Lilford Park Section 19 Flood Investigation Report

Final Report

June 2025

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Wigan Council

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This report describes work commissioned by Wigan Council, by an instruction dated 14 January 2025. The Client's representative for the contract was Laura Morrison of Wigan Council. Elsa Holm and Helen Dawson of JBA Consulting carried out this work.

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The methodology adopted and the sources of information used by JBA in providing its services are outlined in this Report. The work described in this Report was undertaken between January and May 2025 and is based on the conditions encountered and the information available during the said period. The scope of this Report and the services are accordingly factually limited by these circumstances.

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Acknowledgements

We would like to acknowledge the assistance of Wigan Council, the Environment Agency, United Utilities, and local residents.

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Contents

List of Figures

List of Tables

Abbreviations

AGMA	Association of Greater Manchester Authorities
DDF	Depth Duration Frequency
Defra	Department for Environment, Food, and Rural Affairs
EA	Environment Agency
FEH	Flood Estimation Handbook
GMRF	Greater Manchester Resilience Forum
JBA	Jeremy Benn Associates
LLFA	Lead Local Flood Authority
LRF	Local Resilience Forum
mALD	Metres Above Local Datum
mAOD	Metres Above Ordnance Datum
NFM	Natural Flood Management
NHS	National Health Service
PFR	Property Flood Resilience
POT	Peaks Over a Threshold
RMA	Risk Management Authority
RoFSW	Risk of Flooding from Surface Water

Definitions

Annual probability: The chance that a flood event of the specified magnitude or larger will occur in any given year.

Combined sewer system: A type of drainage system where both wastewater (sewage) and stormwater (rainwater runoff) are collected and conveyed through the same pipes to a sewage treatment plant.

Combined Sewer Overflow (CSO): When untreated or partially treated combined wastewater discharges from an outfall directly into a watercourse. They were developed as overflow valves to reduce the risk of sewage backing up during heavy rainfall.

Culvert: Where a watercourse flows through a pipe, often underground.

Flood defence: Infrastructure used to protect an area against floods such as floodwalls and embankments; they are designed to a specific Standard of Protection.

Foul sewer: The underground pipe system that carries wastewater, including sewage and greywater, from homes and businesses to a sewage treatment plant for treatment.

Groundwater: All water which is below the surface of the ground and in direct contact with the ground or subsoil (as defined in the Flood and Water Management Act 2010).

Gully: A drainage point, typically covered by a metal grate, located at the side of the road to collect and remove excess water from the highway, directing it into the surface water sewer or other drainage systems.

Lead Local Flood Authority (LLFA): As either the unitary authority or the County Council for the area, leads on managing local sources of flood risk.

LiDAR: LiDAR stands for Light Detection and Ranging. It is a remote sensing technology that uses laser light to measure distances to objects and surfaces. By collecting these measurements, LiDAR can generate 3D topographic maps of the Earth's surface.

Main river: A watercourse shown as such on the statutory main river map held by the Environment Agency. They are usually the larger rivers and streams. The Environment Agency has permissive powers (not duties) to carry out maintenance and improvement works on main rivers.

Ordinary watercourse: Any river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and passage through which water flows but which does not form part of a main river. The local authority or Internal Drainage Board has permissive powers (not duties) on ordinary watercourses.

Risk Management Authority (RMA): The Environment Agency; a Lead Local Flood Authority; a District Council in an area where there is no unitary authority; an internal drainage board; a water company and a highway authority.

Risk: In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.

Stakeholder: A person or organisation affected by the problem or solution or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.

Surface water sewer: A system designed to collect and channel rainwater and other uncontaminated surface runoff, typically from properties, roads, and pavements. The system directs the water to a stream, river, soakaway, or a combined sewer.

Executive Summary

Background

Lilford Park was impacted by the widespread flooding which occurred in the North West of England on 1 January 2025. It is Wigan Council's statutory duty as Lead Local Flood Authority (LLFA) to investigate the flooding in the Lilford Park area, as set out under Section 19 of the Flood and Water Management Act 2010 (legislation.gov.uk). Wigan Council has appointed JBA Consulting to undertake this investigation on its behalf.

Stakeholder engagement

As part of the Section 19 flood investigation, multiple local stakeholders were engaged in Lilford Park. These stakeholders included residents, local resilience forums, and Risk Management Authorities (RMAs). This reinforced the partnership working group which has been in place since the flood event. The objectives of the engagement were to:

- gather evidence and data to aid the understanding of the investigation;
- involve the community in the investigation; and
- review the flooding mechanisms and recommendations with RMAs and operational partners.

For further information see Section 1.3.

Study area

The Lilford Park study area for this Section 19 flood investigation is situated in the northeast of Leigh in Greater Manchester and is approximately 9km southeast of Wigan.

For further information see Section 2.

Flood risk understanding

Fluvial flood risk: In the Lilford Park study area, the risk of fluvial flooding is from the Atherton Lake/Lilford Park Brook. According to the Environment Agency's 'Check the long term flood risk' (gov.uk), the 'high risk' flood extent covers the area west of the park and the flood plains around the brook in the north and south of the study area. Several residential streets are also within the 'high risk' and 'medium risk' extents. The 'low risk' extent covers more of the residential area adjacent to the park in the southwest.

Surface water flood risk: The Environment Agency's Risk of Flooding from Surface Water (RoFSW) (environment.data.gov.uk) mapping shows that there are several areas of surface water ponding across the study area in the 3.3% (high risk) annual probability event. There is also a 'high risk' of surface water flooding along parts of most residential streets, including Riversmeade, Seven Oaks, Elmridge, Greenways and Redpol Avenue. In the 1% and 0.1% (medium and low risk) annual probability events, the extents of surface water flood risk increase in size, with new areas of ponding across several residential streets.

Groundwater flood risk: No groundwater flooding data was available for this Section 19 flood investigation, and there have not been any reports of groundwater emergence in the study area.

Historic flooding: On 26 December 2015, Storm Eva caused widespread flooding across Greater Manchester. During this event, 14 properties flooded in the Lilford Park area, by fluvial flooding from the Atherton Lake/Lilford Park Brook.

For further information see Section 3.

Hydrometric summary of the event

Antecedent conditions in the days and weeks prior to the event on 1 January 2025 were not unusual. The high volume and intensity of rainfall during the storm on 31 December 2024 and 1 January 2025 was therefore the main driver of the flooding observed in the Lilford Park area. Analysis of the river level gauge at Lilford Park Basin and the nearest rainfall gauge at Bedford shows that the data are broadly in agreement with annual exceedance probability values of around 3%. Analysis at the nearest flow gauge at Little Woolden Hall is also in agreement with these estimates, with an annual probability of 3.9% at this gauge, albeit being located significantly downstream of the flooded properties.

For further information see Section 5 and Appendix B.

Bedford system

Lilford Park is served by the 'Bedford system', which consists of Atherton Lake flood storage reservoir and Bedford pumping station. Due to coal mining subsidence, the area around Bedford Brook has sunk by up to 10 metres. Bedford pumping station, built in the 1960s, lifts water from Bedford brook by 10 metres, returning it to its original channel. Without this system, a lake filling a depression in the ground (a flash) would form.

For further information see Section 3.3.1.

South-pathway-receptor analysis

The sources, pathways, and receptors of flooding were as follows:

- **Sources -** extreme rainfall, high fluvial flows in the Atherton Lake/Lilford Park Brook, and both spillways of the Atherton Lake flood storage reservoir overtopping.
- **Pathways -** overland flows from the storage reservoir south down Elmridge and through the park down to the residential area by Wood End and Eden Bank, continuing to Hathaway Court and across the busway.
- **Receptors -** internal flooding of at least 25 residential properties, damage to the park's storage facilities and equipment, road closures, resident displacement, financial and material losses, and negative impacts to overall wellbeing and mental health.

For further information, including mapping and photos of the sources, pathways, and receptors, see Section 6.

Incident response

Several agencies responded during and after the flood event in Lilford Park, including Greater Manchester Fire and Rescue Service, Wigan Council, and the Environment Agency.

For further information see Section 7.

Conclusions and recommendations

The flood risk in the Lilford Park area is the result of the area having subsided by 10 metres due to coal mining. The Environment Agency manages this risk using Bedford pumping station and the Atherton Lake flood storage reservoir.

The flood event on 1 January 2025 in Lilford Park occurred due to extreme rainfall leading to high fluvial flows in the Atherton Lake/Lilford Park Brook. The flows reaching Bedford pumping station exceeded its maximum pumping capacity (9.4m^3/s). This meant that the sluice gates at the flood storage reservoir went into operation, automatically adjusting the flow released from the reservoir to maintain a steady flow. The closing of the sluice gates led to water being stored in the flood storage reservoir, as designed. However, on 1 January 2025 there was too much rainfall for the system to manage, and the flood storage reservoir exceeded its design capacity. Water overflowed both of the spillways into the park and adjacent residential area, flooding properties and causing significant implications for the local community.

Based on these identified causes and mechanisms of the flooding, a number of recommended actions for the RMAs and residents have been made in Section 8.2.

Appendix A answers a number of frequently asked questions regarding the flood event. Appendix B presents the full hydrological analysis of the event, summarised in Section 5.

This Section 19 Flood investigation report is supported by an action plan developed by Wigan Council, which outlines the required actions of the relevant RMAs. The action plan is a live document and will be regularly updated by Wigan Council.

1 Introduction

1.1 Background to the investigation

Lilford Park was impacted by the widespread flooding which occurred in the North West of England on 1 January 2025. It is Wigan Council's statutory duty as Lead Local Flood Authority (LLFA) to investigate the flooding in the Lilford Park area, as set out under Section 19 of the Flood and Water Management Act 2010 (legislation.gov.uk).

Section 19 states that:

- "(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 carried out an investigation under subsection (1) it must –
  (a) Publish the results of its investigation, and
  (b) Notify any relevant risk management authorities."

Wigan Council has outlined its criteria for undertaking a Section 19 flood investigation on their website and in the Association of Greater Manchester Authorities (AGMA) Policy for Investigating Flood Incidents (wigan.gov.uk). Definitions of a 'significant' flood event that would prompt a flood investigation are based on the following criteria:

- risk to life;
- weight of public, media, political and planning interest;
- impact on critical services;
- impact to either 5 or more residential buildings or 2 or more commercial properties;
- economic disruption;
- impact on critical infrastructure and installations; and
- frequency of flooding.

The flooding that occurred in the Lilford Park area on 1 January 2025 was deemed a significant event by Wigan Council, triggering an inquiry. Wigan Council has appointed JBA Consulting to undertake this investigation on its behalf.

1.2 Data collection

A wide range of data has been collected and analysed to inform the Section 19 flood investigation. This has been used to understand the causes of flooding and establish the context of the area, and includes the following:

- open-source data from GOV.UK;
- residents' questionnaires;

- photographs from the site visit showing flood sources, pathways, and receptors;
- hydrometric data;
- information from Risk Management Authorities (RMAs) on drainage infrastructure; and
- other data such as photographs, videos, YouTube drone footage, newspaper articles, and notes from the events.

1.3 Stakeholder engagement

As part of the Section 19 flood investigation, multiple local stakeholders were engaged in Lilford Park. These stakeholders included residents, Local Resilience Forums (LRF), and RMAs. This reinforced the partnership working group which has been in place since the flood event. The objectives of engagement are to:

- gather evidence and data to aid the understanding of the investigation;
- involve the community in the investigation; and
- review the flooding mechanisms and recommendations with RMAs and operational partners.

A list of key stakeholders and how they were engaged is provided in Table 1-1, based on the following categories of engagement:

- **inform:** provide information;
- **consult:** receive, listen, understand and feedback;
- **involve:** decide together;
- **collaborate:** act together; and
- **empower:** support independent action.

Table 1-1: Key stakeholders.

Role	Organisation	Stakeholder engagement	Engagement details
LLFA	Wigan Council	Involve/ Consult/ Collaborate	Invitation to contribute, site visit, online survey distribution, correspondence, public engagement meeting.
Residents	N/A	Consult/ Empower	Site visit, online questionnaire, correspondence.
Water and sewerage company	United Utilities	Involve/ Consult/ Collaborate	Invitation to contribute, site visit, correspondence, data provision.
Environment Agency	Environment Agency	Involve/ Consult/ Collaborate	Invitation to contribute, site visit, correspondence, data provision.
Charitable	Canal and River Trust	Consult	Correspondence, data

Role	Organisation	Stakeholder engagement	Engagement details
Trust			provision.
Resilience Forum	Wigan Borough Resilience Forum	Consult	Correspondence, data provision.
Resilience Forum	Greater Manchester Resilience Forum	Consult	Correspondence, data provision.
Emergency Services	Greater Manchester Fire & Rescue Service	Consult	Correspondence, data provision.
Emergency Services	North West Ambulance Service	Consult	Correspondence.

1.4 Resident questionnaire

A Microsoft Forms questionnaire was distributed to residents in the Lilford Park area. The purpose of the questionnaire is to help Wigan Council gain insights into how the flooding affected the local community. 37 households provided responses, as well as a community group in the area. The questions addressed the following:

- flood source(s) and pathways;
- impact on properties (e.g. flood depths, water ingress routes);
- event timing;
- whether relocation was necessary;
- whether residents used Property Flood Resilience (PFR) measures and, if so, whether these were effective;
- response from authorities;
- experiences of previous flood events; and
- overall impacts (e.g., mental health, property damage).

2 Study area

2.1 Investigation extent

The Lilford Park study area is mapped in Figure 2-1. Situated in the northeast of Leigh, Lilford Park is in Greater Manchester, and is approximately 9km southeast of Wigan. Urban areas are within the southern part of the study area, with rural land and woodlands to the north. Lilford Park includes residential streets, 'Lilford Park' situated in the north, and green space in the southeast, south of the busway.

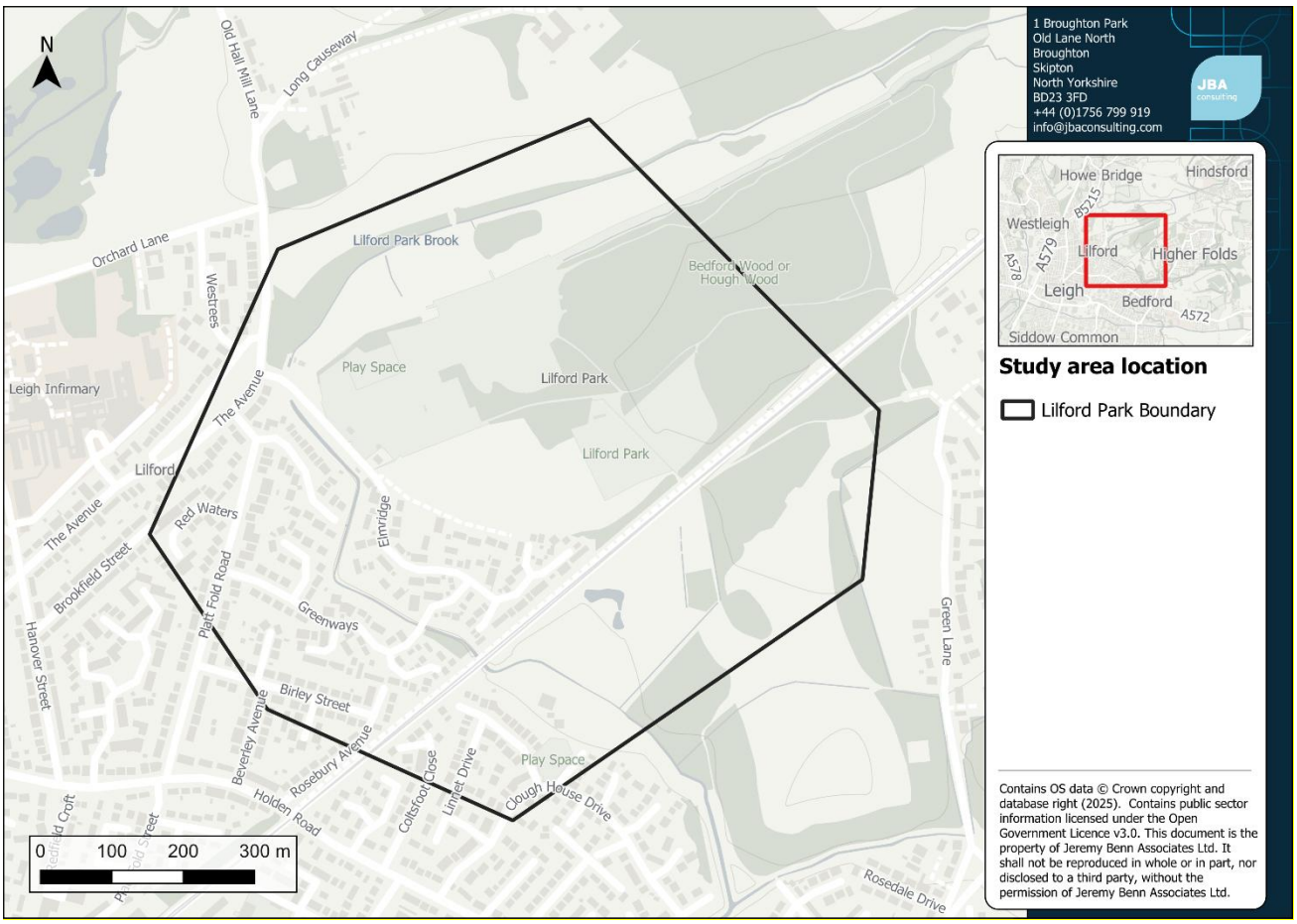


Figure 2-1: Lilford Park study area.

2.2 Topography

The Environment Agency's 1m resolution LiDAR shows that the topography of the Lilford Park area is generally low-lying, relative to the surrounding terrain. As shown in Figure 2-2, lower elevations follow the course of the Atherton Lake/Lilford Park Brook. The west of the park is situated on lower ground, as are a number of adjacent residential streets. These streets include Elmridge, Riversmeade, Eden Bank, and Hathaway Court. Some of the lowest-lying ground is found by the watercourse, south of the busway.

