Leeds City Council

Preliminary Flood Risk Assessment - 2011

Preliminary Assessment Report

Final Report
Sept 2011

Revision Schedule

Preliminary Flood Risk Assessment
Preliminary Assessment Report
July 2011

Rev	Date	Details	Prepared by	Reviewed by	Approved by
1.0	June 2011	Draft Report (for Internal Distribution)	**Ian Hope** Group Engineer	**Peter Davis** Flood Risk Manager	**Scrutiny Board**
1.1	July 2011	Final Report	**Ian Hope** Group Engineer	**Peter Davis** Flood Risk Manager	**Highways Board**
1.2	Sept 2011	Final Report	**Ian Hope** Group Engineer	**Peter Davis** Flood Risk Manager	**Environment Agency**

TABLE OF CONTENTS Page

1 EXECUTIVE SUMMARY

The EU Flood Directive (2007/60/EC) is consolidated into British law in the Flood Risk Regulations 2009, which came into force on 10th December 2009.

Under these regulations Leeds City Council (as a unitary authority) is designated as the *'Lead Local Flood Authority'* (LLFA) for the area. As such, it must undertake a Preliminary Flood Risk Assessment (PFRA) for the District.

The PFRA forms part of an assessment of flood risk across the whole of the European Union and only highly significant areas will be shown on the national submission to the Community – it should be noted that, under the current thresholds, there are 10 "Indicative Flood Areas" across England and Leeds is not one of these.

As part of this process all LLFAs have to prepare a Preliminary Assessment Report (PAR). This should include information on ordinary watercourses, surface water flows, harmful consequences of historic flooding, and future floods, groundwater, canals and the anticipated effects of climate change. As a LLFA, Leeds City Council has to submit their PAR to the Environment Agency for review by 22nd June 2011. The methodology for producing this PAR has been based upon the Environment Agency's Final PFRA Guidance and DEFRA's Guidance on selecting Flood Risk Areas, both published in December 2010

This PAR is a high level review of the surface water flood risk faced by the people of Leeds. It does not take direct account of flooding from Reservoirs or Main Rivers, which are to be considered by the Environment Agency in their assessment.

In order to develop a clear overall understanding of the flood risk across the District, flood incident data and records of historical flooding were reviewed from the Leeds Flood Risk Management (FRM) database, the Environment Agency, British Waterways, Network Rail, the Highways Agency, West Yorkshire Police and West Yorkshire Fire Service.

The information contained in this report looks at flooding from the above sources, many of which are locally significant. This will form the base information for the Council to prepare their Local Flood Risk Strategy, as required under the Flood & Water Management Act 2010.

There is a six year cycle for assessments under the Flood Regulations 2009, so by the time the next edition is published in 2017 there will be further information for it to be based upon.

2 INTRODUCTION

2.1 Statutory Background

2.1.1 The European Union Flood Directive (2007/60/EC) is consolidated into British law in the Flood Risk Regulations 2009, which came into force on 10th December 2009.

2.1.2 Under these regulations Leeds City Council (as a unitary authority) is designated as the *'Lead Local Flood Authority'* (LLFA) for the area. As such, it must prepare a draft of it's Preliminary Assessment Report (PAR) for the District by 22nd June 2011. This Includes information on ordinary watercourses, surface water flows, the harmful consequences of historical and future floods, groundwater, canals and the anticipated effects of climate change.

2.2 Aims and Objectives

2.2.1 The Preliminary Appraisal Report (PAR) is a high level screening process to locate areas in which the risk of surface water and groundwater flooding is significant and demands further analysis, with the preparation of hazard maps and management plans.

2.2.1 This report aims to highlight the key areas at risk of flooding from local sources - such as from surface water flows, ordinary watercourses, groundwater and sewers where it is due to excessive rainfall.

2.2.2 It does not examine the risks from main rivers, the sea or from large raised reservoirs. These are to be considered by the Environment Agency.

2.2.3 The Key Objectives are itemised below

- Identify relevant partner organisations involved in the future assessment of flood risk.
- Outline arrangements for the co-ordination and partnership for future collection, assessment and storage of flood risk data.
- Provide a summary of the systems used for data sharing and storing, including appropriate licensing arrangements.
- Assess historic flood events and the consequences and impacts of these events.
- Assess the potential harmful consequences of future flood events.
- Review the data gathered and outcomes of the report for incorporation into the Local Flood Risk Strategy.

2.3 Physical Characteristics of the Report Area

2.3.1 Leeds Metropolitan District covers 562 square kilometres and includes approximately 360 square kilometres of countryside designated as Green Belt. The general topography is undulating in characteristic and varies in level from 10m above Ordnance Datum at Fairburn on the River Aire and Thorp Arch on the River Wharfe to more than 340m at Hawksworth Moor.

2.3.2 The District is traversed from the Northwest to Southeast by the River Aire. The northern boundary is approximately delineated by the River Wharfe, which flows from West to East. The River Calder forms part of the southern boundary flowing from the southwest to join the River Aire at Castleford. An area to the East of the District flows into the River Ouse and a minor area at the Northeast that drains towards the River Nidd. Two-thirds of the District is to the North of the River Aire (see **Fig 1.3**).

