponding in Windsor Road.					

2. Details of Flooding								
Flood damage incurred? :	No damage. Elderly and vulnerable residents cut off from support.		Through doors:					
			Through windows:					
			Through floors:					
			Through airbricks:					
			Through drainage:		Ponding in car parks and surrounds			
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				
Comments (include estimate of flow path and sketch where possible):	The origin of the water is not clear, but is thought to be surface water flow that cannot discharge through the storm water system. Seven Trent Water sewer records issued in 2013 show that surface water runoff is conveyed by sewer to the east. A council team was met on site and it became apparent that the system had recently been cleaned and a CCTV survey was due to be carried out later in the day. The results of the survey should confirm if there are issues within the drainage system. It is possible that the pipes connecting to the car parks are private and in which case, may not be covered by the survey.							

Water Depth Inside property (m)	N/A
Water Depth Outside property (m)	0.3

Leicestershire CC – Section 19 Reports
Site Visit Data Sheet

3. Effects of Flooding											
Damage to Props. (residential and commercial/retail):	Access is cut off to elderly and vulnerable residents, some of whom rely on regular support.										
Damage to infrastructure:	None visible.										
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 property has any flood defences.
Condition	N/A

5. Potential Flood Alleviation Measures		
Proposed Measure(s) Details incl. length, height, Constructability/Access	Flood Wall	
	Flood Embankment	Raised entrances to the car parks
	Upstream storage	
	Storm Water Drainage System	Possible improvements to the 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; Windsor Road. Private car parks; Hanover Court and Sir Martin Court flats.	
Further Comments		

Leicestershire CC – Section 19 Reports
Site Visit Data Sheet

Add further comments, details, sketches here:

Sir Robert Martin Court is a CAT 2 Sheltered Scheme where a number of residents receive regular visits from outside care agencies. These visits are affected when the car park is flooded as the carers are unable to access the building.

Signature:

Name of Collator:	Date:	Time:
Nick Maynard	29 /11 /2016	11.30 am

APPENDIX F

HYDROLOGICAL STUDY

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

Distribution List

# Hard Copies	PDF Required	Association / Company Name

Prepared for:

Leicestershire County Council

Prepared by:

Lucy Rushmer
Senior Consultant
T: +44(0)113 391 6800
E: lucy.rushmer@aecom.com

AECOM
2 City Walk
Leeds
West Yorkshire
LS11 9AR

T: +44(0)113 3916800
aecom.com

Table of Contents

1. Introduction 5
2. Data Collection 5
3. Rainfall Analysis Methodology 6
   3.1 Observed Rainfall Data 6
   3.2 Event Rarity 7
   3.3 Limitations 9
4. Conclusion 10

Figures

Figure 3-1: Location of flooding incidents and rainfall gauges 6
Figure 3-2: Example of rainfall maximums for different durations plotted against DDF rainfall curves to assess probability of occurrence 8
Figure 3-3: Example of the 'event rarity' function in the DDF rainfall model in FEH CD ROM 3 9

Tables

Table 1-1: Location and date of each flooding incident 5
Table 3-1: Rainfall gauges used for each flooding location 7

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	16/04/2016
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	15/06/2016
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	10.30	12.30
Dunton Road, Broughton Astley	Littlethorpe	09/03/2016	5.00	8.40	16.80
Walnut Leys, Cosby	Littlethorpe	16/04/2016	2.80	2.80	2.80
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	25.40	40.20	49.20
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	27/08/2016	32.00	43.40	44.60
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.