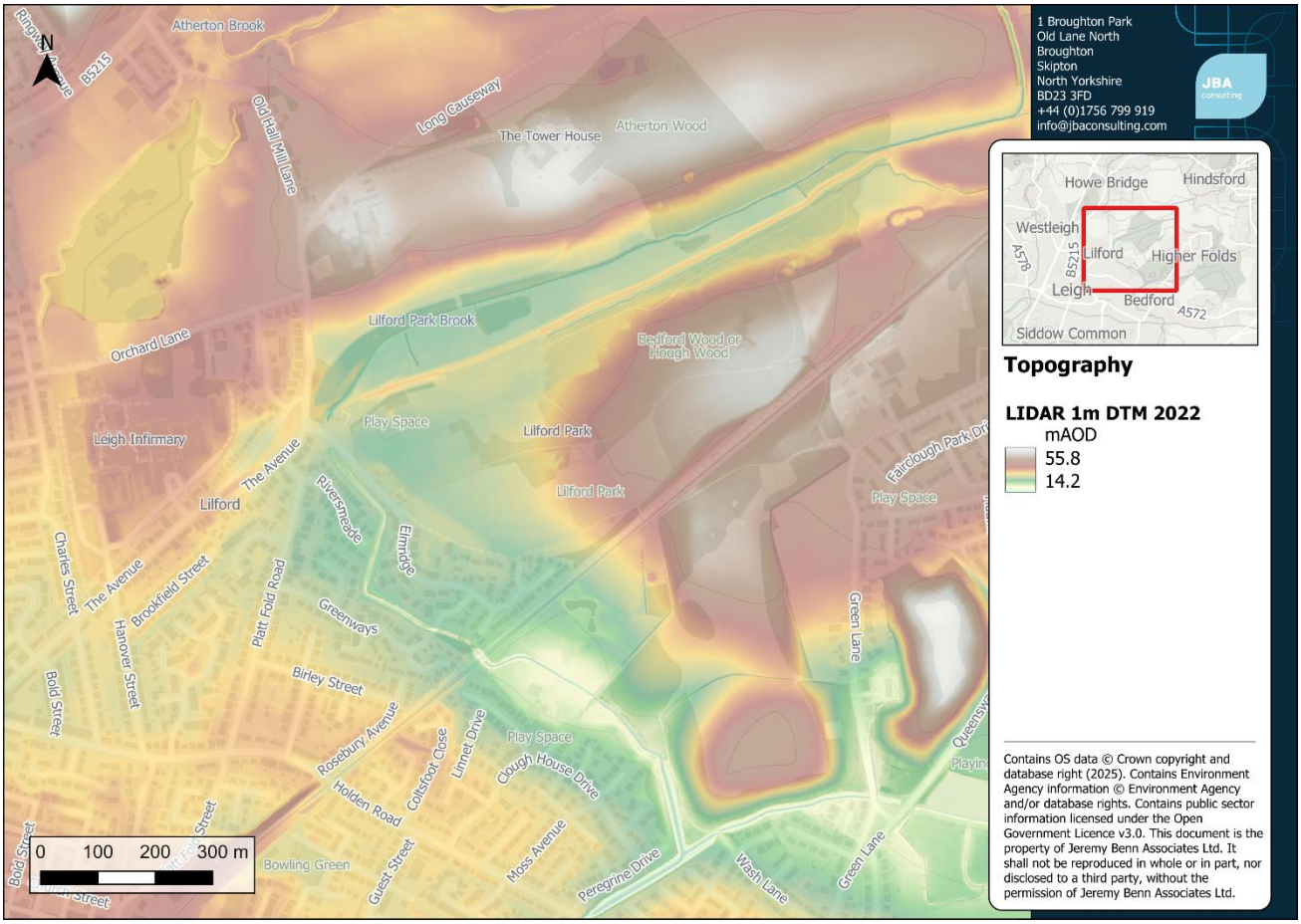


Figure 2-2: Topography of the Lilford Park study area.

2.3 Land cover and soils

The UK Soil Observatory Map (ukso.org) shows that soils across most of the study area are slowly permeable, which may limit infiltration rates of rainfall. The exception is surrounding Atherton Lake Brook north of the park, reaching down to the junction between Elmridge and The Avenue. This area has freely draining, slightly acid, loamy soils. However, given the urban nature of the catchment, it is likely that the amount of impermeable surfaces will have a greater impact on runoff rates than the underlying geology and soils.

2.4 Drainage systems and river network

2.4.1 Watercourses

A watercourse can be any stream of water flowing in a defined channel, or through an underground pipe or culvert. In England there are two types of watercourses, 'main rivers' and 'ordinary watercourses'. Main rivers are designated by the Environment Agency and tend to be larger rivers and streams with the highest flood risk. However, in some cases main rivers can be small watercourses or drainage channels. All other watercourses are referred to as ordinary watercourses. There are different roles and responsibilities in relation to different types of watercourses, which are covered in Section 4.

Watercourses in the Lilford Park area are shown in Figure 2-3. Lilford Park has one main river, the Atherton Lake/Lilford Park Brook, which flows in a southerly direction through the study area. The brook originates from multiple tributaries located northeast of the study area. Around 800m northeast of the area, the Atherton Brook converges with the Hindsford Brook at the intersection of Miller's Lane and Langley Platt Lane. The catchment area upstream of Lilford Park is 23.66 km^2.

The Red Waters drainage ditch lies outside the Flood Storage Reservoir and parallel to the main embankment. In normal conditions this ditch outfalls through a flap valve into the storage reservoir. Once the flood storage reservoir becomes operational and water levels rise, the flap valve will close. Under these conditions the ditch will become 'tide locked' and flooding may occur. There are also other smaller watercourses, unmaintained non-main ditches, and groundwater springs near to the reservoir. In a flood event, these may contribute to the volume of flow through the park and the surrounding land.

There is also a culverted watercourse that drains from an inlet at Wood End, and discharges into the Atherton Lake/Lilford Park Brook.

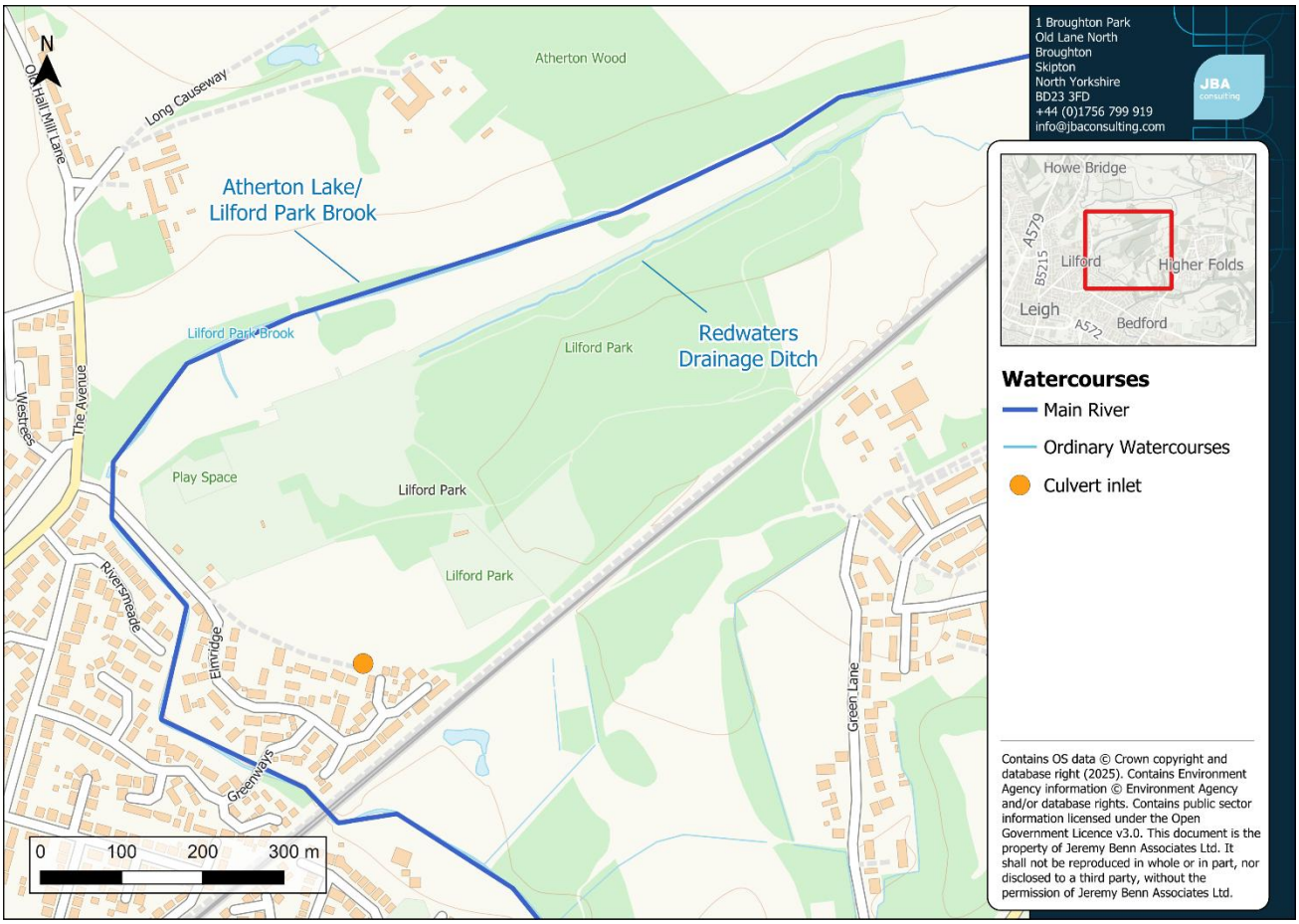


Figure 2-3: Watercourses in Lilford Park.

2.4.2 Sewers

The United Utilities sewer network in the Elmridge area is shown in Figure 2-4.

The surface water sewers along Hathaway Court and Eden Bank discharge into the surface water sewer on Elmridge, which continues down Greenways before flowing into Lilford Park Brook via an outfall. Several residential streets west of Lilford Park Brook, including Seven Oaks and Riversmeade, have surface water sewers that discharge into the brook through a number of different outfalls.

The foul sewers in the residential areas situated around the watercourse are pumped via Bedford House and The Avenue pumping stations to the combined sewer that runs along Platt Fold Road. The majority of the combined network drains to Lions Bridge pumping station which pumps foul flows out of the area.

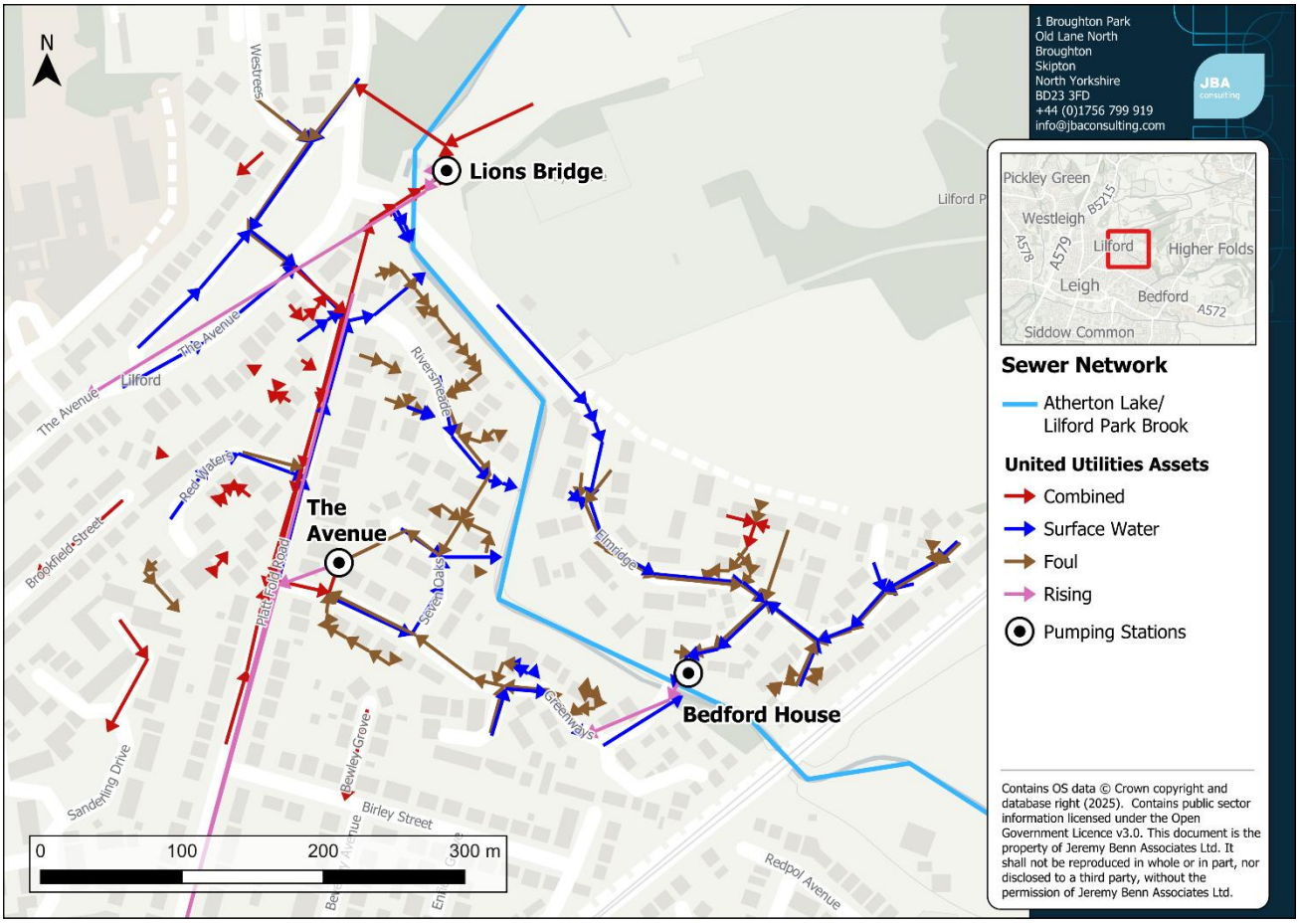


Figure 2-4: United Utilities sewer networks around Lilford Park.

2.4.3 Highway drainage

Roads across the study area are drained by a network of highway gullies which are maintained by Wigan Council Highways Department. These gullies are connected to the United Utilities surface water sewer network, which conveys water into Atherton Lake/Lilford Park Brook at a number of outfalls within the study area.

3 Flood risk understanding

3.1 Existing knowledge of flood risk sources

3.1.1 Fluvial flood risk

The Environment Agency's 'Check the long term flood risk' (gov.uk) can be used to understand the flood risk in an area. This shows the risk of flooding from rivers and sea, accounting for the presence and condition of flood defences, with the following probability of occurring in any given year:

- **high risk**: greater than a 3.3% annual probability;
- **medium risk**: between a 3.3% and 1.0% annual probability;
- **low risk**: between a 1.0% and 0.1% annual probability; and
- **very low risk**: less than 0.1% annual probability.

In the Lilford Park study area, the risk of fluvial flooding is from the Atherton Lake/Lilford Park Brook. As shown in Figure 3-1, the 'high risk' flood extent covers the west of the park and the flood plains around the brook in the north and south of the study area. Several residential streets are also within the 'high risk' extent, including Elmridge, Hathaway Court, and Eden Bank. Parts of Greenways, Riversmeade, Seven Oaks, Wood End, and The Avenue are also in the 'high risk' and 'medium risk' categories.

The 'low risk' extent covers more of the residential area adjacent to the park in the southwest. New streets situated within this category include parts of Platt Fold Road and South Court. South of the busway, there are also a number of streets at risk of fluvial flooding.

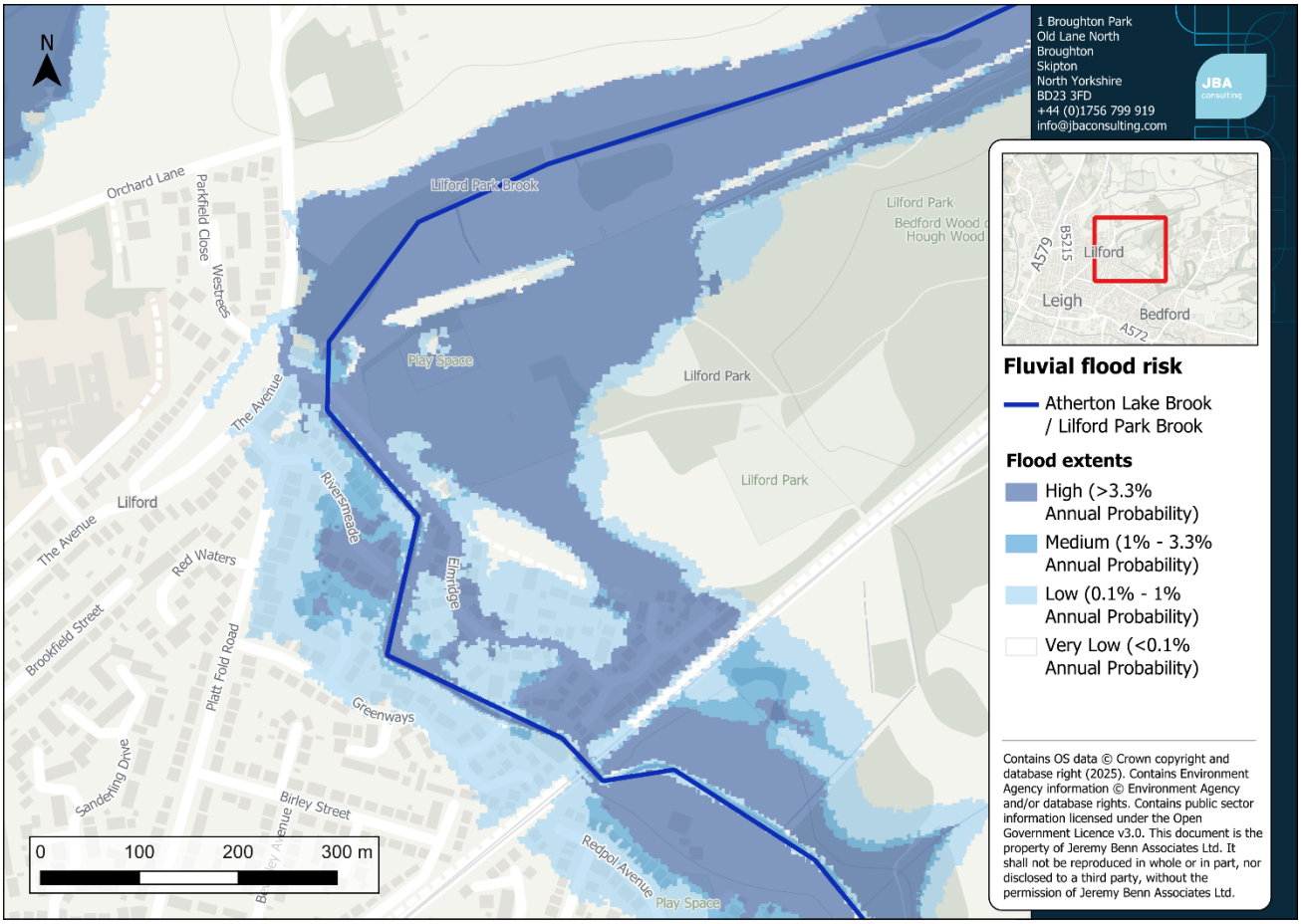


Figure 3-1: The Environment Agency's Risk of Flooding from Rivers and Sea mapping for the study area.

3.1.2 Surface water flood risk

Surface water flooding occurs when the volume and intensity of rainfall overwhelms local drainage systems. Surface water runoff often flows off hills and areas of higher ground and pools in lower-lying flat areas and along roads and paths. The Risk of Flooding from Surface Water (RoFSW) data is national scale mapping showing the risk of flooding from surface water runoff, published by the Environment Agency. This can be viewed on the Environment Agency's 'Check the long term flood risk' (gov.uk) website. Figure 3-2 shows the areas at risk of flooding in response to rainfall events with the following probability of occurring in any given year:

- **high risk:** greater than a 3.3% annual probability;
- **medium risk:** between a 3.3% and 1.0% annual probability; and
- **low risk:** between a 1.0% and 0.1% annual probability.

In the 3.3% annual probability event, there are several areas of surface water ponding across the study area. One of the largest areas of pooling is in the west of the park. There is also a 'high risk' of surface water flooding along parts of most residential streets, including Riversmeade, Seven Oaks, Elmridge, Greenways and Redpol Avenue.

In the 1% and 0.1% annual probability events, the extents of surface water flood risk increase in size, with new areas of ponding across several residential streets. In the 0.1% annual probability event, there is surface water flood risk across many properties situated between Riversmeade and Greenways. There is also a 'low risk' of pooling across much of Elmridge, Greenways, Eden Bank, and Hathaway Court.