2.3.3 The rocks underlying the area date from the Upper Carboniferous period: the sandstones and grits of the older, Millstone Grit, series are to the north of the city; the alternating shales, mudstones, coal seams and sandstones of the Lower Coal Measures are to the south. The soils are mainly clayey or loamy and are relatively impermeable. However, sands and gravels predominate adjacent to the River Aire.

2.3.4 The natural drainage of the area is by a series of watercourses, some of which are culverted, running in steep sided valleys to the Main Rivers and their associated flood plains (see **Fig 1.4**).

2.3.5 The 2001 population of the Metropolitan District was 715,400 - including 301,600 households *(figures from 2001 Census)*. Approximately 80% of the population is in the catchment that drains to Knostrop Waste Water Treatment Works.

2.3.6 Although Leeds was initially served by 'Combined Sewers' (foul and surface water), it has been the policy since the 1950's to ensure that new development and redevelopment would be serviced on a separate sewerage system basis. As a consequence, a significant part of the city now has separate or partially-separate sewers, with the surface water sewers connected in many cases directly to watercourses.

2.3.7 The original trunk interceptor sewer for Leeds was built c.1850 and drained to the Sewage Treatment Works at Knostrop. This trunk sewer, since extended, renewed and partially duplicated, roughly follows the line of the River Aire from Bridge Road, Kirkstall to Knowsthorpe. The sewer varies from 1370 mm diameter to 2362 x 2438 mm in size. In the 1920s further treatment facilities were built on higher ground at Knostrop and a new interceptor sewer - to the north of the original trunk sewer - was laid between Morris Lane, Kirkstall, and the new facilities. This new sewer drains most of the northern part of the city and is known as the High Level Sewer. The High Level Sewer varies from 1143x762mm to 2438mm diameter. The original interceptor sewer has become known as the Low Level Sewer. These sewers drain to the High Level and Low Level treatment works respectively.

2.3.8 The catchment draining to the High Level Sewer is largely residential and commercial. Most of the traditional industry is situated south of the River Aire and this drains to the Low Level Sewer – see **Fig 1.5** for the catchments of the principal waste water treatment works.

2.4 Leeds City Council Flood Risk Management Team

2.4.1 Leeds City Council has developed a dedicated Flood Risk Management Team. This team undertakes:

- The role as Lead Local Flood Authority (LLFA) for Leeds City Council.
- Implementation of the LLFA duties under the Flood and Water management Act 2010.
- A 'Centre of Excellence' for drainage and flooding issues.
- Development of strategies for Flood Risk Management.
- The mitigation of flood risk due to the impact of development, through the planning system.
- Inspection, maintenance and repair of watercourses.
- Inspection and Maintenance of the Local Authority owned pumping Stations.
- Reservoir Supervision and inspections.
- Design, procurement and implementation of Flood Alleviation Schemes.
- Records of the Local Authority drainage system

- Maintaining strong and close links with the Environment Agency, Yorkshire Water and other key partners.

2.4.2 Since the floods of 2007 this work has been developed further, particularly the partnership arrangements with the Environment Agency and Yorkshire Water. This has led to the creation of a Sub-Regional Partnership - which includes senior officers from the five LLFA's in West Yorkshire, together with representatives from the Environment Agency and Yorkshire Water.

3 DATA GATHERING AND REVIEW

3.1 Introduction

The information for the assessment has been gathered from as many sources as possible, so as to gain as full an understanding of the local flood issues as possible.

3.2 Information held by Leeds City Council

- Location of watercourses
- Records of drainage infrastructure
- Records of flooding incidents – **Fig 2.1**
- Records of inspections and investigations
- Records of flood mitigation and asset maintenance

3.3 Information Provided by Yorkshire Water

- Records of public sewers
- Records of sewer flooding incidents
- Modelling information
- Local expertise knowledge exchange

3.4 Information Provided by the Environment Agency

- Flood Zone Maps for Main River flooding – **Fig 4.2**
- Historic Flood Map
- Areas Susceptible to Surface Water Flooding (AStSWF) – **Fig 4.4**
- Flood Map for Surface Water (FMfSW) - **Fig 4.1**
- National Receptors Dataset (NRD) –Versions 1.0 and 1.1
- Indicative Flood Risk Areas – **Fig 3.1**

3.5 Information Provided by British Waterways

- ArcGIS shape files showing waterway breach or overtopping.

3.6 Information Provided by West Yorkshire Fire Service

- Records of incidents and callouts
- ArcGIS shape files and attribute tables.

NOTE: The majority of these incidents are linked to leaks from potable water supplies or are duplicated with LCC Flooding Records.

3.7 Information Provided by West Yorkshire Police

- Aerial reconnaissance video of river flooding events.

NOTE: These were not applicable the Leeds City Council LLFA area.