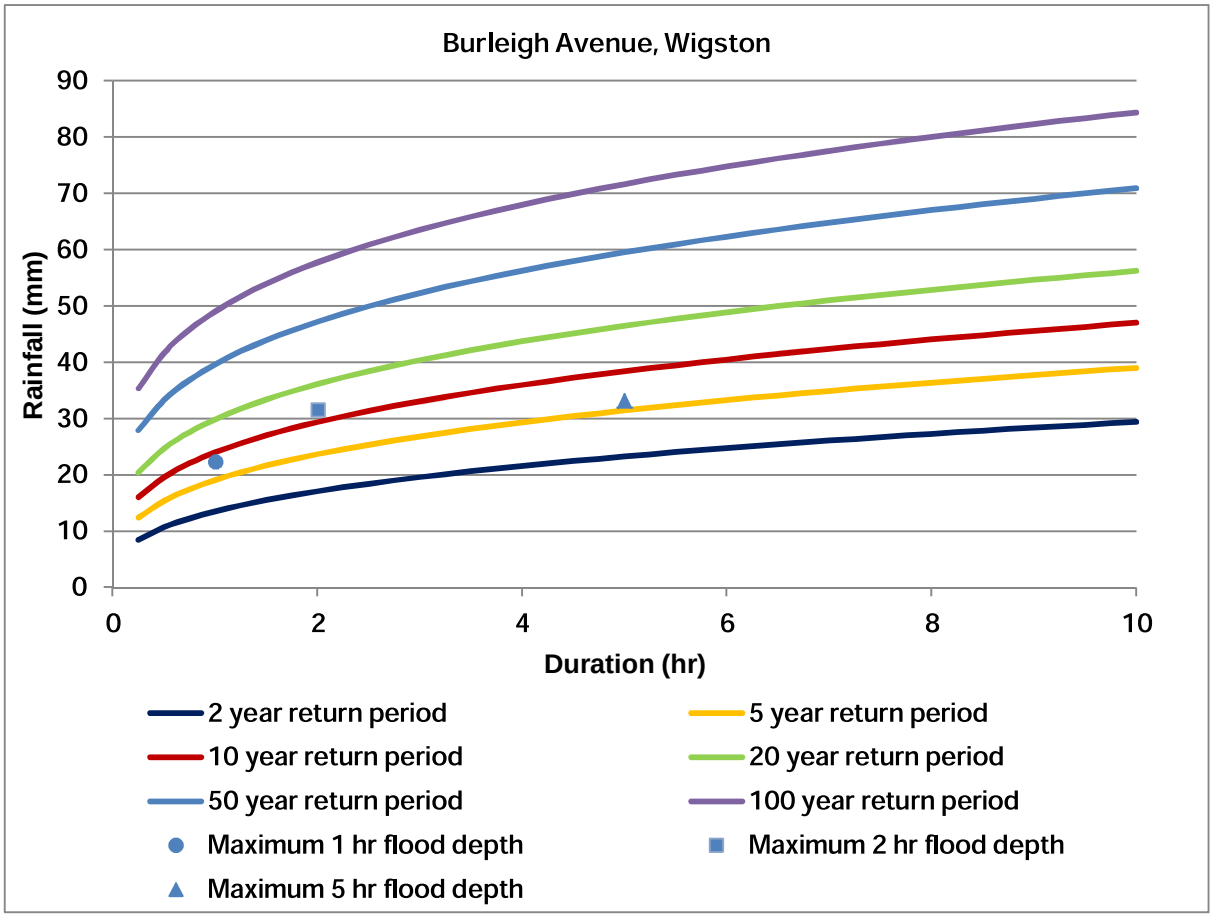


Figure 3-2: Example of rainfall maximums for different durations plotted against DDF rainfall curves to assess probability of occurrence

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

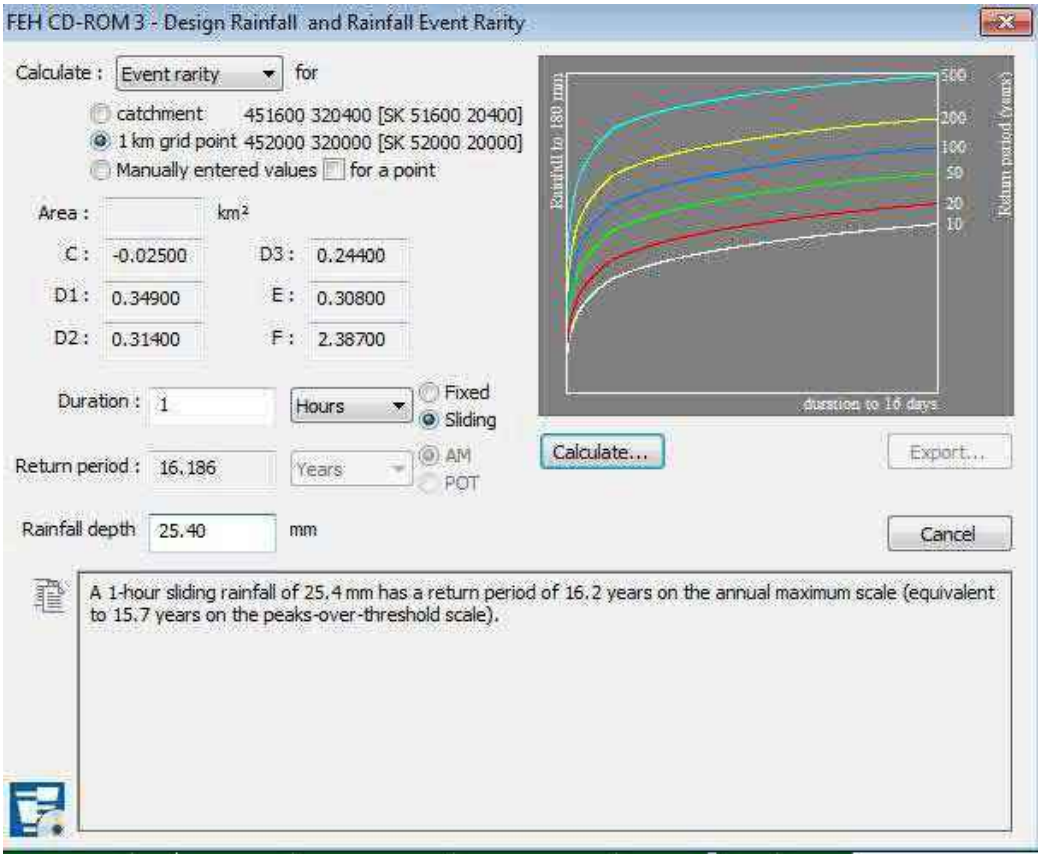


Figure 3-3: Example of the 'event rarity' function in the DDF rainfall model in FEH CD ROM 3

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.

Given more time and money, the use of radar data from the Meteorological office would help to clarify the weather conditions that contributed to these flooding incidents across Leicestershire.

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.

aecom.com

APPENDIX G

RISK OF FLOODING FROM
SURFACE WATER (RoFSW) MAP

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: WINDSOR ROAD

DRAWING NUMBER	SCALE
2016-INV-143	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 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.

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*