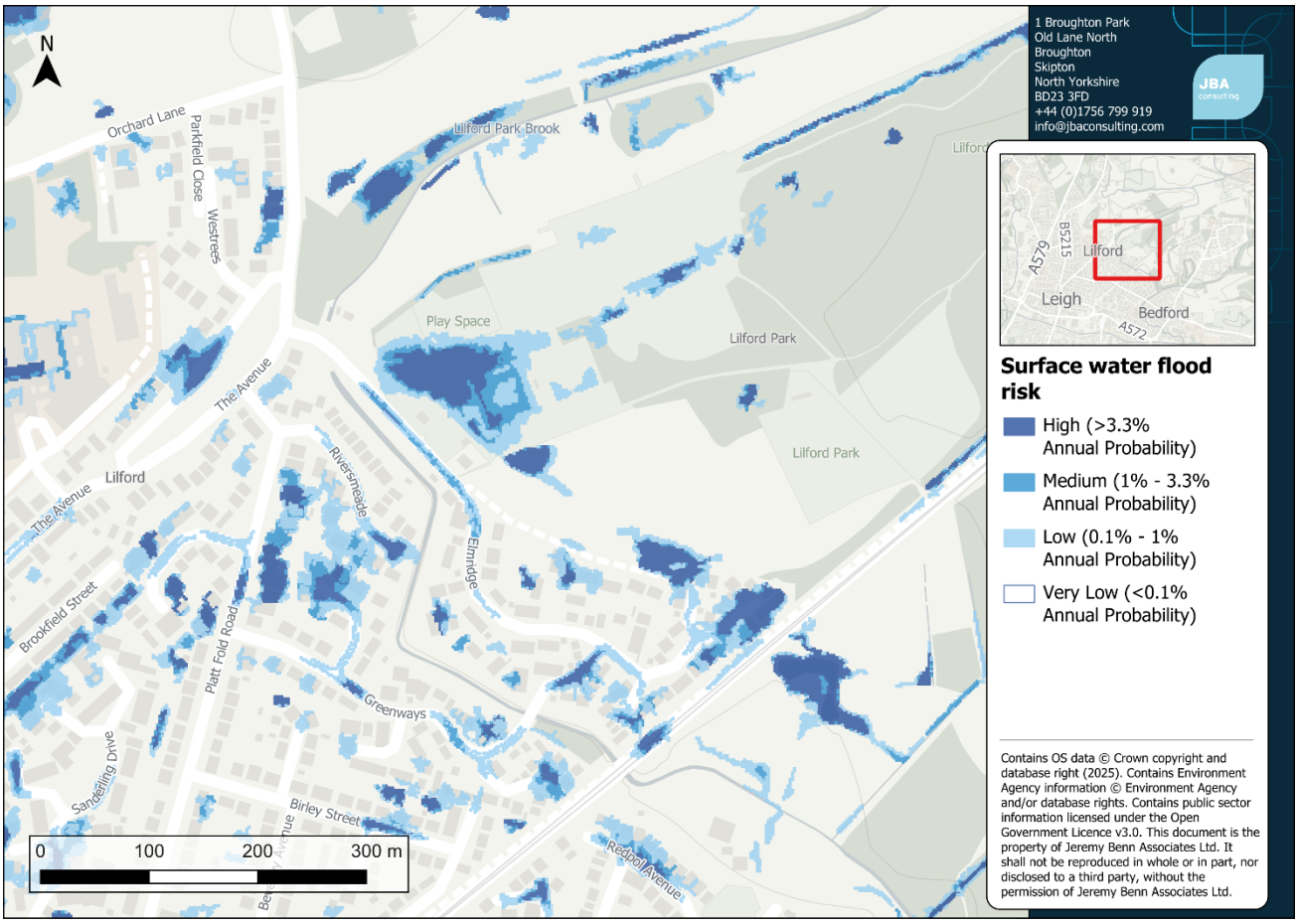


Figure 3-2: The Environment Agency's Risk of Flooding from Surface Water mapping for the study area.

3.1.3 Groundwater flood risk

Flooding from groundwater occurs when the water table within the underlying rock or soil rises above ground level or interacts with properties or infrastructure below ground level. Groundwater flood mapping has not been available for this Section 19 flood investigation, and there have not been any reports of groundwater emergence in the study area.

3.1.4 Sewer flood risk

Sewer flooding occurs when intense rainfall/river flooding overloads sewer capacity (surface water or combined), and/or when sewers cannot discharge to watercourses due to high water levels. Sewer flooding can also be caused by blockages, collapses, equipment failure, or groundwater leaking into sewer pipes.

Since 1980, the Sewers for Adoption guidelines and subsequent Sewer Sector Guidance, mean that new surface water sewers have been designed to have capacity for a 3.3% annual probability rainfall event, although until recently this did not apply to smaller private systems. This means that the capacity of sewers can be exceeded in larger rainfall and flood events. These guidelines do not apply to sewers constructed prior to 1980, which includes those in Lilford Park, and therefore these sewers may have been designated to a lower capacity.

Details of the sewer system in Lilford Park can be found in Section 2.4.2. In the study area, there are three pumping stations which rely on electricity to function. As a consequence, these can cause flooding issues from the sewer network should they lose power. Bedford House pumping station in the south of the study area is at fluvial flood risk in the 3.3% annual probability event. Lions Bridge pumping station in the north and the Avenue pumping station in the west are shown to be at fluvial flood risk in a 0.1% annual probability event. This fluvial flood risk presents an additional vulnerability, as the pumping stations may become inoperable or lose power should they become flooded.

During times of high flow in the watercourse, surface water outfalls into the Atherton Lake/Lilford Park Brook could become submerged. This limits the rate at which they can discharge, potentially allowing river water to back up via the sewer system.

3.2 Flood history

On 26 December 2015, Storm Eva caused widespread flooding across Greater Manchester. There is a Section 19 Flood Investigation Report (www.greatermanchester-ca.gov.uk) from this event available on the Greater Manchester Combined Authority website. According to this Section 19 flood investigation, 14 properties flooded in the Lilford Park area, by fluvial flooding from the Atherton Lake/Lilford Park Brook.

75% of residents who responded to the questionnaire answered that they had experienced flooding in the vicinity of their property, prior to 1 January 2025. One response noted that while the park completely flooded in 2015, there have been cases of flooding at a smaller scale within the park since then.

Persistent rainfall from November 2015 onwards meant that the catchment was saturated. 33mm of rainfall fell across the catchment, and the recorded rainfall is estimated to have a likelihood of occurring once in up to 2 years. The river levels at the Atherton Lake Brook, Lilford Park Basin gauge peaked at 4.51 meters, which was 1.3 meters higher than any other recorded level in its 10-year record.

The sluice gates did not operate as expected and it was likely that debris may have prevented a penstock from opening. This meant that water that should have gone to the Environment Agency's Bedford pumping station, near Leigh, instead backed up and filled the Atherton Lake flood storage reservoir. The flood storage reservoir exceeded its design capacity and overtopped. The operation of the pumping station and the flood storage reservoir are covered in more detail in Section 3.3.1. The extent of the flooding from the 26 December 2015 is mapped in Figure 3-3.

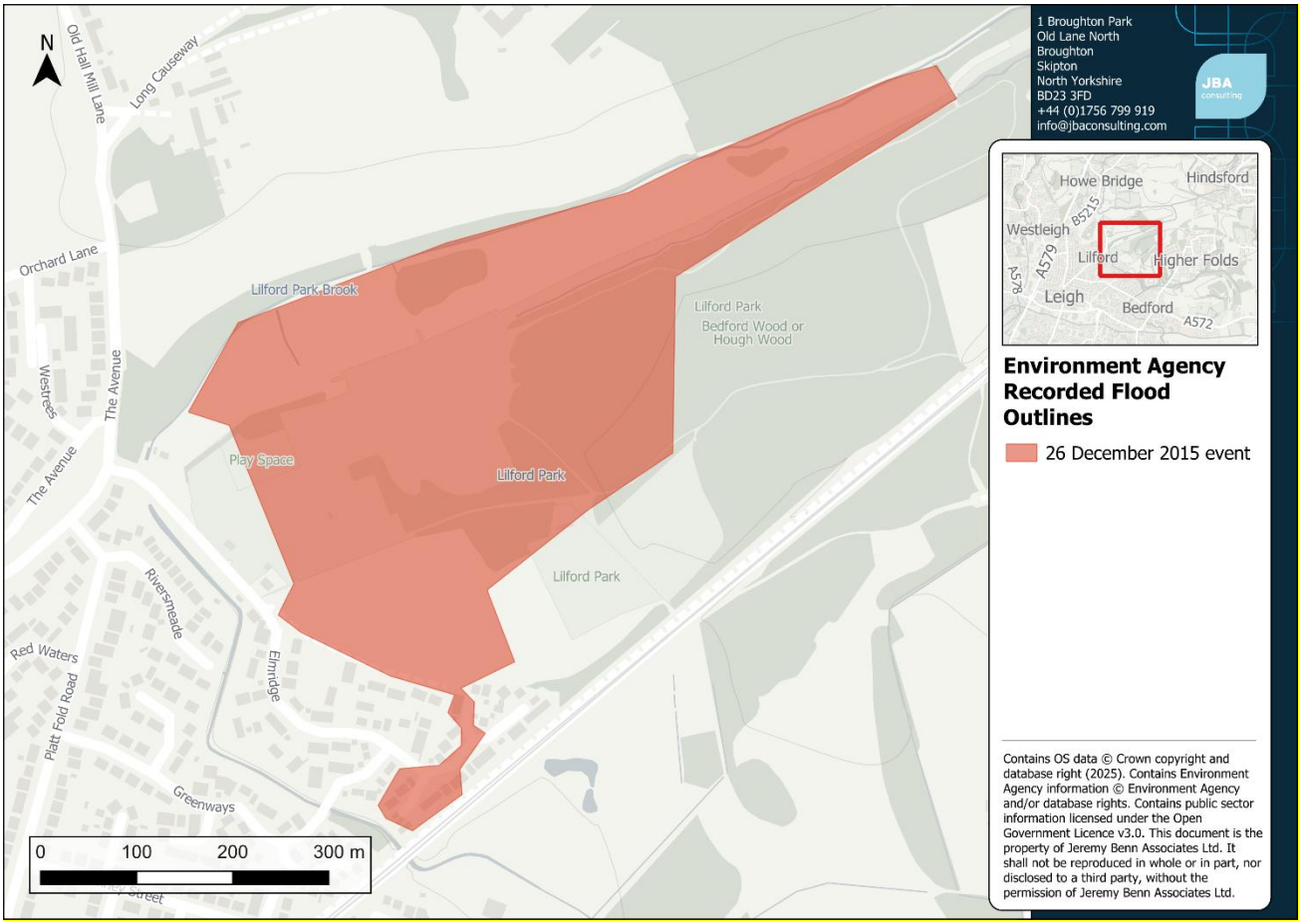


Figure 3-3: Environment Agency's Recorded Flood Outlines for the 26 December 2015 event.

3.3 Existing flood risk management activities

This section discusses existing flood risk management activities and assets in the Lilford/Bedford area. This information was partially provided by the Environment Agency and further supplemented with data available in the Section 19 Flood Investigation Report (www.greatermanchester-ca.gov.uk) for the 26 December 2015 event. The existing flood management infrastructure is mapped in Figure 3-4.

The Environment Agency provided a list of Frequently Asked Questions relating to the operation of their flood risk management infrastructure in Lilford Park. This is shown in Appendix A, alongside comments from Wigan Council.

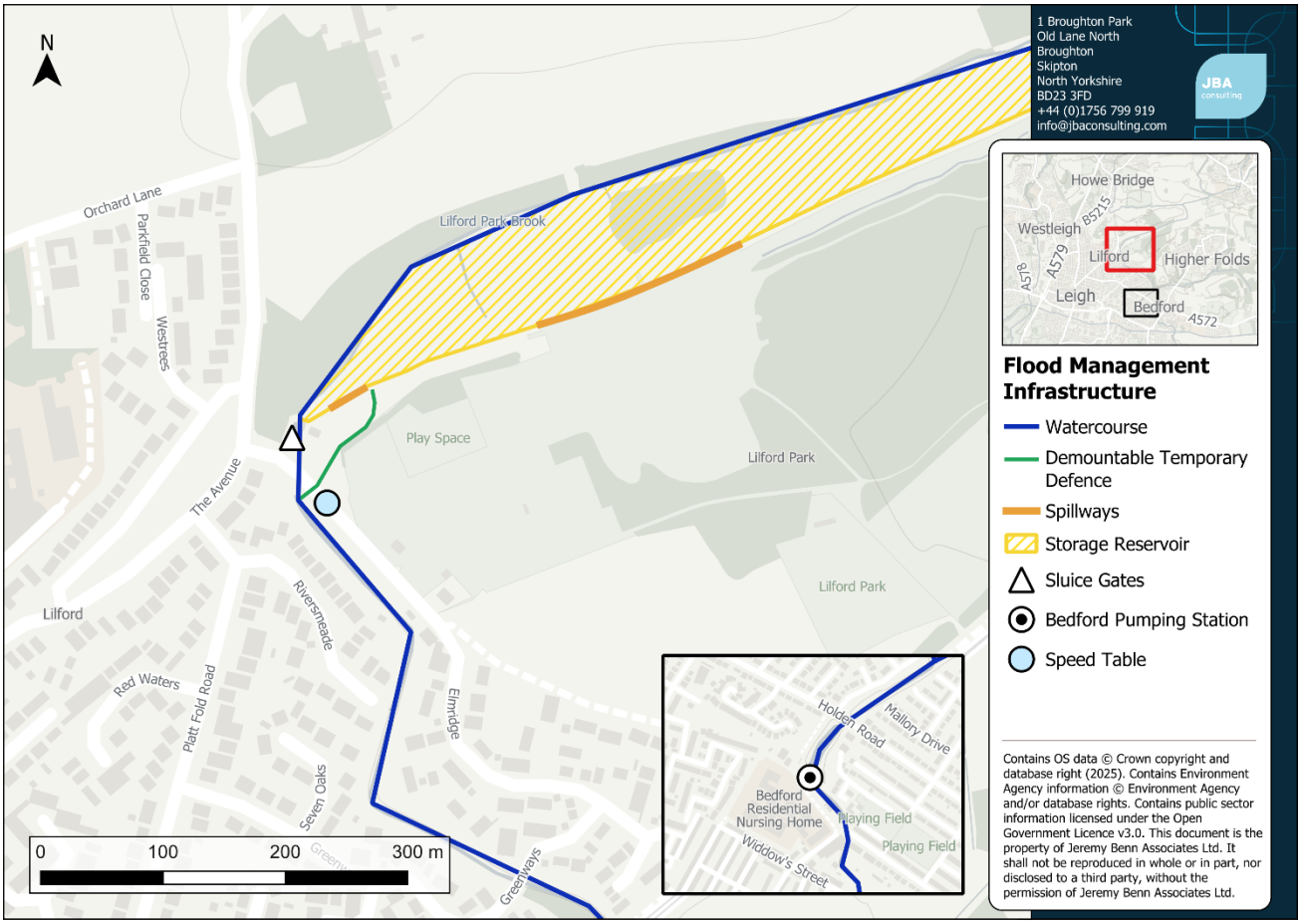


Figure 3-4: Existing flood management infrastructure in Lilford Park.

3.3.1 The Bedford system

Lilford Park is served by the 'Bedford system', which consists of Atherton Lake flood storage reservoir and Bedford pumping station. Due to coal mining subsidence, the area around Bedford Brook has sunk by up to 10 metres. Bedford pumping station, built in the 1960s, lifts water from Bedford brook by 10 metres, returning it to its original channel. Without this system, a lake filling a depression in the ground would form, which is known as a 'flash'.

Bedford pumping station is located approximately 1 kilometre southeast of Lilford Park. The pumping station has a total of seven pumps, and they pump the equivalent of 36 bathtubs per second. The flow enters the onsite basin at Bedford pumping station and is pumped automatically at a maximum rate of 9.4m^3/s, based on the capacity of the downstream channel.

The Lilford Park Brook watercourse is part of the Atherton Lake flood storage reservoir, which lies within Lilford Park itself. The storage reservoir has a capacity of approximately 180,000m^3, with Lilford Park Brook having an additional 20,000m^3. If the flow reaching the pumping station exceeds the maximum rate of 9.4m^3/s, there are two sluices/control gates at the flood storage reservoir that open and close to maintain a steady flow. This

happens automatically. The full or partial closing of the sluice gates causes water to be stored within the reservoir.

There are two spillways at the reservoir, shown in Figure 3-4 above. Spillways let water overtop in a regulated way and prevents the reservoir from overflowing earth embankments, which could cause them to collapse. If the Atherton Lake flood storage reservoir capacity is exceeded, excess water spills over them into the adjacent park and fields.

The spillways are a requirement under the Reservoirs Act 1975 for a Category A reservoir. The Reservoirs Act 1975 applies to “large, raised reservoirs” that store more than 25,000m^3 above ground level. The aim of the Reservoirs Act 1975 is to ensure that reservoirs are properly constructed and well managed and maintained, to ensure they are safe. The government website provides further guidance on reservoirs' owner and operator requirements (gov.uk).

The sluice gates and pumps within the system are protected from debris by automatically operated screen cleaning. The pumping station runs continuously, and the Atherton Lake flood storage reservoir can operate frequently during the winter months. Both Bedford pumping station and Atherton Lake flood storage reservoir operate automatically and are monitored remotely. They do not require personnel on site.

3.3.2 Temporary aluminium barrier

Since the 26 December 2015 flood event, a temporary defence management plan was adopted to erect a temporary aluminium barrier. An exercise tested this procedure in July 2016.

The temporary defence is designed for use in normal flow conditions when Atherton Lake Flood Storage Reservoir is experiencing issues, such as failure of the penstocks/sluice gates in a closed position. In such instances only the primary (western) concrete spillway is in operation. The normal flows can be managed effectively by the temporary defence deployment when there is capacity in the brook downstream for additional water to be diverted into it, and Bedford Pumping Station has capacity to pump.

The temporary defence barriers redirect floodwater overflowing from the Atherton Lake flood storage reservoir across the road at Elmridge and back into the river channel. This redirection occurs only from the primary (western) concrete spillway of the flood storage reservoir, not the secondary (eastern) spillway. It offers no benefits once water overflows both spillways.

The temporary aluminium barriers were not deployed in the 1 January 2025 event, as the flooding was due to an exceedance event and not an asset failure.

3.3.3 Road drainage

The Council obtained funding to improve road drainage on Elmridge after the 26 December 2015 flood event. This included lowering the footpath and constructing a speed table, shown in Figure 3-5. The speed table was added to direct initial surface water run-off and

spills from the storage reservoir back into Atherton Lake/Lilford Park Brook, immediately downstream of the culvert under Elmridge.

Figure 3-5: Speed table on Elmridge (Source: JBA Consulting).

3.3.4 Property Flood Resilience

PFR includes a range of measures, such as flood barriers and automatically closing airbricks, that can be installed around the perimeter of a building to reduce the risk of internal flooding. PFR can also be used within a building, to minimise damage if internal flooding still occurs. PFR aims to help households and businesses reduce the damage caused by flooding, helping to speed up recovery and reoccupation.

All of the respondents to the questionnaire who flooded internally on 1 January 2025 answered that they did not have any PFR measures in place.

3.3.5 Maintenance regimes

The frequency of gully cleansing may impact surface water flood risk as blocked gullies can prevent water from entering the drainage network. Wigan Council maintain priority gulleys on an annual basis and aim to maintain other gulleys on a three-year cycle. They also undertake reactive maintenance following reports of issues.