3.8 Information Provided by Network Rail

- Schedule of flooding incidents
- Location plan for flooding incidents

3.9 Information Provided by the Highways Agency

- Memorandum of Understanding submitted. However there has been some difficulty in obtaining any information from this source.

3.10 Information Provided by members of the General Public

- Records of flooding incidents – contained within **Figs 2.1 & 2.2**

3.11 Scrutiny and Review procedure

3.11.1 General

The scrutiny and review procedures that must be adopted when producing a PFRA are set out by the European Commission. An important aspect of the review procedure is to ensure that the guidance is applied consistently and will allow all partners to understand the risks identified and manage these appropriately. The scrutiny and review procedures consist of two stages as outlined below

3.11.2 Local Authority Review

The first part of the review procedure is through an internal review and scrutiny. The initial draft of the PAR was considered by partners and then presented to a meeting of the Leeds City Council City Development Scrutiny Board on 5th April 2011. The final PAR was approved by the Council's Highways Board on 26th July 2011.

3.11.3 Environment Agency Review

Under the Flood Risk Regulations the Environment Agency has been given a role in reviewing, collating, and publishing all of the PAR's once submitted.

The Environment Agency will undertake a technical review (area review and national review) of the PAR to ensure that they meet the minimum standards required by the European Commission. The review panel will make recommendations to the relevant Regional Flood Defence Committee (RFDC) for endorsement.

The first review cycle of the PFRA must be submitted to the Environment Agency by the 22nd June 2017, who will then submit it to the European Commission by the 22nd December 2017 following the review procedure described above.

3.11.4 Review Criteria

A spreadsheet style checklist (Annex 3 to the Final Guidance) has been completed. This is included as Annex 4 within the Leeds City Council PAR.

4 PREPARING THE PRELIMINARY ASSESSMENT REPORT

4.1 National Receptor Dataset (NRD)

4.1.1 The National Receptor Dataset (NRD) is provided by the Environment Agency and is a collection of risk receptors primarily intended for use in flood and coastal erosion risk management. The NRD provides coverage, where data is available, for England and Wales. Users should be aware that in some instances local data may be needed to give more detailed information.

4.1.2 The NRD is available for use by LLFA's in connection with the preparation of flood risk for statutory purposes. It is appropriate for the production of PFRA's and has been designed with this in mind.

4.1.3 The flood information has then been examined against the National Receptor Dataset (Version1.0) to determine the number of receptors within the study area that will be affected by any flood event.

4.2 Review of Indicative Flood Risk Areas

4.2.1 From the above data, an assessment by the Environment Agency has been carried out, in accordance with the national methodology, to determine whether Leeds should be included as an Indicative Flood Risk Areas.

4.2.2 The assessment was based upon the following significance thresholds following DEFRA guidance for 1km2 areas. 'Significant harmful consequences' defined as greater than (see **Fig 3.2**):

- Human Health – 200 people, or
- Economic Activity – 20 businesses, or
- Critical services – 1

4.2.3 These are then looked at in 3km squares to see if there are more than 5 of the nine squares meeting the above criteria. Where this is so they formed into 'clusters' with touching 3km squares. Clusters with greater than 30,000 people at risk have been designated as 'Indicative Flood Risk Areas' – **Fig 3.3**.

4.2.4 The main cluster within Leeds has 26,821 people at risk of flooding and therefore does not meet the cut-off for "national significance", though all these areas are significant locally and Leeds City Council will be taking steps over the coming years to mitigate the impact and risk that the people of the District face.

4.3 Location and extent

4.3.1 The Flood Map for Surface Water (FMfSW) has been selected as best representing the local sources of flood risk for Leeds City Council - **Fig 4.1**.

4.4 Consistency with Neighbouring LLFA PAR's

4.4.1 Consistency with adjoining LLFA's has been developed as a continuous and ongoing process through a series of meetings and telephone/email exchanges. The neighbouring LLFA's are:

- City of Bradford MDC
- Kirklees MC
- Wakefield MDC
- North Yorkshire CC

4.4.2 However, it is considered that the greatest amount of connectivity is along the Main River network and these are not considered in detail within this PAR.

5 HISTORICAL FLOOD RISK

5.1 Previous Significant Flooding

There have been a number of significant floods within the Leeds area, going back many years, these are listed below;

- 1775 – River Aire, Leeds
- 1866 – River Aire, Leeds – considered to be the worst recorded flood in Leeds.
- 1935 – River Wharfe, Otley
- 1946 – River Aire and Wortley Beck, Leeds
- 1960 – River Calder, Methley
- 1965 – River Wharfe, Otley
- 1975 – River Wharfe, Otley
- 1982 – River Wharfe, Otley
- 2000 – River Aire & Wharfe
- 2002 – River Aire and Wortley Beck
- 2004 – Wyke Beck, Dunhills
- 2005 – Wyke Beck and Wortley Beck
- 2007 – River Aire, Wyke Beck, Wortley Beck and many other locations across the District – **Fig 4.5**

5.2 Historical Flood Data Sources

5.2.1 Leeds City Council Flooding Incident Database (2001-11)

The Flood Risk Management Team maintains a database of flooding incidents reported from various sources. This has existed since 2001 and records the date, location, and description of each flood incident. Such records are assigned a category, based on an initial assessment of the type of flooding (made when the incident was first reported): sewer, watercourse, highway, overland, groundwater. The location is stored using a 12-digit national grid reference (and, where a property is involved, the OS address point reference is also stored). Approximately 2000 flooding incidents are recorded. Some of these relate to isolated properties and one-off incidents, but others represent clusters of properties and ongoing flood risks or flooding problems. These are shown in **Fig 2.1**.

5.2.2 Leeds City Council Call Centre - SIEBEL Database

The Leeds City Council Call Centre keeps of record of all calls that it receives. Records of calls for the Environmental and Highways Services area that are categorised (by Sub-Type) as 'Flooding' or 'Sand Bag Requests' are also recorded on the GIS system of the Flood Risk Management Section. This has been done since August 2008 and by the summer of 2010 approximately 300 such calls had been logged – see **Fig 2.2.**

5.2.3 Environment Agency - 'Floodline' Incident Records

It is understood that there is no easily accessible archive of 'Floodline' calls relating to the Leeds LLFA area.

5.2.4 Yorkshire Water - DG5 and Area Flooding Registers

Yorkshire Water has provided details of surface water flood incidents where they have this information.

5.3 Current Asset Condition and Risk

5.3.1 Blockage 'Hot Spot' List

A higher risk of flooding has been created by the locations on watercourse systems where blockages can easily form. These are often at physical 'pinch points', such as entrances to culverts or at trash screens, but the vulnerability of the location to the accumulation of debris depends also upon the nature of the upstream catchment (for example, does the vegetation generate substantial amounts of natural debris) and the accessibility to fly-tippers.

The Flood Risk Management Section has identified 95 blockage 'hot spots' (see **Fig 1.1**), on the basis of detailed flooding records and the amount of debris that tends to accumulate at each one. Each 'hot spot' has been given a risk ranking, in terms of the required clearance frequency (see table below).

Figure 1.1 Distribution of blockage 'hot spot' locations

These 'hot-spots' are visited and cleared by our term-contractor at preset frequencies. The frequency appropriate for each location is determined by a risk assessment. The contractor takes a photograph of the location upon arrival and a photograph before departure. These photographs provide a record of conditions, but also assist in fine-tuning visit frequencies, which are currently as shown in the following table:

'HOT SPOT VISITS	
Fortnightly	43
Monthly	26
Two monthly	10
Three monthly	16
TOTAL	95

The 'hot spot' location details and frequencies are available through the public portal of the Leeds City Council website.

5.3.2 CCTV Surveys of Culvert Condition

The Flood Risk Management Section investigates reported flooding incidents and carries out a pro-active programme of CCTV inspection for both publicly and privately owned watercourse culverts, which has been very effective in revealing blockages and defects that pose a serious flood risk. These have included excessive silt, structural weaknesses, collapses, obstruction by statutory undertaker's apparatus, and more unusual obstructions. In 2009-10 a total length of 15,858 metres of culvert was CCTV surveyed. Culvert desilting is often required before a CCTV camera can enter. Thus, the very act of facilitating a survey, by clearing the culvert, itself makes a significant contribution to flood risk reduction. Details of each survey are held on a database and GIS system. Each culvert length is assigned structural and service condition grades.

5.3.3 Beck Condition Surveys

The Flood Risk Management Section carries out routine inspections of the condition of both council-owned and privately owned watercourse channels. These inspections are arranged on a risk basis, with higher risk reaches being visited more frequently. The inspection schedule constitutes an assessment of the flood risk associated with each reach. A log sheet of each visit – describing the condition of the channel – is completed, and a record of each visit is kept on a database.

5.3.4 CCTV Surveys of Public Sewer Condition

Yorkshire Water undertake CCTV surveys of public sewers where either condition issues exist or where regular flood incidents occur. Under an informal partnering arrangement and as LLFA, Leeds City Council Flood Risk Management Team has access to these CCTV records where applicable.

6 FUTURE FLOODING – PREVIOUS STUDIES

6.1 Integrated Urban Drainage (IUD) pilot studies

6.1.1 West Garforth

The West Garforth Drainage Area has a history of flooding, going back to the 1980s and earlier. An Integrated Urban Drainage (IUD) pilot project, sponsored by DEFRA, was carried out in 2006-08 by a partnership involving Leeds City Council, Bradford Metropolitan District Council, Yorkshire Water, the Environment Agency and the Pennine Water Group (Bradford and Sheffield Universities). The aim was to examine a range of approaches to develop more integrated urban drainage management, including examples of best practice in both technical terms and stakeholder collaboration.