The Environment Agency carries out both proactive and reactive maintenance on its assets in the Lilford/Bedford area. This includes routine maintenance of Lilford Park Brook, Atherton Lake flood storage reservoir, and the sluice gates, as well as operational checks at the Bedford pumping station.

4 Roles and responsibilities

For the purposes of this investigation, responsibilities for flood risk are divided into 'flood risk management' and 'emergency response'. Section 4.1 describes the roles of the agencies and authorities involved in flood risk management and Section 4.2 covers the roles and responsibilities for those involved in emergency response.

It should be noted that the following sections provide a high-level overview of the flood risk management roles and responsibilities that are relevant to this Section 19 Flood Investigation. They do not provide a comprehensive review of all roles and responsibilities.

4.1 Flood risk management roles and responsibilities

Flood risk in England is managed by a range of different RMAs as set out in the Flood and Water Management Act 2010 (gov.uk). The Flood and Water Management Act places a duty on all RMAs to co-operate with each other, act in a manner that is consistent with the National Flood and Coastal Erosion Risk Management Strategy for England (gov.uk) and the local flood risk management strategies developed by LLFAs, and exchange information.

The Flood and Water Management Act defines a "Flood risk management function" which are functions set out within the Act which may be exercised by an RMA for a purpose connected with flood risk management.

4.1.1 Environment Agency

The Environment Agency has permissive powers to maintain and improve main rivers for the efficient passage of flood flows and the management of water levels for various river users and to protect the environment. As these powers are permissive only, the Environment Agency is not obliged to carry out either maintenance or new works on main rivers. Funding is allocated to work where it provides the greatest benefit to flood risk to better protect people, property, and wildlife.

Maintenance of a watercourse is unlikely to be carried out by the Environment Agency for amenity only, or to stop erosion, where this does not threaten flood risk management assets or other structures. Routine maintenance work can include:

- grass cutting and weed control
- removing obstructions from rivers
- repairing and operating sluice gates and pumping stations

The Environment Agency has powers to construct and maintain defences against flooding, to issue flood warnings, and to manage water levels. They will also undertake any works or assess any permits in-line with the government’s environmental ambitions.

The Environment Agency can choose to stop maintaining and operating the assets on main rivers. This happens either because the costs are greater than the benefits to reducing flood risk, or there is another party better placed to take on these responsibilities.

4.1.2 Lead Local Flood Authority

LLFAs were established under the Flood and Water Management Act 2010, which sets out their roles and responsibilities. They are county councils or unitary authorities and are responsible for managing the risk of flooding from surface water, groundwater, and ordinary watercourses (non-main rivers) and lead on community recovery.

The LLFA has powers under the Land Drainage Act 1991 to regulate ordinary watercourses to maintain a proper flow. They can do this by issuing consents for altering, removing or replacing certain structures or features, as well as enforcing obligations to maintain flow and repair watercourses, bridges, and other structures.

The LLFA has powers to carry out maintenance of ordinary watercourses when it is affordable and in the public interest. However, the LLFA do not have a duty to maintain watercourses, as this responsibility lies with the landowner (see Section 4.1.5).

The LLFA is also responsible for developing, maintaining, and applying a strategy for local flood risk management in their area, and for maintaining a register of flood risk assets.

Wigan Council is the LLFA for the Lilford Park area.

4.1.3 Water and sewerage company

Water and sewerage companies are responsible for managing the risks of flooding from surface water and foul or combined public sewer systems providing drainage from buildings and yards.

United Utilities is the water and sewerage company for the Lilford Park area.

4.1.4 Highway Authority

Highway Authorities are responsible for providing and managing highway drainage and roadside ditches and must ensure that road projects do not increase flood risk. They are also a riparian owner and responsible for sections of watercourses where these are crossed by a highway bridge.

Wigan Council is the Highway Authority for the Lilford Park area.

4.1.5 Riparian landowners

Riparian landowners who own land or property next to a river, stream or ditch, (including where this runs through a pipe or culvert), have rights and responsibilities over the management of the land including:

- a responsibility to let water flow through the land without any obstruction;
- prevent pollution;
- keep the banks clear of anything that could cause an obstruction and increase flood risk;
- maintain the bed and banks of the watercourse;
- control invasive species; and

- keep structures clear of debris.

There is more information on these rights and responsibilities in the Environment Agency online guidance 'Owning a watercourse' (gov.uk) and the Environment Agency publication Your watercourse: rights and roles (engagementhq.com).

4.1.6 Community

Property owners are responsible for looking after their own property, including the risks of water entering it and causing damage.

It is good practice for local residents to find out about any flood risk in the area, sign up for the Environment Agency's free flood warnings/alerts where available and make a written plan of how they will respond to a flood situation. Business owners should also make a flood plan for their business. There are measures that can be taken to reduce the amount of damage caused by flooding and properties at risk should be insured. Local residents can find out if their property is at risk, prepare for flooding, get help during a flood and get help after a flood. Additional information and resources are available on The Flood Hub (thefloodhub.co.uk) website.

4.2 Emergency response

Wigan Council, the Environment Agency, and the emergency services are Category 1 responders for flooding incidents across England, as defined by the Civil Contingencies Act 2004 (legislation.gov.uk). As Category 1 responders they are required to:

- assess the risk of emergencies occurring and use this to inform contingency planning;
- put in place emergency plans;
- put in place business continuity management arrangements;
- put in place arrangements to make information available to the public about civil protection matters and maintain arrangements to warn, inform and advise the public in the event of an emergency;
- share information with other local responders to enhance co-ordination;
- co-operate with other local responders to enhance co-ordination and efficiency; and
- provide advice and assistance to businesses and voluntary organisations about business continuity management (local authorities only).

Category 2 responders (which include transport and utility companies) are 'co-operating bodies'. They are less involved in the emergency planning work but heavily involved in emergencies which relate to their own services. They have a duty to co-operate and share relevant information with other Category 1 and Category 2 responders.

The Local Government Association (local.gov.uk) provide further information on the key roles and responsibilities during and after a flooding emergency.

4.2.1 Local Resilience Forum

LRFs are multi-agency partnerships made up of Category 1 responders, including the emergency services, local authorities, the National Health Service (NHS), the Environment Agency and others. LRFs are supported by Category 2 responders, such as the Highways Agency and public utility companies. The geographical area the forums cover is based on police areas.

The LRF is not a legal entity, nor does a Forum have powers to direct its members. Nevertheless, the Civil Contingencies and the Regulations provide that emergency responders, through the Forum, have a collective responsibility to plan, prepare and communicate for emergencies in a multi-agency environment.

The LRF for Lilford Park is the Greater Manchester Resilience Forum (GMRF).

The Greater Manchester Resilience Strategy 2020-2030 (greatermanchester-ca.gov.uk) prepared by the GMRF identifies flood risk as one of the top risks in Greater Manchester.

The GMRF leads multi-agency emergency planning across the city-region through multi-agency joint working, co-ordinated through a clear shared structure. The Resilience Oversight Group oversees several sub-groups including the Commissioning Group for Training and Exercising and the Risks, Plans and Lessons Group.

The GMRF and supported by and work in partnership with the:

- Greater Manchester Local Authorities Chief Officers Group;
- Greater Manchester Local Health Resilience Partnership;
- Health Economy Resilience Group;
- Borough Resilience Groups; and
- Voluntary Sector and Community Forum.

Wigan Borough Resilience Forum are the Borough Resilience Group for Lilford Park and work closely with Wigan Council as LLFA regarding flood risk issues in the area.

Wigan Borough Partnership Resilience Forum is made up of partners for all Blue Light Services, Acute and Primary Health care, Council Services with representatives from the CVS and Business Sector, and other relevant responders and services who, while not part of the core membership, are invited to participate as needed. The forum considers the Wigan Borough.

Wigan Borough Partnership Resilience Forum may hold Borough Tactical and Strategic Coordinating Groups for issues that are affect the Wigan Borough only, that have not been declared a Major Incident. Anything they declare as a Major Incident will trigger the Greater Manchester Resilience Forum plans for Tactical and Strategic Coordinating Groups.

4.2.2 Flood warning service

The Environment Agency is the lead organisation for providing warnings of main river flooding. The Environment Agency's Flood Warning Service provide flood warnings and alerts based on constant monitoring and forecasting of flooding from rivers and sea. The Environment Agency sign up for Flood Warnings (gov.uk) page provides further information

on how to sign up for these warnings. This service operates 24 hours a day, 7 days a week, and protocols do not change on bank holidays and weekend.

The Environment Agency's Flood Warning Duty Officers are updated with forecasting information regularly each day via their Monitoring and Forecasting Duty Officers, whose role it is to interpret their local forecasting flood models. Where forecasting models predict that Flood Warning thresholds will be reached, these are passed to the Flood Warning Duty Officers for action. Other forecast updates are given as appropriate through the flood event, or when requested.

4.2.2.1 Flood Alerts

The Environment Agency issues a flood alert when forecasts show that flooding may be possible from:

- rivers
- high tides, surges or strong winds at sea

The Environment Agency usually issues a flood alert between 2 and 12 hours before flooding. Flood alerts are usually issued during waking hours where possible.

There is currently one Flood Alert Area covering the Lilford Park study area, named 'River Glaze catchment including Leigh and East Wigan' (code: 013WAFGL). The extent of this Flood Alert Area is shown in Figure 4-1, and covers an area surrounding the brook's course and the western side of the park. It also encompasses the adjacent residential area, extending south to Greenways, as well as a number of streets south of the busway.

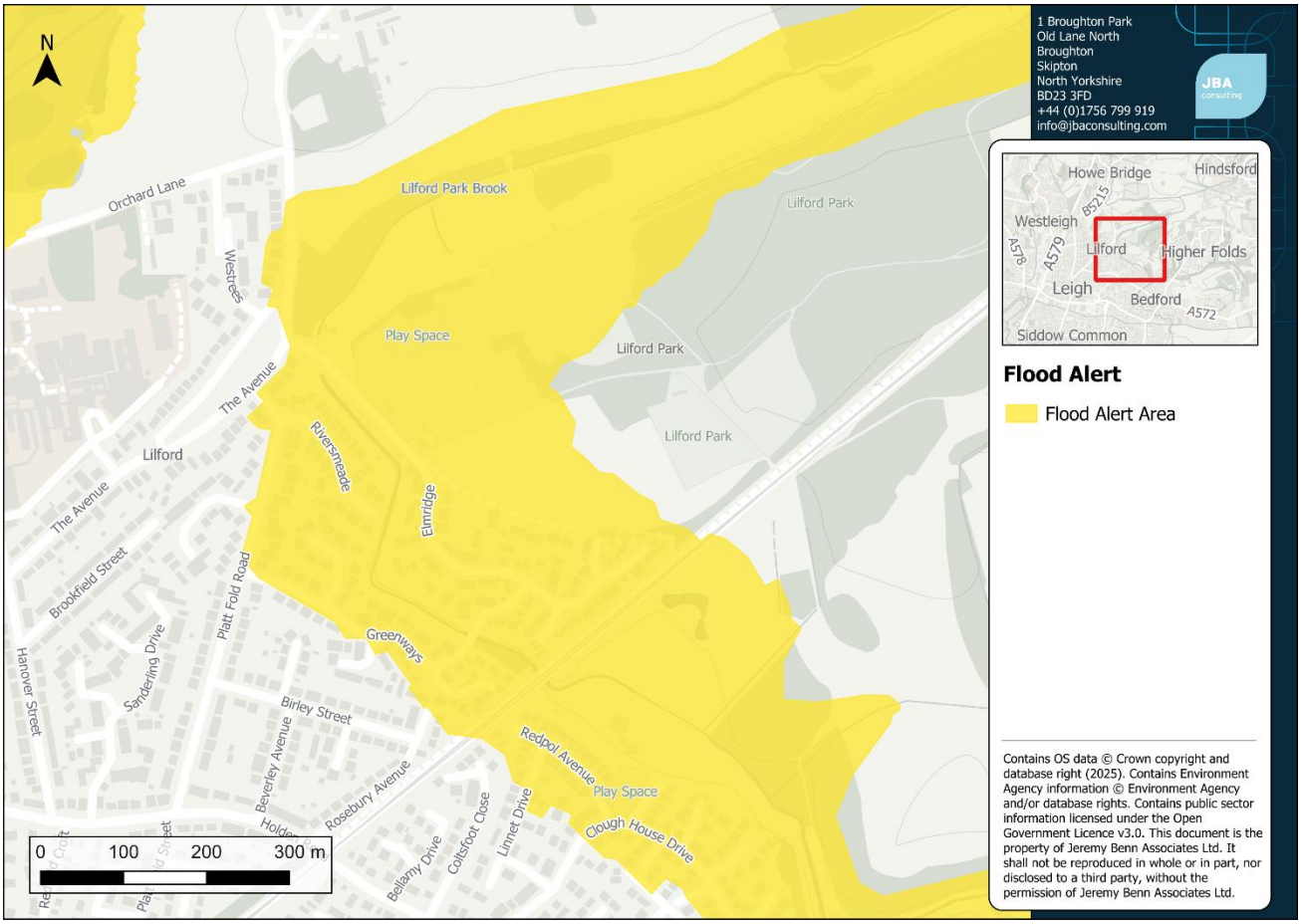


Figure 4-1: Extent of the Environment Agency's Flood Alert Area.

4.2.2.2 Flood Warnings

The Environment Agency issues a flood warning when forecasts show that flooding is expected from:

- rivers
- heavy rain that will cause rivers to flash flood
- high tides and surges coupled with strong winds at sea.

The Environment Agency usually issues a flood warning 30 minutes to 2 hours before flooding.

There is one Flood Warning Area covering the study area, named 'Lilford Park Brook at Lilford' (code: 013FWFGM28). The extent of this Flood Warning is shown in Figure 4-2, and covers an area surrounding the brook's course and the western side of the park. It also encompasses properties on and around The Avenue down to Peregrine Drive south of the busway. This includes properties on adjacent roads, including around Riversmeade, Elmridge, Platt Fold Road, Sevenoaks, Hathaway Court, Greenways, South Court, Linnet Drive, and Redpol Avenue.

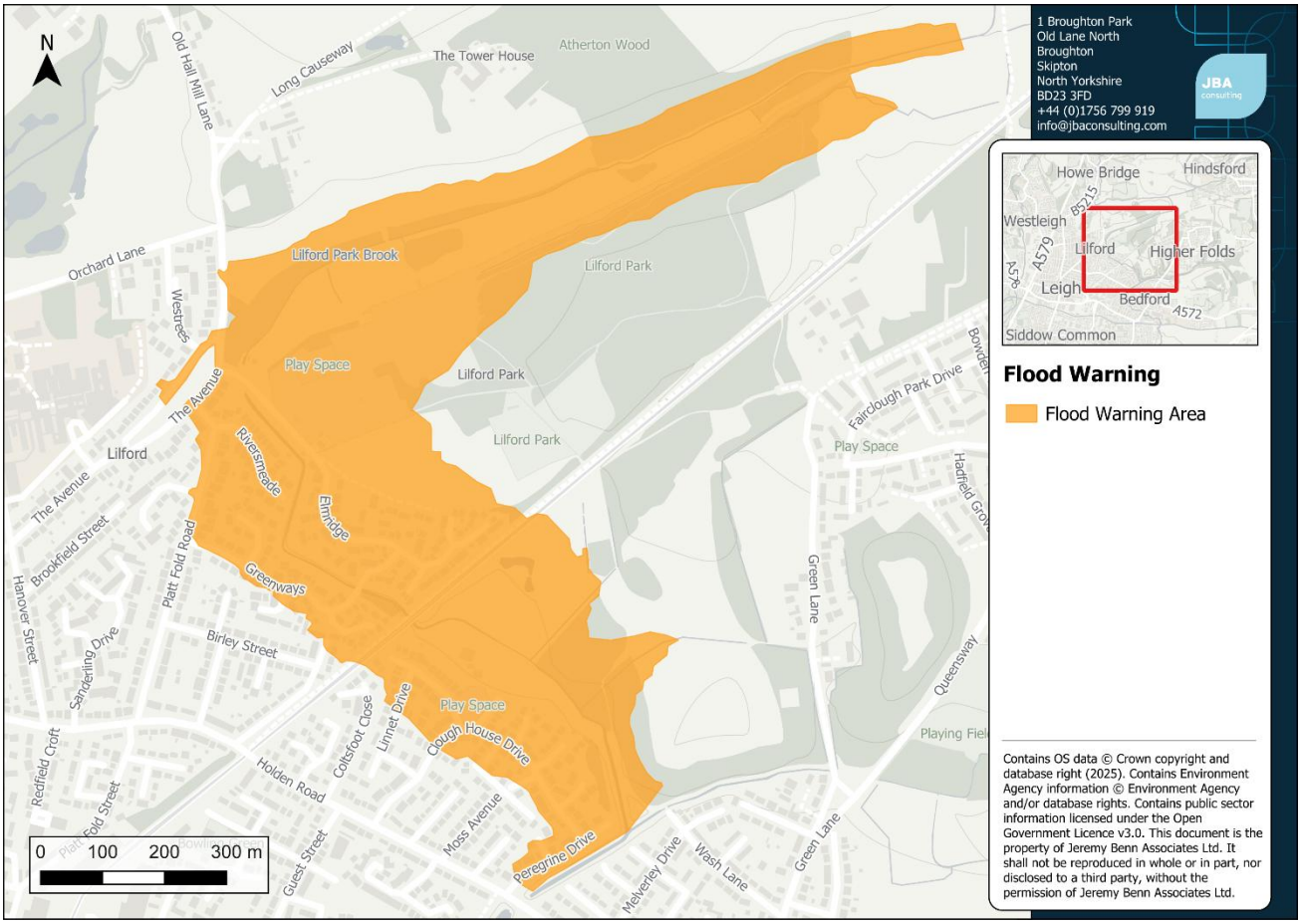


Figure 4-2: Extent of the Environment Agency's 'Lilford Park Brook at Lilford' Flood Warning Area.

5 Hydrological summary of the event

The following sections provide a summary of the 1 January 2025 event, including the conditions leading up to the event, the rainfall and corresponding fluvial response during the event, and an estimation of the rainfall and fluvial return periods. This section provides a short overview, and full details of the hydraulic analysis of the event can be found in Appendix B.

5.1 Hydrometric data

Figure 8-1 shows the study area and gauges used to analyse the event. These include:

- Four level gauges within a 3km radius of the study area;
- A rainfall gauge at Bedford; and
- A downstream flow gauge at Little Woolden Hall (just over 7km downstream).