Shared record data, along with supplementary surveys, was used to build a computer model of the surface water drainage and the model was verified by use of observational data from a new short-term flow survey, along with historic data. Engagement with the residents by means of newsletters and two public meetings also produced a wealth of incident data as well as proposals for remedial measures.

The carrying out of CCTV surveys for the project necessitated silt and obstruction removal that will have reduced flood risk. Excavation to construct new manholes for survey access revealed constricted pipe junctions that have now been removed. Investigation of sewer connectivity, for modelling purposes, enabled the explanation and resolution of some long-standing, non-hydraulic, sewer flooding problems.

A significant number of the blockages in culverts and highway drains were caused by services severing them. Some of these still remain to be dealt with, but if they were removed in isolation from further measures, these could exacerbate downstream flood risk.

Modelling identified six areas in West Garforth with significant flood risk (Lowther Road, Oak Drive, Barleyhill Road/ Queensway/ Alandale Drive, Ninelands Lane, Richmond Road/ Glebelands. The use of a design rainfall event with a return period of 2 years indicated that significant flooding would be likely to occur at two of these locations with minor flooding at two others. If a rainfall event with a return interval of 30 years was used significant flooding would be expected at all six areas. Modelling was also used to predict changes in future flood risk. Future rainfall predictions indicated that flood volumes, from a rainfall event with a 30 year return period, would increase in this catchment by around 50% over the period to 2085. Flooding would also become more widespread, especially in the south eastern part of the study area.

During or subsequent to the IUD project, works have been carried out to improve the highway drainage at Ninelands Lane and to upgrade the culvert crossing of Barleyhill Road.

6.1.2 Leeds & Bradford River Aire Studies

The River Aire Integrated Urban Drainage (IUD) pilot project covered two large urban areas, the cities of Leeds and Bradford, which are linked by the River Aire. The project included the same partners as the West Garforth project and also took place at the same time (2006-08).

The focus was mainly on a strategic level and the longer term impacts of flooding in these two major urban areas. Methods were developed to use existing knowledge and models to identify, at a strategic level, surface flooding locations, given a particular level of risk.

The study demonstrated the impact of current land use practices and climate change on flood risk within the urban areas in the Aire valley. Modelling identified that over a time scale up to 2085 in the study area there will be an:

- Increase in the frequency of surface water flooding at vulnerable locations by around 100%
- Increase in the number of vulnerable locations by approximately 40%
- Increase the surface water flow volume by around 100%

The study identified that these increases were caused both by climate change and increased urbanization, with each of these factors have a similar level of influence. A key finding was that permitted development had the most significant impact in terms of urbanization. The study also identified that increased surface water flooding from urban areas would impact on the water quality of local receiving waters.

The project team identified actions that a range of stakeholders could take to mitigate and adapt to these pressures. These included both structural and non structural approaches. The role of development control was examined, and this highlighted the need for better training and the need to examine the impacts from permitted development at a strategic level. Emergency planning in the response to flooding was well developed, but the need for better engagement with vulnerable communities before flood incidents was highlighted. Some flood risk management practices appear to be more beneficial than others at a strategic level, and the study identified a need for improved knowledge in this area

6.2 Environment Agency – Section 105 Flood Risk Mapping

6.2.1 The Environment Agency have carried out a number of Flood Risk Mapping exercises for key locations, where there has been a history of flooding over the years, these have included:

- Fir Green Beck
- Meanwood Beck
- Cock Beck
- Wortley/Farnley Beck
- Wyke Beck

6.3 East Leeds Flooding – August 2004 (Joint Leeds CC – YWS report)

6.3.1 During the evening of 12th August 2004 serious flooding occurred at numerous locations throughout the eastern part of Leeds. An investigation into the circumstances of the flooding was carried out jointly by technical staff from Yorkshire Water and Leeds City Council.

6.3.2 On the basis of rainfall radar data, it was calculated that the worst 2-hour rainfall was of a depth that would be expected to occur on average about once in every 180 years. In other words, there is a 0.6% chance of such a depth of rain, in such a duration, occurring in any one year. This caused internal flooding to about 240 households. As could be expected, it overwhelmed becks, sewers, and highway drains.

6.3.3 The investigation concentrated on identifying additional factors (besides the extraordinary rainfall) that increased the risk at the following locations:

- **The Dunhills Estate (Halton):** The primary source of the flooding was Wyke Beck. The key additional factor causing the flooding was the poor condition of the watercourse channel. Large amounts of debris – some washed downstream by heavy storm flows – were present in the channel. The debris included natural material and a substantial amount of illegal flytipped rubbish, including more than 30 supermarket trolleys. The capacity of the channel has been reduced by tree growth since the estate was built in the late 1930s, whilst at the same time flows in Wyke Beck have increased due to the large scale development of upstream areas.

- **Wykebeck Valley Road/Foundry Lane (Gipton):** The flooding from public sewers was primarily due to problems relating to the operation and design of a new storage facility in Wykebeck Valley Road. This has since been replaced by a new one in Oakwood Lane. Overland flow from King George's playing fields caused some flooding to property in Foundry Lane. This has since been mitigated with a new swale and land drain along the edge of the fields. Flooding of St Nicholas's primary school has since been mitigated by installing a new land drainage system, connected into the public sewers.