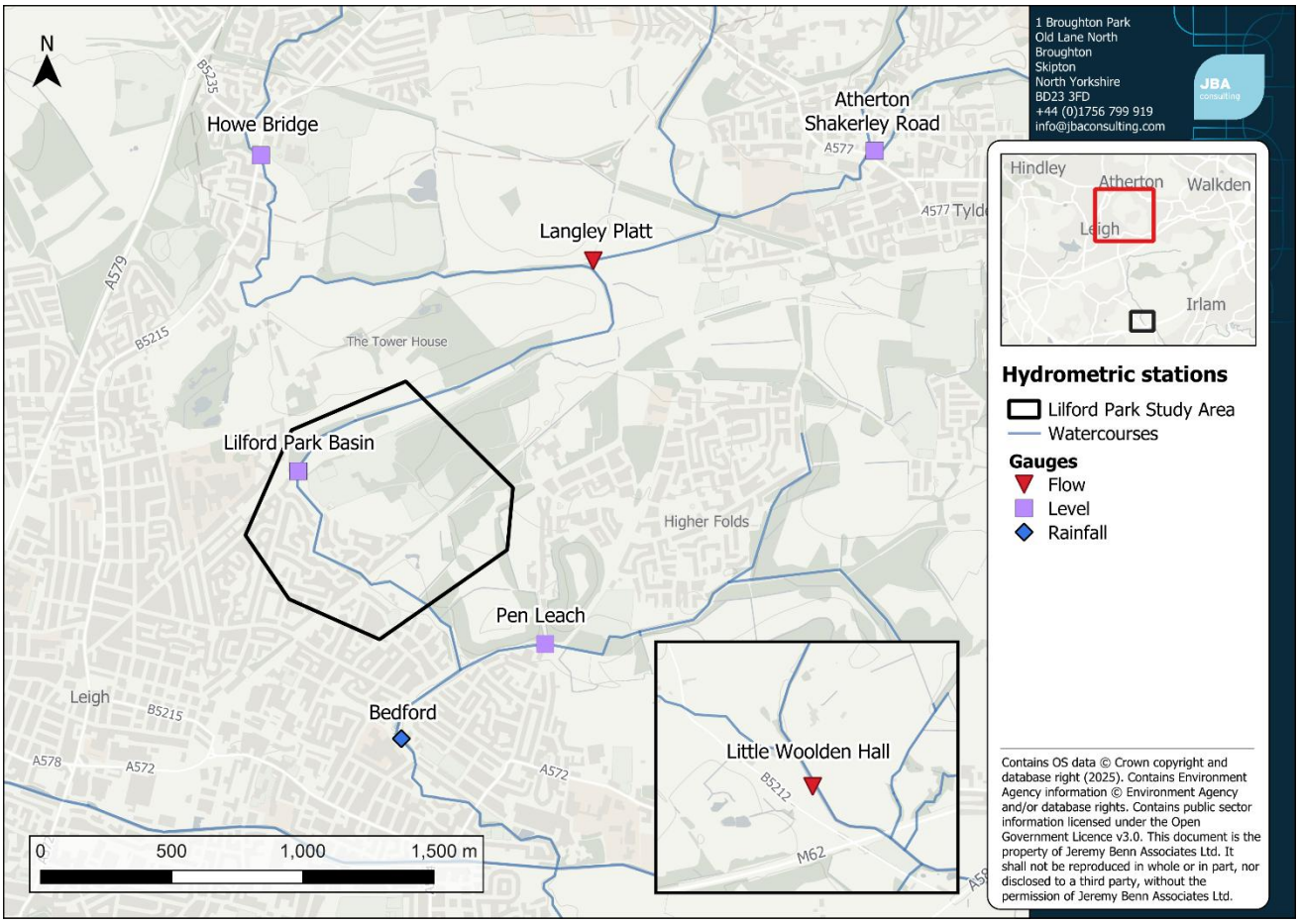


Figure 5-1: Hydrometric stations around Lilford Park.

5.2 Conditions leading up to the event

A high-level review from the 'UK Water Resources Portal' (UK Centre for Ecology and Hydrology) indicates the overall average monthly rainfall and resulting river flows in December 2024 were 'Notably High' in the month leading to the 1 January 2025 flood event, relative to conditions in the long-term record for that time of year.

Rainfall totals at the Bedford rain gauge show that the climatic antecedent conditions in the weeks and days leading up to the flood event were not particularly unusual. Omitting the flood event itself, the remaining summed December 2024 rainfall is not particularly notable at the Bedford rain gauge, falling slightly below the long-term December monthly average. Despite the heavy rainfall during 31 December to 1 January period, the December 2024 monthly rainfall was exceeded in 2023, 2015, 2012, 2011, and 1999 over the prior quarter-century.

Local stream levels in the days leading up to the event were not particularly unusual. The hydrometric data at the Langley Platt and Lilford Park basin show constant baseflow conditions from 24 December 2024, to the arrival of the rainstorm event on the evening of 31 December 2024. Levels in Lilford Park basin remained in the 0.2mALD - 0.3mALD range in this antecedent period. Likewise incoming flows slowly fell from 0.3m^3/s to 0.1m^3/s in the week leading up to the flood event.

5.3 Rainfall and fluvial response

Residents from Elmridge reported that flooding began sometime in the morning on 1 January 2025 between 07:30 and 09:30, with a few noting that water began entering their property from 10:00. Residents from Greenways, Woodend, and Eden Bank reported that flooding began between 07:00 and 8:30, with those on Hathaway Court providing times between 06:30 and 09:00.

Figure 5-2 shows the fluvial response at the Lilford Park Basin gauge, and additional nearby gauges, to the rainfall event. Whilst the gauges at Atherton Shakerley Road and Pen Leach are not included in more detailed analysis, the data are included in Figure 5-2 for information.

The peak rainfall occurred overnight from 31 December 2024 to the early hours of 1 January 2025, peaking in intensity between 00:00 to 04:00. The local gauging stations show a typical north-to-south flood response as the flood wave progressed through the catchment, following the flow direction of the local streams. River levels at the Lilford Park Basin gauge started to rise in the evening of 31 December with the peak level occurring at 08:30 on 1 January. The peak river level coincided with the reported flooding at many of the affected properties. The peak at the Atherton Shakerley Road and Howe Bridge gauges occurred slightly earlier (between 04:00 to 05:30) as these gauges are situated upstream. The location of Bedford pumping station downstream of the Pen Leach gauge will likely affect the level recorded, as shown in the unusual profile for Pen Leach on the hydrograph. This is likely a result of pumps switching on and off as designed throughout the flood event.

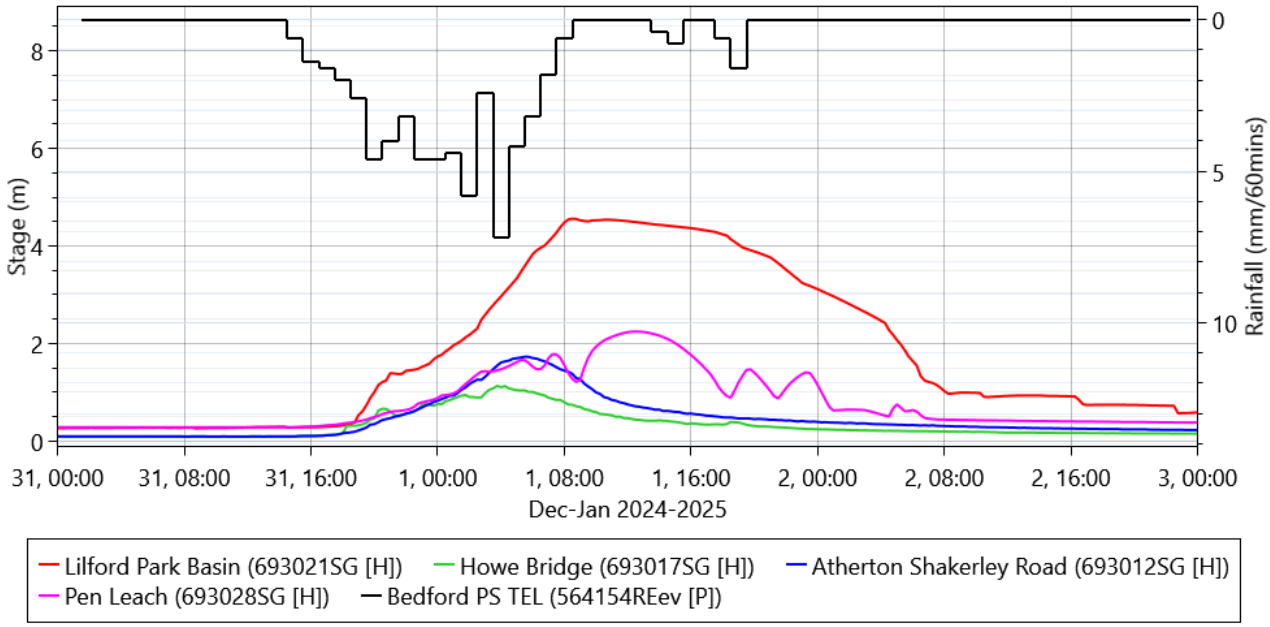


Figure 5-2: Fluvial response to the rainfall event.

5.4 Rainfall return period estimation

The industry-standard Flood Estimation Handbook (FEH) Depth-Duration-Frequency (DDF) 2022 model (FEH22 model) estimates the rarity of observed rainstorms. The FEH22 model was applied in a rolling-window manner to the observed rainstorm data, for various durations between 1 hour to 30 hours. The worst-case result was obtained for the 16-hour window as shown in Table 8-3. A rainfall annual probability of 2.8% is estimated.

Table 5-1: Rainfall event rarity analysis for the 1 January 2025 event.

Rain gauge	Maximum rolling-window summed rainfall (mm)	FEH22 model event annual probability (%)
Bedford	57.6mm	2.8%

5.5 Fluvial event probability estimation

The level only gauges at Lilford Park Basin and Howe Bridge provide an initial indication of the severity of the flood at Lilford Park, using a peak-over-threshold (POT) analysis. Flow records at the Langley Platt gauge are also assessed using a POT analysis. In the absence of a nearby flow gauge, analysis of data at the Little Woolden flow gauge, which is just over 7km downstream, provides an indicative magnitude of the event.

5.5.1 Lilford Park Basin

POT analysis indicates that the peak level recorded on 1 January 2025 is the largest peak in the record (from January 2004 to present, but with a six-year data gap from 2015 to 2021), with a calculated annual probability of 3.2%, with a level of 4.559 mALD.

5.5.2 Howe Bridge

POT analysis of the Howe Bridge gauge indicates the level on 1 January 2025 (1.13 mALD) was the second highest level recorded since the gauge was opened in November 2012, exceeded only by an event on 12 June 2023. The annual probability is estimated to be 11.9% for the 1 January event. A visual assessment indicates the presence of a gradual drift over time in the Howe Bridge telemetry. This event annual probability is likely over-estimated as a result, and carries lower confidence relative to other calculations at nearby gauges.

5.5.3 Langley Platt

POT analysis indicated that the event on 1 January (estimated peak flow of 8.7m^3/s) had the second highest recorded flow since the gauge was opened in January 2014, with an annual probability of 14.0%, exceeded only by the event on 26 December 2015. This annual probability is broadly in line with the annual probability calculated for the Howe Bridge gauge. There is low confidence in flood flow magnitude estimates at this gauge, but this does not affect the relative event comparisons within its own record, for the purposes of the event rarity assessment.

5.5.4 Little Woolden Hall

The Little Woolden Hall gauge is a well-established flow gauge, with good quality Annual Maximum (AMAX) peak flow data, lending itself well to this type of analysis. FEH analysis of the data at Little Woolden Hall draws the following conclusions:

- The 50% annual probability peak flow (QMED) is estimated at 32.7m^3/s, taken directly from the AMAX record.
- The estimated peak flow for the 1 January 2025 event is 52.3m^3/s. Note this is an unchecked value, extracted directly from the Environment Agency Hydrology Data Explorer. This is the second-highest value on records here, only just exceeded by a recent event in January 2021.
- The above QMED value combined with a standard FEH 'Enhanced Single Site' analysis (including the local good quality AMAX in the calculation) gives an annual probability of 3.9% for the 1 January 2025 event.

5.6 Summary

Antecedent conditions in the days and weeks prior to the event on 1 January 2025 were not unusual. The high volume and intensity of rainfall during the storm on 31 December 2024 and 1 January 2025 was therefore the main driver of the flooding observed in the Lilford Park area. Analysis of the river level gauge at Lilford Park Basin and the nearest rainfall gauge at Bedford shows that the data are broadly in agreement with annual exceedance probability values of around 3%. Analysis at the nearest flow gauge at Little Woolden Hall is also in agreement with these estimates, with an annual probability of 3.9% at this gauge, albeit being located significantly downstream of the flooded properties.

6 Source-pathway-receptor analysis

The Source-Pathway-Receptor model is a concept that can provide an understanding of all aspects of a flood hazard. It breaks down a flood incident into three key elements:

- **source:** the origin of flood water;
- **pathway:** a route or means through which a receptor can be affected by flooding; and
- **receptor:** the entities that can be adversely affected by flooding (e.g. people, property, infrastructure).

Available information was analysed to determine the main sources of flooding impacting the study area, the pathways it took, and the main receptors. These are summarised in Figure 6-1 and described in the following sections.

Photographs included in the following sections were taken during the site visit undertaken by JBA Consulting on 28 February 2025. Section 6.2 also includes two screenshots of drone footage available on YouTube, showing flood extents across the Lilford Park area.

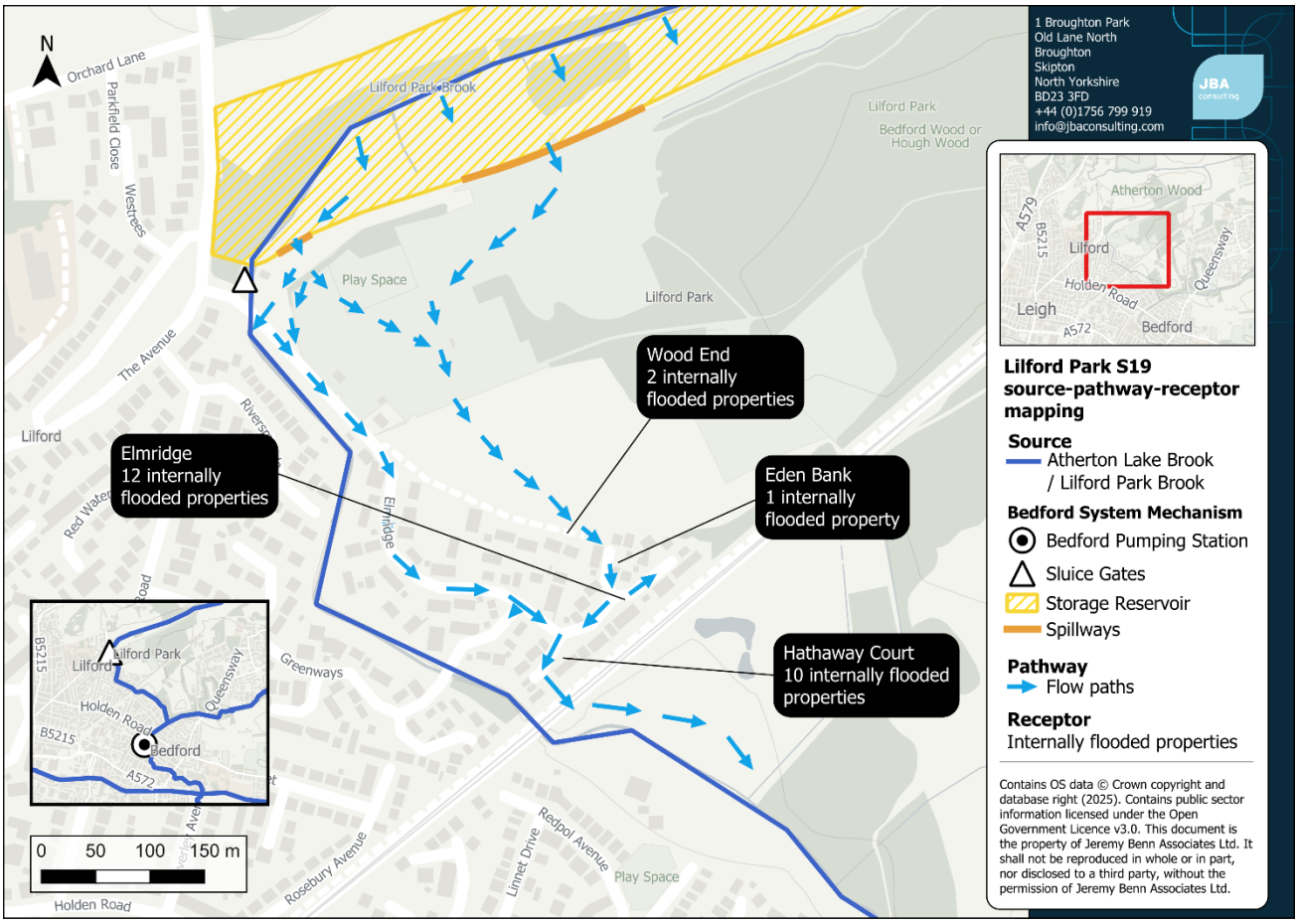


Figure 6-1: The sources, pathways, and receptors in the Lilford Park Area.

6.1 Source

6.1.1 Extreme rainfall

The peak rainfall occurred overnight from 31 December 2024 to the early hours of 1 January 2025, peaking in intensity between 00:00 to 04:00. As discussed in Section 5, antecedent conditions in the weeks prior to the event on 1 January 2025 were not unusual, which suggests that rainfall on 31 December 2024 and 1 January 2025 was the main driver of the flooding observed in the Lilford Park area.

6.1.2 Atherton Lake/Lilford Park Brook (Main River) and the Bedford system

The extreme rainfall resulted in corresponding high fluvial flows in the Atherton Lake/Lilford Park Brook. River levels at the Lilford Park Basin gauge started to rise in the evening of 31 December with the peak level occurring at 08:30 on 1 January. The peak river level coincided with the reported flooding at many of the affected properties.

Bedford pumping station pumps water automatically at a maximum rate of 9.4m^3/s (for more information see Section 3.3.1). However, during the event, the flows reaching Bedford pumping station exceeded its maximum pumping capacity of 9.4m^3/s. This meant that at 02:45 on 1 January 2025, the sluice gates went into operation at Atherton Lake flood storage reservoir and opened and closed to maintain a steady flow. Both sluice gates were fully closed from 10:30 to 17:30 on 1 January 2025.

The closing of the sluice gates led to water being stored in the reservoir. Photographs 1 and 2 compare the flood storage reservoir during and after the event, showing when it was actively holding floodwater and when it was empty. However, on 1 January 2025 there was too much rainfall for the system to manage, and the flood storage reservoir exceeded its design capacity. Water overflowed both of the spillways into the park and adjacent residential area, discussed further in the next section (Section 6.2). From 17:30 on 1 January 2025, the sluice gates started open again and continued to open and close according to their design parameters to release water from Atherton Lake flood storage reservoir. Both sluice gates were back in their pre-event open positions at 04:45 on 2 January 2025.

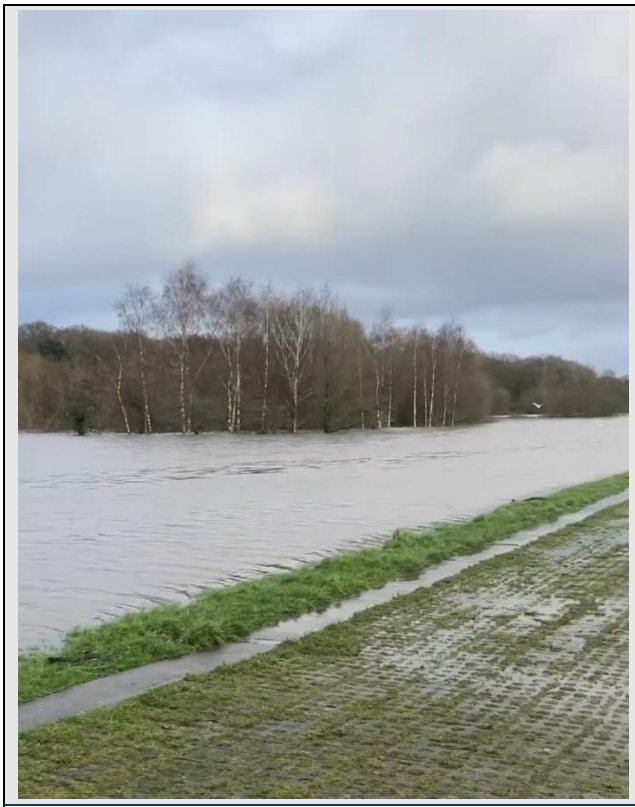


Photo 1: Atherton Lake flood storage reservoir, being used during the event (Source: Lilford Park residents).

Photo 2: Atherton Lake flood storage reservoir after the event, not being used (Source: JBA Consulting).

6.2 Pathway

Figure 6-1 shows the pathways of the floodwater during the event on 1 January 2025. The pathways are also seen in the drone footage in Figure 6-2.

Figure 6-2: Drone footage showing flood extents across the Lilford Park area (CP Overview, 2025)[1].

1 CP Overview (2025). *NEW YEAR FLOODS - 2025 - new years day - Leigh , Lancashire, drone footage.* [Video]. YouTube. https://www.youtube.com/watch?v=IXWS-j7I924 (last accessed 17/04/2025).

6.2.1 Overland fluvial flows

The flood storage reservoir exceeded its capacity and water overflowed both spillways. Floodwater from the secondary (eastern) spillway flowed south into the park, resulting in a pathway across the horse field and down to the residential area by Wood End and Eden Bank. The primary (western) concrete spillway also overflowed and added to the volume of water in the park (Photo 3).

Floodwater from the primary (western) concrete spillway also resulted in a flow path across the majority of Elmridge (Photo 4). The flood water travelled partially up Greenways but did not flood any properties internally. The eastern flow path that had travelled through the park internally flooded at least two properties on Wood End and at least one on Eden Bank. The flow path travelling onto Elmridge then joined with the other flow path (Photo 5). At least 12 properties on Elmridge internally flooded. The combined flow from the two flow paths then continued further south, onto Hathaway Court where at least 10 properties flooded internally. The water then flowed between the houses in the south of Hathaway Court and across the busway to an area of green space adjacent to the watercourse.

Photo 3: Floodwater in Lilford Park (Source: Lilford Park residents).

Photo 4: Floodwater on Elmridge, looking northwest with the park to the right side (Source: Lilford Park residents).

Photo 5: Floodwater on Elmridge and entrance to Eden Bank (Source: Lilford Park residents).

Photo 6: Floodwater on Hathaway Court (Source: Lilford Park residents).

6.3 Receptor

6.3.1 People

The event has caused significant disruption to the lives of the residents that were flooded, as well as impacting those living in the vicinity. According to the questionnaire sent to residents (discussed in Section 1.4), many have suffered economic losses and are facing ongoing financial pressures as a result. The flooding caused damage to properties and material goods, such as furniture and vehicles. Responses also shared concerns over the impact the flood event would have on their insurance premiums and property values. 35% of residents who responded to the questionnaire reported having to move out of their homes to temporary accommodation.

The flood event has had a detrimental effect on the overall wellbeing and mental health of those impacted. Responses included comments on the challenges of dealing with the event while facing existing health and mobility issues. Additionally, some residents discussed the added pressures of looking after elderly family members. The flooding caused considerable emotional distress for those who lost sentimental belongings and the home that once served as their safe space. For some, the event has led to a loss of pride in their home and a reluctance to invite guests. One response noted that seeing their property in disrepair serves as a constant reminder of the flood.

Residents wrote about the time and resources needed for the cleanup, redecorating and replacing items, as well as communicating with insurers and tradespeople. Some explained that they needed to take time off work due to stress. Overall, the experience has generated anxiety about the future, including over the possibility that their homes could flood again. Many residents commented on the fear that they now associate with rainfall.

6.3.2 Properties

The overtopping of the Atherton Lake/Lilford Park Brook resulted in internal and external property flooding on Elmridge, Eden Bank, Hathaway Court, and Wood End.

Internal flooding (including to ground floor living accommodation, attached garages, and inhabited cellars) was recorded to have affected at least 25 residential properties. This number only includes properties that have been verified through site visits by Community Information Officers (CIOs) at the Environment Agency, or through the questionnaire sent to residents (Section 1.4).

6.3.3 Park facilities

Questionnaire responses reported that the toilet block flooded and there was flood damage to the park's storage facilities and equipment, including a generator.

6.3.4 Road closures

The flooding event led to multiple road closures. In the Lilford Park study area, there were road closures on Elmridge and Greenways.

7 Incident response

7.1 Flood warnings

7.1.1 Met Office

The Met Office is the national meteorological service for the UK. The first indication of forecast flooding in Greater Manchester was at 10:30 on Monday 30 December 2024 when the Met Office Flood Guidance Statement indicated a Yellow (Low) flood risk for Greater Manchester on New Year's Eve and extended their existing Yellow warning of rain to include the Greater Manchester region. A post-flood report (greatermanchester-ca.gov.uk) from the Greater Manchester Combined Authority stated that the flood risk was never forecasted as Amber or Red (Medium or High) on the Met Office Flood Guidance Statement, so the Strategic and Borough Flood Plans were not triggered.

The Met Office Yellow warning of rain was further updated on the morning of Tuesday 31 December 2024, bringing forward the rain warning with a lead time of 4 hours. A Met Office Amber warning of rain was issued at 20:38 on Tuesday 31 December 2024, however this did not cover the Lilford Park area.

7.1.2 Environment Agency Flood Alerts and Flood Warnings

A Flood Alert was issued for the 'River Glaze catchment, including Leigh and East Wigan', at 06:03 on 1 January 2025. Later in the morning, at 07:43, a Flood Warning was issued for 'Lilford Park Brook at Lilford'.

7.2 Incident response

There was a Flood Advisory Service Teleconference at 21:30 on 31 December 2024 where the decision was made to escalate this to a Tactical Coordinating Group meeting. In response to flood warnings, the Greater Manchester Tactical Coordinating Group was activated at 01:00 on Wednesday 1 January 2025. Greater Manchester then declared a major incident at 06:45 and the Strategic Coordinating Group was activated. However, resource constraints meant that a Forward Incident Officer from Wigan Council was not deployed at Lilford Park.

All three Atherton South and Lilford ward Councillors have made multiple visits to individual properties and have been actively involved in a wide range of community engagement efforts. These include distributing newsletters and leaflets, providing verbal updates, liaising with the Council and other agencies, attending site visits and meetings. They spent over four hours on site during the event on New Year's Day.

Greater Manchester Fire and Rescue responded to reports of trapped individuals and unsafe dwellings. They evacuated residents from one property on Elmridge. At Lilford and in the wider area, residents were either carried to safety or transported using inflatable watercraft provided by Greater Manchester and Rescue's water incident unit stations, based at Eccles and Heywood. Appliances were also used to pump flood water out of properties and from the road network.

The Environment Agency has incident staff on duty 24/7 and rosters additional staff to cover shifts during holiday periods. The pumps at Bedford pumping station and Atherton Lake sluices were operating automatically, duty officers monitor these remotely.

The Environment Agency deployed a team of three, consisting of one experienced Greater Manchester, Merseyside & Cheshire (GMMC) Environment Agency Field Operations Site Controller, supported by two Environment Agency maintenance framework contractors. They were on site from 13:45 to 22:00 on New Year's Day. The Environment Agency teams on site were not required to make any manual adjustments to Atherton Lake flood storage reservoir sluice gates or Bedford pumps.

It is the role of the Field Operations Site Controller to brief their on-site team. The Team's task was to communicate with the local community and work with other Authorities on site. They spoke to many residents at Lilford Park and Elmridge Road. They liaised on-site with Wigan Council Highways to support the Elmridge road closure. They carried out flood asset checks and confirmed everything was working as it should.

Other daytime and evening visits to Atherton Lake flood storage reservoir were by Environment Agency GMMC Leigh-based Field Operatives. They ensured the skip adjacent to the automated weedscreen cleaner continued to have capacity for debris and checked the footpath gates continued to be closed alongside the reservoir embankment.

7.2.1 Questionnaire responses

Residents from Elmridge reported that flooding began sometime in the morning between 07:30 and 09:30, with a few noting that water entered their property from 10:00. Residents

from Greenways, Woodend, and Eden Bank reported that flooding began between 07:00 and 8:30, with those on Hathaway Court providing times between 06:30 and 09:00.

Respondents to the questionnaire who flooded internally were asked if they received a response from emergency services, the Council, the Environment Agency or any other authority during, or after the event. The questionnaire responses confirmed that the Greater Manchester Fire and Rescue service were present. Many households said that they did not get help during the event but did receive support afterwards. However, they did not expand on what this post-event support was. A number of households shared that a local councillor had visited them during a door-knocking round.

All of the respondents to the questionnaire who flooded internally answered that they did not have any PFR measures in place.

7.3 Subsequent actions

Greater Manchester Fire and Rescue Service reported that they held tactical debriefs at the scene. Their crews attended affected properties in the area to carry out Home Fire Safety assessments, with focus on correct and safe use of heaters/dehumidifiers and checking for vulnerable residents. Local commanders attended Technical Coordinating Groups to assist with collaborating information, such as the number of dwellings, the number of persons, and the correct addresses etc. Their Organisational Learning and Operational Assurance Team are gathering information from crews that attended flooding across the whole of Greater Manchester in order to gather learning points and areas of notable practice that can be shared across the service to improve future response to incidents.

Wigan Council provided skips for flooded properties along Hathaway Court, Eden Bank, Elmridge, and Woodend. Several skip companies and local businesses also volunteered their assistance.

Following the event, the Environment Agency conducted research to verify the impact of the flood event and the number of flooded properties. They also reviewed how their assets operated and completed post flood inspection surveys.

8 Conclusions, lessons learnt, and recommendations

8.1 Conclusions and lessons learnt

The flooding that occurred in Lilford Park on 1 January 2025 is reported to have caused internal flooding to at least 25 residential properties. Wigan Council, as the LLFA for Lilford Park, has exercised their duty to undertake a Section 19 flood investigation, as the event fulfils the criteria set by Wigan Council. The Council has appointed JBA Consulting to undertake this investigation on its behalf.

The flood risk in the Lilford Park area is the result of the area having subsided by 10 metres due to coal mining. The Environment Agency manages this risk using Bedford pumping station and the Atherton Lake flood storage reservoir. The high volume and intensity of rainfall during the storm on 31 December 2024 and 1 January 2025 was the main driver of the flooding observed in the Lilford Park area, with annual exceedance probability values of around 3%. The rainfall led to high fluvial flows in the Atherton Lake/Lilford Park Brook. Flows at Bedford pumping station exceeded its 9.4m^3/s capacity, triggering the sluice gates to automatically close and store water in the Atherton Lake flood storage reservoir. However, the flood storage reservoir exceeded its design capacity.

Floodwater from the primary (western) concrete spillway resulted in a flow path across the majority of Elmridge. Floodwater from the secondary (eastern) spillway flowed south into the park, resulting in a pathway across the horse field and down to Wood End and Eden Bank. The two flow paths joined on Elmridge, continuing south to Hathaway Court and beyond across the busway.

A Flood Alert for the area was issued at 06:03 on 1 January 2025, and a Flood Warning was issued at 07:43. Greater Manchester declared a major incident at 06:45 and the Strategic Coordinating Group was activated. However, resource constraints meant that a Forward Incident Officer from Wigan Council was not deployed at Lilford Park. Greater Manchester Fire and Rescue responded to the event and evacuated residents on Elmridge. The Environment Agency monitored the flood storage reservoir and Bedford pumping station remotely and reported no issues with the operation of the assets. A team of three were also deployed on site from 13:45 to 22:00 on New Year’s Day. All three Atherton South and Lilford ward Councillors have been actively involved in a wide range of community engagement efforts and were present on the day of the event. A number of households shared that they had been visited by a local councillor during a door-knocking round. Many residents shared that they did not get help during the event, but did receive support afterwards.

The flooding led to road closures on Elmridge and Greenways and damaged the park's storage facilities and equipment. The event has caused significant disruption to the lives of the residents that were flooded, as well as impacting those living in the vicinity. Economic losses have been incurred, several residents reported having to move out of their homes,

and the flood event has had a detrimental effect on the overall wellbeing and mental health of those impacted.

8.2 Recommendations

Based on the identified causes and mechanisms of flooding, potential actions to mitigate flood risk and/or damages have been considered, together with the responsible stakeholders. These are recommendations for consideration, and their deliverability will be subject to funding and other limitations.

The Environment Agency should review the operation of the Bedford Pumping Station and Atherton Lake flood storage reservoir (Lilford Park) and identify and apply any lessons from the New Year's Day Floods.

Timescale: by Winter 2025

The flood risk in the Lilford Park area is the result of the area having subsided by 10 metres due to coal mining. The Environment Agency manages this risk using Bedford pumping station and the Atherton Lake flood storage reservoir. The finite capacity of the pumping station and basin mean that with anticipated climate change impacts, flooding from overflows may become more likely. The Environment Agency should therefore review the operation of the system, see what lessons can be learnt that can be immediately implemented, and develop long-term plans to improve the resilience of the system.

The Environment Agency should use the new hydraulic model currently being developed to review the standard of protection offered by the system now and how that will change in the future.

Timescale: By end of Summer 2026

The Environment Agency should use the hydraulic model that they are currently building to determine the current standard of protection provided by their assets forming the Bedford System: Bedford pumping station and Atherton Lake flood storage reservoir (including sluice gates and automatic screen cleaner). They should also consider how that standard will change due to climate change.

The Environment Agency should develop a long-term Leigh East Asset Management and Investment Plan for the Bedford Brook Catchment to ensure the catchment and system are resilient to climate change.

Timescale: By end of 2028

This hydraulic model (discussed in the previous recommendation) should be used as the basis to develop a long-term Leigh East Asset Management and Investment Plan, aiming to develop a long-term strategic and sustainable approach to managing flood risk from all sources within the catchment and improving the environment. This plan should evaluate options to manage flood now and in the face of climate change and asset deterioration. It should include proposals for maintaining and optimising existing assets and the provision of new assets, for example more upstream storage or measures to slow the flow higher up in the catchment.

The Environment Agency should implement projects recommended by the Leigh East Asset Management and Investment Plan for the Bedford Brook Catchment.

Timescale: Any quick win improvements to be implemented as soon as possible. Longer term plans begin after the Investment Plan is completed in 2028.

Recommendations from the review, such as improvements to the assets and other flood risk management measures, like additional storage, should, where economically viable, be delivered to increase the long-term protection against flooding in the Lilford Park area.

Wigan Council should undertake a feasibility study to explore potential actions for alleviating residual flood risk.

Timescale: by Summer 2026

Wigan Council should undertake a feasibility study which explores actions to alleviate residual flood risk in the area. This should be carried out in consultation with the Environment Agency. These actions include the use of raised defences and flood risk management infrastructure, the incorporation of Natural Flood Management (NFM) features in Council owned land, and PFR measures for individual properties where a residual risk remains. It should also include highway improvements (see the next recommendation), to divert floodwater away from properties.

Wigan Council should review and implement any necessary highway alterations along Elmridge to divert floodwater.

Timescale: by Spring 2026

During the January 2025 event, water that overflowed from the primary (western) concrete spillway of the flood storage reservoir travelled south down Elmridge. Wigan Council should review and implement any necessary highway alterations along Elmridge to divert the floodwater away from properties.

However, any actions intending to divert floodwater to the watercourse, such as installing another speed table on Elmridge, need to be reviewed with the Environment Agency first. This is necessary to ensure that this would not result in flows exceeding 9.4m^3/s reaching Bedford pumping station. This important because if water is diverted back into the channel,

it would be bypassing the sluice gates. This is signalling to Bedford pumping station that more water is entering the brook than it can manage (9.4m^3/s). Due to this, the pumping station is telling the sluice gates to remain closed and thus store more water in the basin, which is then overtopping for longer.

Wigan Council (Highways and LLFA) should alleviate the reported issues of drain blockages in Lilford Park and highway drains on Elmridge.

Timescale: by end of 2025

Questionnaire responses noted blocked drains both within the park and along Elmridge. Wigan Council should alleviate the reported issues of drain blockages in these locations.

Wigan Council should carry out inspections along the lanes in Lilford Park and review its gully cleaning programme, with particular attention to reassessing the priority gullies and updating them as necessary.

The local Flood Action Group, supported by the National Flood Forum, Wigan Council (Resilience Team and the LLFA), the Environment Agency, and United Utilities, should create a community Flood Action Plan to formalise any existing emergency response plans.

Timescale: by end of 2025

Residents in the Lilford Park area are already active in taking steps to improve their preparedness and resilience to flooding. Formalising a Flood Action Plan will allow all residents to take ownership of their flood risk, increase awareness, and improve community preparedness. The Flood Action Plan could also include information for use by the Emergency Services with details of the most vulnerable residents in the area.

Residents in the Lilford Park area should sign up to the Environment Agency's free flood warnings/alerts service, make a personal action plan, and consider implementing PFR measures.

All of the respondents to the questionnaire who flooded internally on 1 January 2025 answered that they did not have any PFR measures in place. Residents should be prepared for scenarios where the flood storage reservoir exceeds its capacity and consider implementing PFR measures, such as installing flood barriers.

It is also good practice for local residents to find out about any flood risk in the area, sign up for the Environment Agency's free flood warnings/alerts where available and make a written plan of how they will respond to a flood situation. Business owners should also make a flood plan for their business. There are measures that can be taken to reduce the amount of damage caused by flooding and properties at risk should be insured. Local residents can find out if their property is at risk, prepare for flooding, get help during a flood and get help

after a flood. Additional information and resources are available on The Flood Hub (thefloodhub.co.uk) website.

Wigan Council should review their flood risk asset register to identify assets critical to flood management.

Timescale: ongoing

In line with Section 21 of the Flood and Water Management Act, Wigan Council should review and update their records of all flood risk assets in the Lilford Park area. Having an awareness of those that are particularly significant to managing flood risk in the area will help target maintenance and inspections of assets, so they are fully operational during flood events.

A Appendix: Frequently Asked Questions

The Environment Agency and Wigan Council have provided the following list of Frequently Asked Questions relating to the operation of their flood risk management infrastructure in Lilford Park.

Question 1: Why was the excess water not re-directed into the brook?

There was more water than the whole system could cope with on 1 January 2025. Bedford pumping station downstream of Lilford Park was pumping at maximum capacity (9.4m^3/s). The brook and the flood storage reservoir were full and could not hold any more water. Therefore, excess water from the flood storage reservoir exceeding its design capacity could not be re-directed into the brook.

Question 2: Why was the temporary barrier not installed?

The temporary barrier procedure was adopted as a resilience measure in direct response to the issues which occurred in the 2015 Boxing Day flood event; specifically for situations involving the failure of the sluice gates to operate as designed. The temporary barrier can only be installed during normal flow conditions, when there is capacity in the brook downstream for additional water to be diverted into it. If water is diverted back into the channel, it would be bypassing the sluice gates. This is signalling to Bedford pumping station that more water is entering the brook than it can manage (9.4m3/s). Due to this, the pumping station is telling the sluice gates to remain closed and thus store more water in the basin, which is then overtopping for longer.

All the Environment Agency assets worked as designed during the 1 January 2025 event, meaning that barrier deployment was not required as part of their procedures. The barriers are not used for diverting flows in exceedance events, such as the 1 January 2025 event, where the flood storage reservoir exceeded its design capacity.

Question 3: Were all the pumps fully operational at Bedford pumping station on 1 January 2025?