- **Skelwith Walk/Sandway (Seacroft):** The primary source of the flooding was the public sewerage system. This was due to a blockage caused by debris – introduced by a third party – and a subsequent collapse of another public sewer. The sewer was to be reconstructed

- **Parkway Vale/South Parkway (Seacroft):** A blockage in the combined sewer near Parkway Vale caused an escape of water. Flooding also occurred from several locations on the combined sewer system due to sheer volume of flow, exacerbated by backing up from the trunk combined sewer in the valley bottom. The latter sewer was adversely affected by the entry of flood flows from Wyke Beck, via a collapsed private sewer (serving the Seacroft Hospital site) near Pembroke Grange and via a pipe defect (now repaired) near Wetherby Road. High flows and backing up from high levels in Wyke Beck are likely to have caused flooding from the public surface water sewer and the culverted watercourse. Debris and other obstructions in the beck channel were probably also a significant factor.

- **Kirkfield View/Kirkfield Drive/Chantry Garth/Garland Drive (Colton):** The prime source of the flooding at Kirkfield View and Chantry Garth was natural run-off from the public open-space to the north, supplemented by surface water escaping from the public surface water sewer system (via manholes in the open space and possibly in Garland Drive). The flooding at Garland Drive was possibly caused by a blocked surface water sewer that has now been cleared. The flooding from the combined sewer at Kirkfield Drive was likely to have been caused by surface water entering this sewer as a result of people in Kirkfield View lifting manhole covers on the foul sewers in order to relieve local flooding.

- **Kennerleigh Avenue (Cross Gates):** The initial investigation concluded that the prime cause of flooding was likely to have been the inability of the highway gullies, although clear, to deal with the high volume of flows travelling down the carriageway. Subsequent investigation however revealed local defects in the combined sewer and an intrinsic lack of capacity. A 100 metre length of combined sewer was upsized in 2008.

- **Green Lane (Halton):** The primary sources of flooding were highway run-off and overland flow from local allotments. A major blockage in the public surface water sewer was responsible for some of the water escaping from several highway gullies onto the highway and the failure of these gullies to deal with any other highway flows. Subsequently, tree roots have been discovered in the surface water sewer and removed several times.

- **Whitkirk Lane/Austhorpe Lane (Whitkirk):** No defects or blockages were found in the public or private drainage systems. Properties below road level were flooded by water backing up from the public sewer system. Downstream combined sewer capacity was subsequently determined to be inadequate. Works have been carried out by Yorkshire Water to divert the connection of the local drainage system to a new outfall (in the public combined sewer in Selby Road). The highway authority has installed a series of new gullies in Austhorpe Lane, there were none previously.

7 FUTURE FLOODING – CURRENT ASSESSMENTS

7.1 Climate Change and Long Term Developments

7.1.1 The Evidence

There is clear scientific evidence that global climate change is happening now. It cannot be ignored.

Over the past century around the UK we have seen sea level rise and more of our winter rain falling in intense wet spells. Seasonal rainfall is highly variable. It seems to have decreased in summer and increased in winter, although winter amounts have changed little in the last 50 years. Some of the changes might reflect natural variation; however the broad trends are in line with projections from climate models.

Greenhouse gas (GHG) levels in the atmosphere are likely to cause higher winter rainfall in future. Past GHG emissions mean some climate change is inevitable in the next 20-30 years. Lower emissions could reduce the amount of climate change further into the future, but changes are still projected at least as far ahead as the 2080s.

We have enough confidence in large scale climate models to say that we must plan for change. There is more uncertainty at a local scale but model results can still help us plan to adapt. For example we understand rainstorms may become more intense, even if we can't be sure about exactly where or when. By the 2080s, the latest UK climate projections (UKCP09) are that there could be around three times as many days in winter with heavy rainfall (defined as more than 25mm in a day). It is plausible that the amount of rain in extreme storms (with a 1 in 5 annual chance or rarer) could increase locally by 40%.

7.1.2 Key Projections for Humber River Basin District – **Fig 1.2**

If emissions follow a medium future scenario, UKCP09 projected changes by the 2050s relative to the recent past are:

- Winter precipitation increases of around 12% (very likely to be between 2 and 26%)
- Precipitation on the wettest day in winter up by around 12% (very unlikely to be more than 24%)
- Relative sea level at Grimsby very likely to be up between 10 and 41 cm from 1990 levels (not including extra potential rises from polar ice sheet loss)
- Peak river flows in a typical catchment likely to increase between 8 and 14%.

7.1.3 Implications for Flood Risk

Climate changes can affect local flood risk in several ways. Impacts will depend on local conditions and vulnerability.

Wetter winters and more of this rain falling in wet spells may increase river flooding. More intense rainfall causes more surface runoff, increasing localised flooding and erosion. In turn, this may increase pressure on drains, sewers and water quality. Storm intensity in summer could increase even in drier summers, so we need to be prepared for the unexpected.