Bedford pumping station has seven pumps with a total nominal pumping capacity of 9.4m^3/s, and all seven pumps were fully operational on 1 January 2025. Should there be an issue with a pump, the Environment Agency has spare medium and large storm pump units ready to install. The Environment Agency's contractors are available 24/7 to provide mechanical and electrical assistance, and pump replacement where necessary.

Question 4: If all assets were working properly, why did flooding still occur?

Flooding occurred because there was more water in the system than the pumping station was designed to pump, and the Atherton Lake flood storage reservoir was designed to hold. The flood storage reservoir filled up and then exceeded its design capacity and overtopped.

This does not mean the system is not fit for purpose. The system works as designed and pumps water 24/7. While the risk of flooding is reduced by the pumps and flood storage reservoir, the risk can never be entirely removed. Many improvements have been made to the assets within the Bedford system since 2015. The Environment Agency have assessed the likelihood of asset failure, design exceedance and other scenarios, and developed contingency plans.

Question 5: Is the park used as part of the floodplain?

The floodplain covers the park and surrounding area, including the land enclosed by the Atherton Lake flood storage reservoir. When the flood storage reservoir is in use, containing the water from the Atherton Lake Brook, there are other smaller watercourses and springs outside of the reservoir which may result in water flowing through the park and the surrounding land, across the floodplain. When the flood storage reservoir exceeds its design capacity, the excess water overflows onto the wider floodplain where there are currently no formal measures in place to contain it.

Question 6: Why were the spillways built?

The spillways are a requirement under the Reservoirs Act 1975 for a Category A reservoir. This is to ensure that the reservoir can safely pass any flows that exceed its design capacity, without causing a potentially catastrophic failure, or breach of the embankment and other associated reservoir infrastructure. As such, spillways are designed to operate when exceedance of the design capacity of the system occurs. The flood warning system is the current contingency measure in place for such occurrences.

Question 7: How is the brook maintained? Will the Environment Agency dredge the brook to provide some level of protection for properties?

The Environment Agency uses its permissive powers to maintain watercourses. Every year they maintain Lilford Park Brook by completing a full walk-through, from Elmridge to the confluence of Penleach Brook. They remove any debris that could cause blockage and lead to increased flood risk. Dredging or desilting of a watercourse requires a lot of careful considerations, such as the benefits to flood risk, the impacts on bank stability and ecology. Therefore, the Environment Agency cannot guarantee the brook will be dredged in this location.

The Environment Agency assess each situation individually to understand the effectiveness, sustainability, environmental impact and value for money that dredging and desilting will provide. Where they conclude that dredging and desilting is economically viable, will not harm the environment and will reduce flood risk, this will be considered as part of the Environment Agency's annual maintenance programme.

Question 8: What data does the Environment Agency rely on to check the river levels at Lilford Park Monitoring Station?

There is a water level gauge within the Atherton Lake flood storage reservoir which sends real-time information to the Environment Agency.

Question 9: What measures can the local authority put in place to ensure road access is properly managed during flood events?

The Council have provided sandbags and road closure signs to be stored in the container. We would advise the Flood Action Group to prepare a Flood Plan which sets out who from the group is responsible for installing the signs and the agreed locations.

Question 10: To what extent does the Council have an overview of the safe operation of the catchment basin?

The Council have no jurisdiction over the operation and maintenance of the Lilford Basin.

Question 11: What powers and resources will the Community Flood Action Group have? How will residents be involved in decision-making, and will there be regular progress updates?

A flood action group is a voluntary group of local residents, who meet on a regular basis, to work on behalf of the wider community to help to try and reduce the impact of future flood events. The group can focus on emergency planning, flood resilience, warning and informing and can also tackle local issues, whilst providing a unified voice for the community to communicate ideas and queries to others. The group has the ability to request officers from other risk management authorities to attend meetings to discuss on going works and plans. The frequency of these meetings is decided by the group.

Question 12: Past flood mitigation measures included the installation of overflow pipes from the road gullies on Elmridge to Lilford Park Brook. Where are these?

The gullies surrounding the speed table discharge directly into the Brook. The gullies serving the estate connect into the sewer network.

Question 13: What short-term measures have been put in place since New Year's Day?

Since New Year's Day the Council has worked with local Councillors to purchase and deliver a container, with sandbag provision. We have reached out to all residents to advise on financial assistance available to them, as well as providing updates through the new resident newsletters.

Question 14: What is the timeline for reviewing and upgrading flood defences?

The Council will work closely with the Environment Agency to discuss the review of flood defences in this area.

Question 15: Will the Council commit to a formal action plan with clear deadlines, responsible parties, and funding details?

The Flood Action Group can bring forward an action plan and the Council will support and engage other authorities to add to the discussion.

Question 16: Should landowners of the fields that flooded not ensure they have an irrigation and drainage system in place to help prevent flooding? When were the ditches on Wood End last cleared to ensure they can hold any potential flood water?

The Council met with the land agent to discuss works needed and open the dialogue. We believe the ditchline has been reinstated by an unknown party. We would encourage land owners to contact us prior to works going forward.

B Appendix: Hydrological summary of the event

B.1 Hydrometric data

Figure 8-1 shows the study area and gauges used to analyse the event. These include:

- Four level gauges within a 3km radius of the study area;
- A rainfall gauge at Bedford; and
- A downstream flow gauge at Little Woolden Hall (just over 7km downstream).

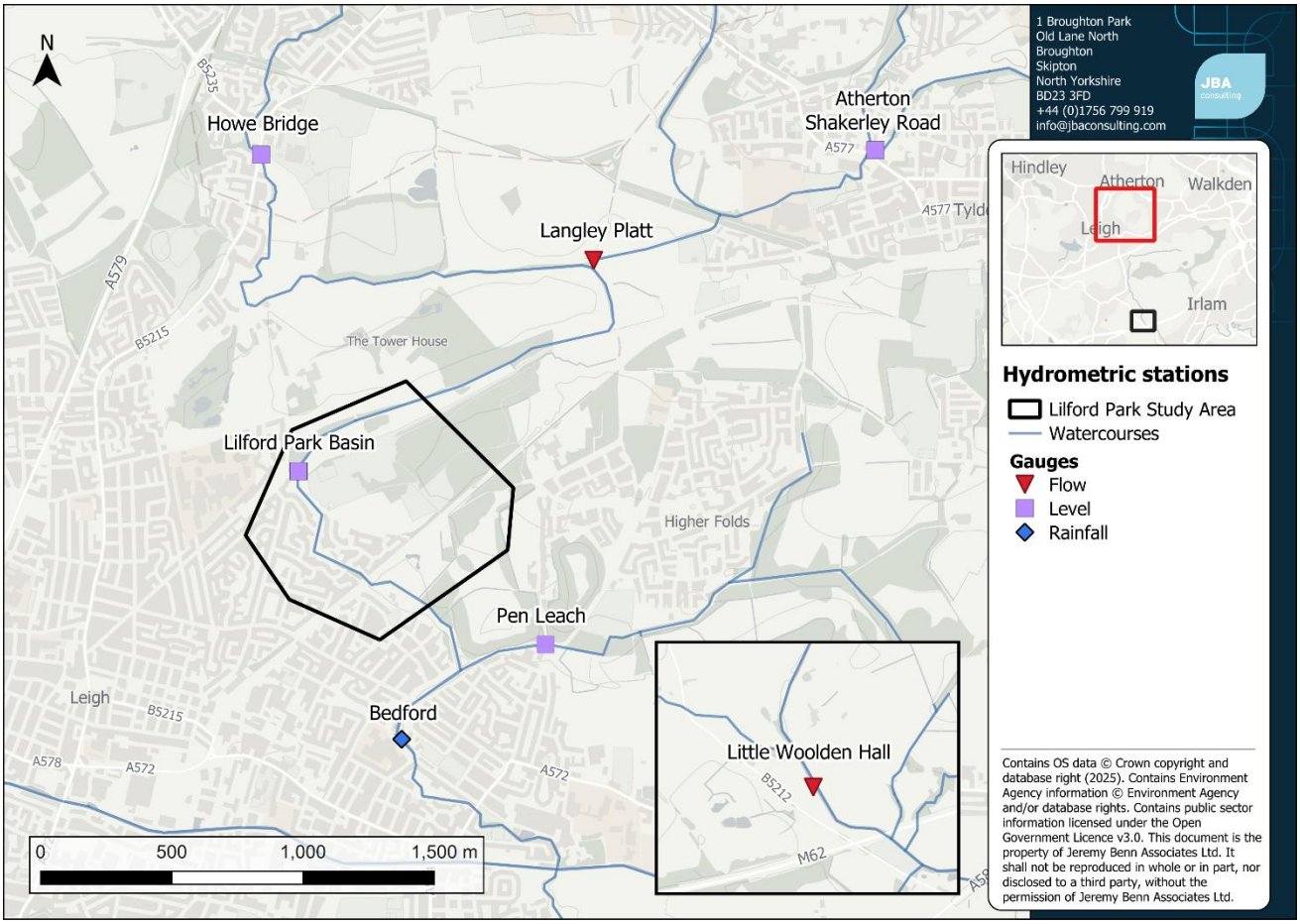


Figure 8-1: Hydrometric stations around Lilford Park.

The data available at each gauge is summarised in Table 8-1. Two gauges not used for this analysis are shown in Table 8-2.

Table 8-1: Hydrometric data available for Lilford Park.

Gauge name	Type	Period of record	Further notes
Lilford Park Basin	Level (15-minute data)	January 2004 to May 2025	Gap in record from 2015 to 2020
Howe Bridge	Level	November 2012 to May 2025	
Little Woolden Hall	Flow	October 1996 to	Gauge significantly

Gauge name	Type	Period of record	Further notes
		March 2025	downstream of Lilford Park but results provide an indication of the magnitude of flow during the event. Listed on National River Flow Archive as a gauge suitable for pooling.
Langley Platt	Flow	January 2014 to February 2025	Small gap in record from end of 2016 to early 2017 (approx. 7 months). Gauge is not listed on National River Flow Archive and therefore is not used for FEH analysis. Treated as level gauge and included in peak over threshold analysis.
Bedford	Rainfall (daily and sub daily)	Daily - November 1990 to January 2025 Sub daily - November 1990 to May 2025	

Figure 8-2: Gauges not used for this analysis.

Gauge name	Type	Period of record	Further notes
Atherton Shakerley Road	Level	April 2022 to May 2025	Period of record not long enough for return period analysis
Pen Leach	Level	June 2003 to May 2025	Record shows evidence of drift in levels.

B.2 Conditions leading up to the event

A high-level review from the 'UK Water Resources Portal' (UK Centre for Ecology and Hydrology) in Figure 8-3: indicates the overall average monthly rainfall and resulting river flows in December 2024 were 'Notably High' in the month leading to the 1 January 2025 flood event, relative to conditions in the long-term record for that time of year.

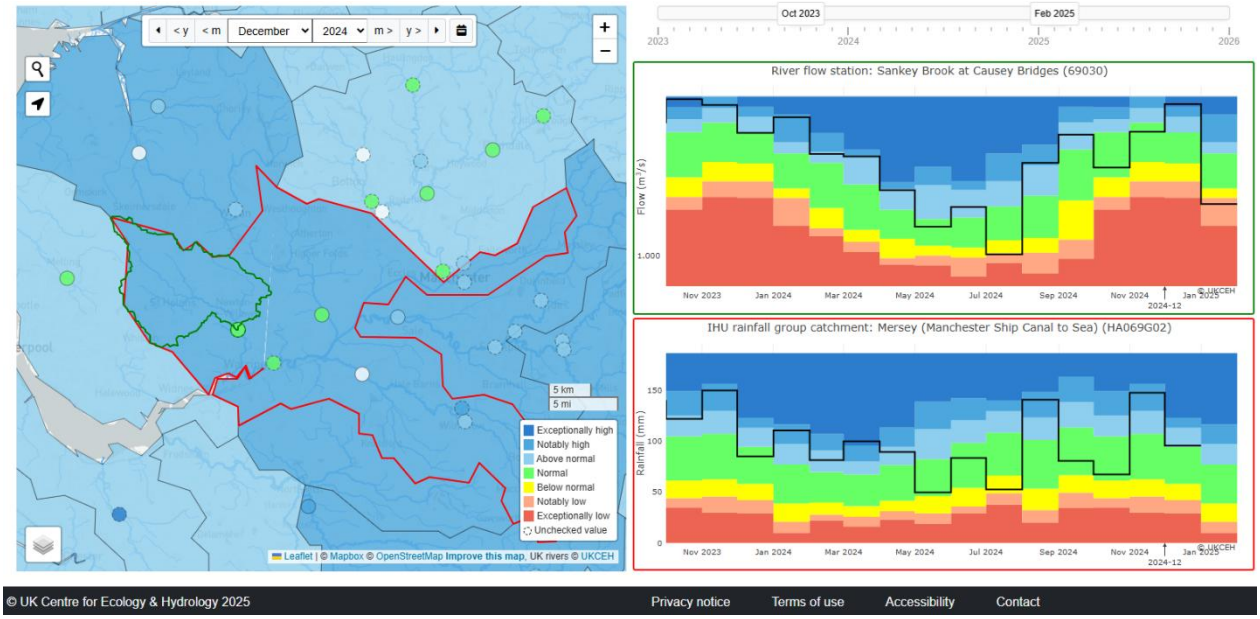


Figure 8-3: Screenshot from the UK Centre for Ecology and Hydrology Water Resources Portal (© UK Centre for Ecology and Hydrology 2025).

Figure 8-4: shows daily rainfall (09:00 to 09:00 the following day) at the Bedford gauge during December 2024. The final bar highlighted in red includes the rainfall driving the observed flooding on 1 January 2025. These data indicate the rainfall between 31 December 2024 to 1 January 2025 makes up a dominant fraction (just under 40%) of the December 2024 monthly rainfall sum.

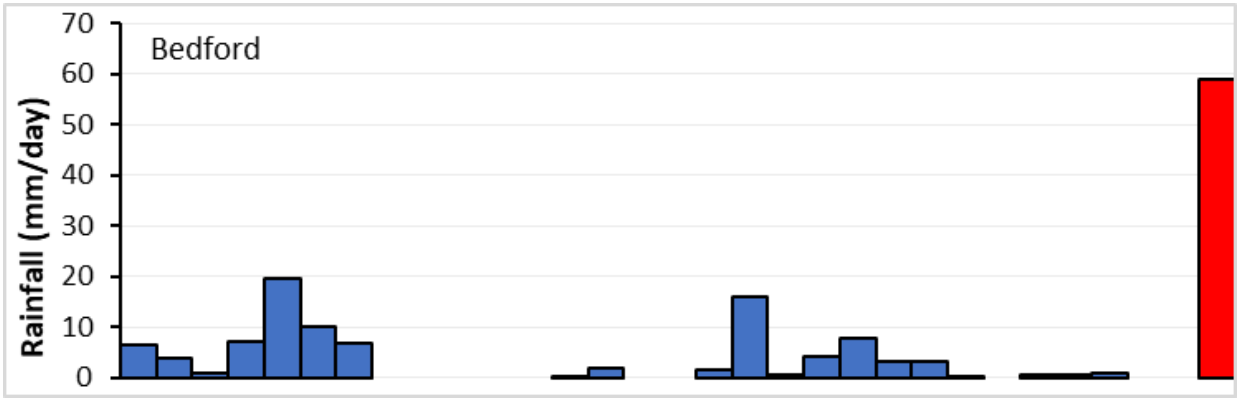


Figure 8-4: Antecedent rainfall at Bedford during December 2024.

The climatic antecedent conditions in the weeks and days leading up to the flood event were not particularly unusual. Omitting the flood event itself, the remaining summed December 2024 rainfall is not particularly notable at the Bedford rain gauge (Table 8-2), falling slightly below the long-term December monthly average. Despite the heavy rainfall

during 31 December to 1 January period, the December 2024 monthly rainfall was exceeded in 2023, 2015, 2012, 2011, and 1999 over the prior quarter-century.

Table 8-2: Antecedent period rainfall review for December 2024.

Rain gauge	5-day summed rain prior to event (09:00 26 Dec to 09:00 31 Dec)	Daily rainfall (09:00 31 Dec to 09:00 1 Jan)	December 2024 rain as a % of long-term monthly average
Bedford	2.0mm	58.8mm	155% including event 95% excluding event

Local stream levels in the days leading up to the event were not particularly unusual. The hydrometric data at the Langley Platt and Lilford Park basin show constant baseflow conditions from 24 December 2024, to the arrival of the rainstorm event on the evening of 31 December 2024. Levels in Lilford Park basin remained in the 0.2mALD - 0.3mALD range in this antecedent period. Likewise incoming flows slowly fell from 0.3m3/s to 0.1m3/s in the week leading up to the flood event.

B.3 Rainfall and fluvial response

Residents from Elmridge reported that flooding began sometime in the morning on 1 January 2025 between 07:30 and 09:30, with a few noting that water began entering their property from 10:00. Residents from Greenways, Woodend, and Eden Bank reported that flooding began between 07:00 and 8:30, with those on Hathaway Court providing times between 06:30 and 09:00.

Figure 8-5 shows the fluvial response at the Lilford Park Basin gauge, and additional nearby gauges, to the rainfall event. Whilst the gauges at Atherton Shakerley Road and Pen Leach are not included in more detailed analysis, the data are included in Figure 8-5: for information.

The peak rainfall occurred overnight from 31 December 2024 to the early hours of 1 January 2025, peaking in intensity between 00:00 to 04:00. The local gauging stations show a typical north-to-south flood response as the flood wave progressed through the catchment, following the flow direction of the local streams. River levels at the Lilford Park Basin gauge started to rise in the evening of 31 December with the peak level occurring at 08:30 on 1 January. The peak river level coincided with the reported flooding at many of the affected properties. The peak at the Atherton Shakerley Road and Howe Bridge gauges occurred slightly earlier (between 04:00 to 05:30) as these gauges are situated upstream. The location of Bedford pumping station downstream of the Pen Leach gauge will likely affect the level recorded, as shown in the unusual profile for Pen Leach on the hydrograph. This is likely a result of pumps switching on and off as designed throughout the flood event.

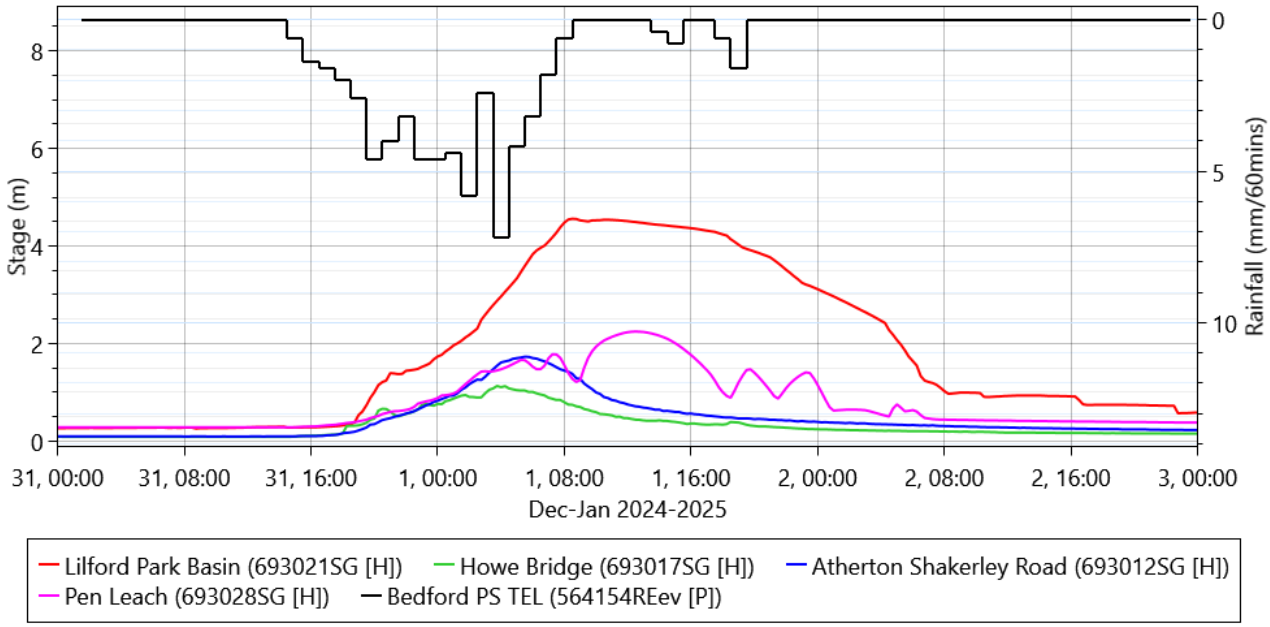


Figure 8-5: Fluvial response to the rainfall event.