Drainage systems in the district have been modified to manage water levels and could help in adapting locally to some impacts of future climate on flooding, but may also need to be managed differently. Rising sea or river levels may also increase local flood risk inland or away from major rivers because of interactions with drains, sewers and smaller watercourses. Even small rises in sea level could add to very high tides so as to affect places a long way inland.

Where appropriate, we need local studies to understand climate impacts in detail, including effects from other factors like land use. Sustainable development and drainage will help us adapt to climate change and manage the risk of damaging floods in future.

7.1.4 Adapting to Change

Past emissions mean some climate change is inevitable. It is essential we respond by planning ahead. We can prepare by understanding our current and future vulnerability to flooding, developing plans for increased resilience and building the capacity to adapt. Regular review and adherence to these plans is key to achieving long-term, sustainable benefits.

Although the broad climate change picture is clear, we have to make local decisions against a background of uncertainty. We will therefore consider a range of measures and retain flexibility to adapt. This approach, embodied within flood risk appraisal guidance, will help to ensure that we do not increase our vulnerability to flooding.

7.1.5 Long Term Developments

It is possible that long term developments might affect the occurrence and significance of flooding. However current planning policy aims to prevent new development from increasing flood risk.

In England, Planning Policy Statement 25 (PPS25) on development and flood risk aims to "ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk. Where new development is, exceptionally, necessary in such areas, policy aims to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall."

In Wales, Technical Advice Note 15 (TAN15) on development and flood risk sets out a precautionary framework to guide planning decisions. The overarching aim of the precautionary framework is "to direct new development away from those areas which are at high risk of flooding."

Adherence to Government policy ensures that new development does not increase local flood risk. However, in exceptional circumstances the Local Planning Authority may accept that flood risk can be increased contrary to Government policy, usually because of the wider benefits of a new or proposed major development. Any exceptions would not be expected to increase risk to levels which are "significant" (in terms of the Government's criteria).

7.2 Urban Creep

7.2.1 In recent decades Leeds has had one of the one of the fastest developing economies in the UK, accounting for almost 27% of the 423,000 net jobs created in Yorkshire and Humber over the 20 years prior to 2007. This has naturally brought with it an extension of the developed area (both business and housing premises) onto 'Brownfield' and 'Greenfield' land. This will have inevitably increased the volume of storm run-off into local drainage systems, thus potentially increasing the flood risk for areas downstream of the development.

7.2.2 In common with most urban areas, Leeds has seen a significant increase in the density of impermeable surfaces within existing developed areas as a result of property owners paving over gardens and other permeable land in order to create drives, patios and other hardstandings.

7.2.3 Quantification of this phenomenon is hard to obtain, but there is anecdotal evidence that it is a factor in the increasing incidence of flooding in some parts of the city, such as Halton in east Leeds. On the suggestion of the Flood Risk Management Section a study was carried out in the Halton area by students at the School of Geography, Leeds University. In this investigation, aerial photographs from 1971 and 2004 were used to map changes in the impervious cover of a 1.16 km^2 suburban area.

7.2.4 The finished report (*An Investigation into the Extent and Impacts of Hard Surfacing of Front Gardens in an area of Leeds*, 2006, Thomas Perry and Rizwan Nawaz) indicated a 13% increase in impervious surfaces over the 33 year study period. Of the increase in impervious surfaces, 75% was due to paving of residential front-gardens. It is likely that a similar trend has been followed in other residential areas.

7.2.5 A restriction on the paving of front gardens was introduced in an amendment to the Town and Country Planning (General Permitted Development) Order 1995, on 1 October 2008. The implementation of this restriction will be a major challenge and efforts will have to be made to ensure that householders are aware of the restriction. To this end, Leeds CC Highways has produced an advice note (*Your Front Garden: Save it, Don't Pave it! – Advice for Constructing Drives, Patio's and Parking Spaces*, 2010).

7.3 Environment Agency Flood Zone Maps

7.3.1 Though Main River flooding is not directly assessed as part of the PRFA, the EA's Flood Zone Map is included as **Fig 4.2**.

7.4 Leeds Strategic Flood Risk Assessment

7.4.1 As part of the Council Local Development Framework a Strategic Flood Risk Assessment has been produced, which though it mainly deals with Main River flood risk it also refers to surface water risk. See **Fig 4.3.**

7.5 Surface Water Flooding (Environment Agency)

7.5.1 The Environment Agency has two national datasets showing surface water flooding that are available to LLFA's:

- Areas Susceptible to Surface Water Flooding (AStSWF) – **Fig 4.4**
- Flood Map for Surface Water (FMfSW) – **Fig 4.1**

7.5.2 The AStSWF dataset contains one rainfall event , with 3 susceptibility bands. The FMfSW contains two rainfall events, 1in 200 (0.005 probability) and 1 in 30 (0.033 probability) each divided into two depths.