B.4 Rainfall return period estimation

The industry-standard Flood Estimation Handbook (FEH) Depth-Duration-Frequency (DDF) 2022 model (FEH22 model) estimates the rarity of observed rainstorms. The FEH22 model was applied in a rolling-window manner to the observed rainstorm data, for various durations between 1 hour to 30 hours. The worst-case result was obtained for the 16-hour window as shown in Table 8-3. A rainfall annual probability of 2.8% is estimated.

Table 8-3: Rainfall event rarity analysis for the 1 January 2025 event.

Rain gauge	Maximum rolling-window summed rainfall (mm)	FEH22 model event annual probability (%)
Bedford	57.6mm	2.8%

B.5 Fluvial event probability estimation

The level only gauges at Lilford Park Basin and Howe Bridge provide an initial indication of the severity of the flood at Lilford Park, using a peak-over-threshold (POT) analysis. The Gringorten formula is used at both gauges to assess the annual exceedance probability for the 1 January event. There are no nearby flow gauges with sufficiently high quality data so standard FEH methods cannot be used. Flow records at the Langley Platt gauge are assessed using a POT analysis. In the absence of a nearby flow gauge, analysis of data at the Little Woolden flow gauge which is just over 7km downstream provides an indicative magnitude of the event. There is good confidence in the data available at this gauge as it is flagged as "OK for Pooling" in the National River Flow Archive.

B.5.1 Lilford Park Basin

The level gauge at Lilford Park Basin has data at 15-minute intervals from January 2004 to May 2025. However, there is a year gap in the record between 2015 and 2020. It is possible that this gap in record may be due to a change in the gauge position or setup and this should be noted when considering the results of the analysis.

POT analysis indicates that the peak level recorded on 1 January 2025 is the largest peak in the record (from January 2004 to present, but with a six-year data gap from 2015 to 2021), with a calculated annual probability of 3.2%, with a level of 4.559 mALD. The second peak in record is considerably lower at 3.594 mALD (as shown in Table 8-4 and Figure 8-5), and suggests that the Gringorten formula may be underestimating the severity of the 1 January event in this instance.

Table 8-4: Annual exceedance probabilities for Lilford Park Basin level gauge.

Rank	Date	Level (mALD)	Annual exceedance probability
1	01 January 2025 08:30	4.559	3.2%
2	30 September 2024 21:30	3.594	10.4%
3	20 January 2021	3.47	17.5%
4	01 October 2024 00:15	3.382	24.6%

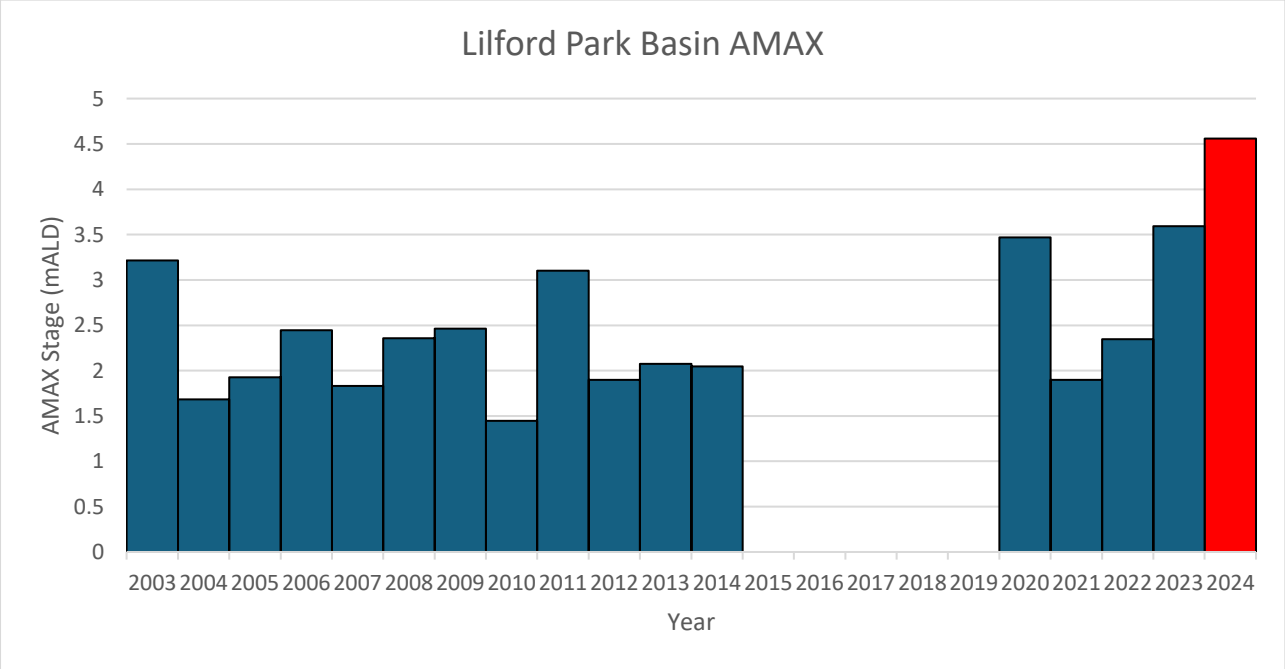


Figure 8-6: Lilford Park Basin Annual Maximum (AMAX) series.

B.5.2 Howe Bridge

The record at the Howe Bridge gauge provides data at 15-minute intervals from November 2012 to May 2025. POT analysis of this gauge indicates the level on 1 January 2025 was the second highest level recorded, exceeded only by an event on 12 June 2023. Using the Gringorten formula, the annual probability is estimated to be 11.9% for the 1 January event.

Table 8-5: Annual exceedance probabilities for Howe Bridge level gauge.

Rank	Date	Level mALD	Annual probability
1	12 June 2023 19:15	1.184	4.3%
2	1 January 2025 03:45	1.131	11.9%
3	31 July 2019 02:00	1.105	19.5%
4	30 September 2024 14:45	1.055	27.1%

Plotting the AMAX series for Howe Bridge indicates that there is some upward drift over the length of the record (Figure 8-7). Due to this, the results for the Howe Bridge gauge carry higher uncertainty.

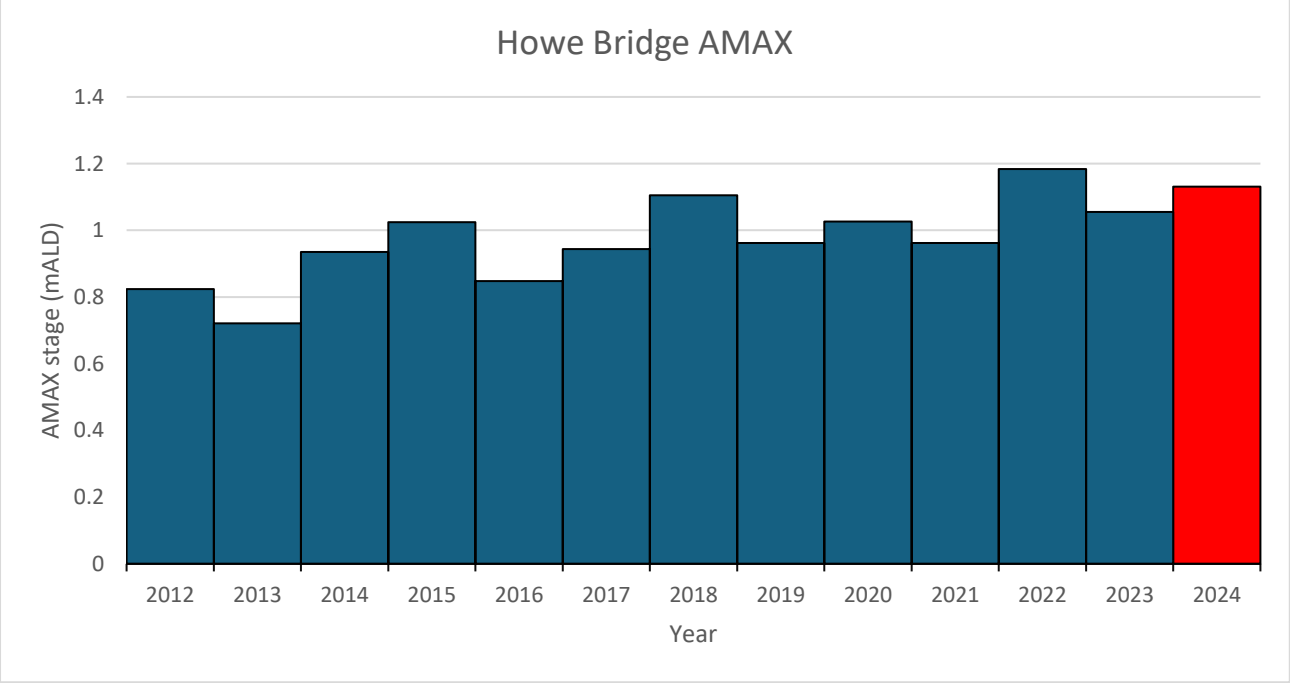


Figure 8-7: Howe Bridge Annual Maximum (AMAX) series.

B.5.3 Langley Platt

The flow record at Langley Platt provides data at 15-minute intervals from January 2014 to May 2025. POT analysis indicated that the event on 1 January (estimated peak flow of 8.7m^3/s) had the second highest recorded flow since the gauge was opened in January 2014, with an annual probability of 14.03%, exceeded only by the event on 26 December 2015. This annual probability is broadly in line with the annual probability calculated for the

Howe Bridge gauge. While an annual probability has been calculated using the Gringorten formula, it should be noted that this may be uncertain due to the relatively short length of the record (11 years).

Table 8-6: Annual exceedance probabilities for Langley Platt flow gauge.

Rank	Date	Flow	Annual Exceedance
1	26 December 2015 12:30	9.814	5.04%
2	1 January 2025 06:30	8.685	14.03%
3	20 January 2021 16:45	8.307	23.02%
4	9 February 2020 13:45	7.393	32.01%

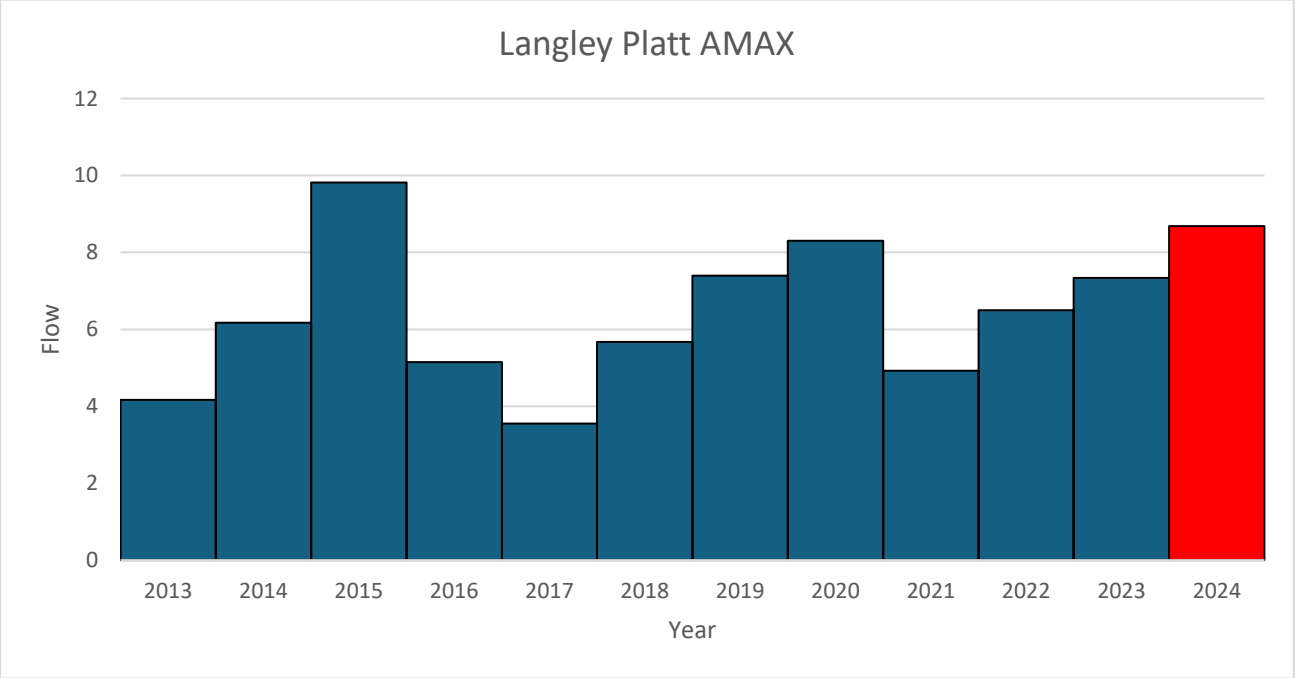


Figure 8-8: Langley Platt Annual Maximum (AMAX) series.

B.5.4 Little Woolden Hall

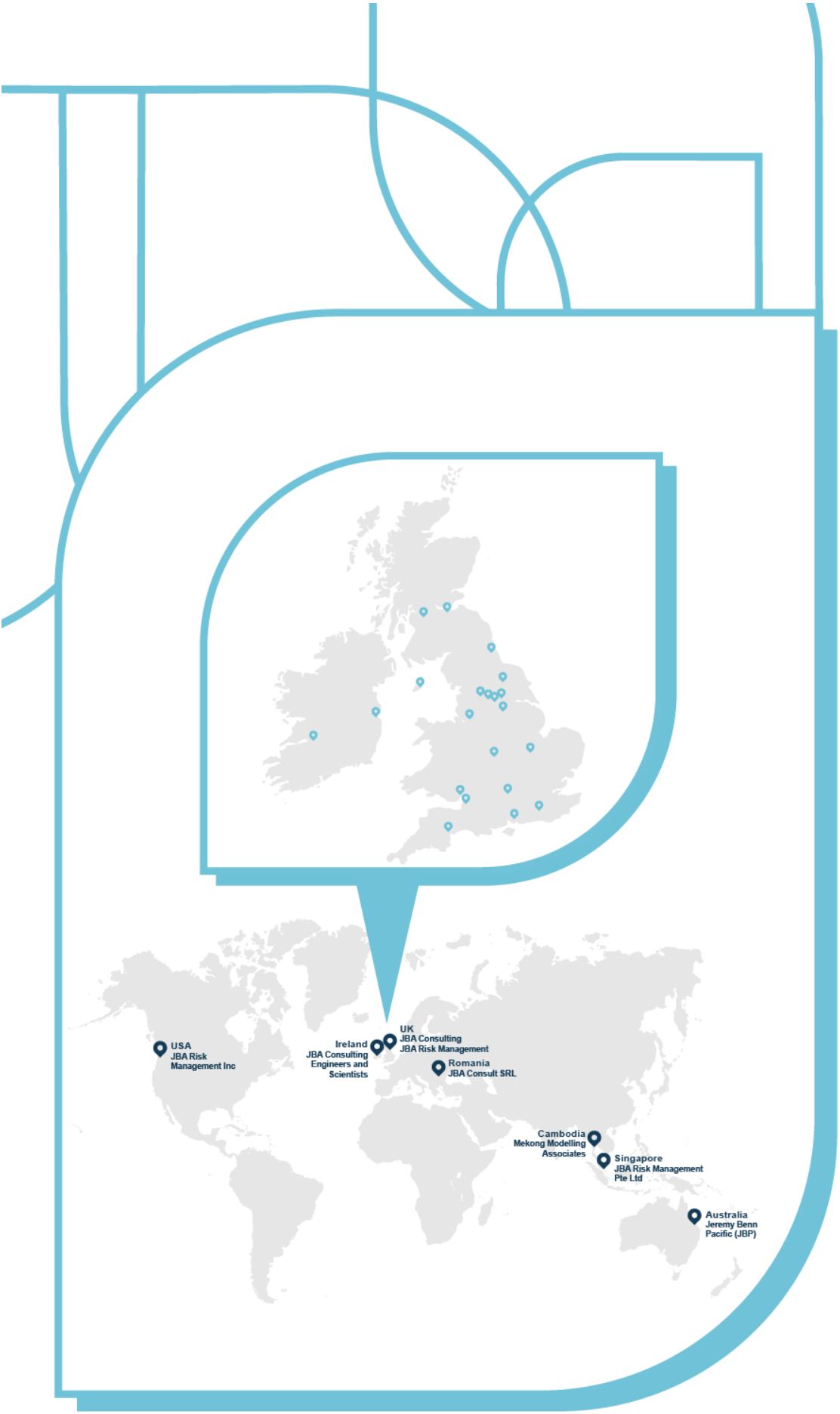
POT analysis indicated that the event on 1 January (estimated peak flow of 8.7m^3/s) had the second highest recorded flow since the gauge was opened in January 2014, with an annual probability of 14.0%, exceeded only by the event on 26 December 2015. This annual probability is broadly in line with the annual probability calculated for the Howe Bridge gauge. There is low confidence in flood flow magnitude estimates at this gauge, but this does not affect the relative event comparisons within its own record, for the purposes of the event rarity assessment.

The Little Woolden Hall gauge is a well-established flow gauge, with good quality Annual Maximum (AMAX) peak flow data, lending itself well to this type of analysis. FEH analysis of the data at Little Woolden Hall draws the following conclusions:

- The 50% annual probability peak flow (QMED) is estimated at 32.7m^3/s, taken directly from the AMAX record.
- The estimated peak flow for the 1 January 2025 event is 52.3m^3/s. Note this is an unchecked value, extracted directly from the Environment Agency Hydrology Data Explorer. This is the second-highest value on records here, only just exceeded by a recent event in January 2021.
- The above QMED value combined with a standard FEH 'Enhanced Single Site' analysis (including the local good quality AMAX in the calculation) gives an annual probability of 3.9% for the 1 January 2025 event.

B.6 Summary

Antecedent conditions in the days and weeks prior to the event on 1 January 2025 were not unusual. The high volume and intensity of rainfall during the storm on 31 December 2024 and 1 January 2025 was therefore the main driver of the flooding observed in the Lilford Park area. Analysis of the river level gauge at Lilford Park Basin and the nearest rainfall gauge at Bedford shows that the data are broadly in agreement with annual exceedance probability values of 3.2% and 2.8% respectively. Analysis at the nearest flow gauge at Little Woolden Hall is also in agreement with these estimates, with an annual probability of 3.9% at this gauge**,** albeit being located significantly downstream of the flooded properties.



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