7.5.3 These surface water maps are not designed to assess risks from other sources of flooding. However, as these datasets use a 2D representation of the ground, they route surface water runoff into channels and depressions.

7.5.4 For the Leeds Area catchments it is considered that FMfSW, 1 in 200 'deep' (300mm or greater) dataset is the most appropriate in the following ways:

- Better ground and surface data
- Sewer flow now represented
- Ground infiltration now represented
- Storm duration more representative
- Buildings now included
- Different roughness coefficients for urban and rural now included

7.6 Surface Water Flooding (Leeds City Council)

7.6.1 Further to the above, Leeds City Council has also modelled overland surface water flooding for two 'local' areas. These are at the Potternewton and Guiseley districts of Leeds. The modelling was undertaken using the 'Floodflow' module of the Microdrainage software suite.

- **Potternewton**

  The total catchment area is approximately 1.8km2 and is predominately urban in characteristic. The results of the modelling indicate that up to 850 property boundaries may be affected by surface water flooding for a 1 in 200 year return rainfall event (0.005 probability). This includes both residential and commercial properties.

  The main 'Hot Spots' within the Potternewton catchment are:

  - Newton Road and Newton Park Drive
  - Avenue Crescent and Harehills Avenue
  - Blake Grove, close to the junction with Manor Grove

- **Guiseley**

  The total catchment area is approximately 14.8km2 and is a mix of rural and urban areas. The results of the modelling indicate that up to 2500 property boundaries may be affected by surface water flooding for a 1 in 200 year return rainfall event (0.005 probability). This includes both residential and commercial properties.

  The main 'Hot Spots' within the Guiseley catchment are:

  - The railway cutting adjacent to Silverdale Drive, Guiseley
  - West Side Retail Park, Leeds Road, Guiseley
  - Various business premises adjacent to Guiseley Beck, Milner's Road, Guiseley
  - Coppice Wood Crescent, Yeadon
  - Whitestone Crescent, Yeadon
  - High Street, Yeadon
  - Henshaw Lane and Back Lane, Yeadon

7.7 Wyke Beck Surface Water Management Plan

7.7.1 Wyke Beck is one of the most susceptible areas in Leeds to flooding and a number of studies have been carried out to assess the level of flood risk and means of alleviating it.

7.7.2 Subsequently, it has now been classified as a Main River and the EA are leading on flood risk.

7.8 Groundwater Flooding

7.8.1 A desk top assessment of flooding has been carried out for the Talbot Road area of North Leeds, where there are a number of properties with water filled cellars and saturated gardens.

7.8.2 The assessment reviewed the historical development of the area, quarrying, coal mining, geotechnical archives, borehole information, LIDAR information, and Leeds City Council Flooding Incidents. A site walkover was not undertaken.

7.8.3 The main conclusions of the review are:

- 'The area is not at risk from flooding from water courses according to the Strategic Flood Risk Assessment.' (SFRA)
- 'No significant historical conditions have been identified predisposing [arts of the study area to risk of flooding. An exception to this is the culverting that has taken place, since the groundwater no longer has outlet to these previous streams, and there may attendant groundwater level rises at times.'
- 'Considering the extensively impermeable strata, the number of incidents (recorded) is small within the 10 year time span (2001 – 2010) that occur in relation to the number of households. Furthermore, apart from cellar incidents, the houses at the other incidents have not been affected. Consequently, it is appropriate to deal with incidents on an individual basis, rather than engage in extensive investigation and monitoring.'

7.9 Reservoir Breach Assessments

7.9.1 The Environment Agency has undertaken reservoir breach assessments on the 100 most risky reservoirs within England and Wales, only 2 of these are in Leeds, both of which are subject to inspections under the Reservoirs Act 1975. Though the impact of a breach would be potentially catastrophic the probability of this happening is assessed as being low. All such reservoirs are registered under the Reservoirs Act and overseen by the Environment Agency reservoir's team.

7.9.2 Leeds City Council has also undertaken, independently, breach assessments for the two reservoirs and concur with the Environment Agency assessment that the probability of a breach is considered to be low. However there are a number of smaller reservoirs, which don't come under the Act, and Leeds City Council has concerns over the condition of some of them, and will continue to raise these concerns with the owners.

7.9.3 It should be noted that the Flood and Water Management Act has a clause in it that reduces the volume of reservoirs that come under the Reservoirs Act from 25,000 to 10,000 cubic metres. This will mean many more reservoirs, than present, will have to be assessed on a regular basis.

7.10 Existing Sewerage Capacity

7.10.1 Existing sewer capacity issues have been examined based on an appraisal of existing models. There are a variety of problem areas, particularly for higher return period (greater than 1 in 30 year) storms, for which some sewers are inadequate.

7.11 Drainage Area Plans

7.11.1 Yorkshire Water is proposing to undertake further Drainage Area Plans. These will facilitate a better understanding of how the sewer network will react during larger storms.

8 MANAGEMENT AND MAINTENANCE OF DATA

8.1 Leeds City Council already has close partnership arrangements with all the other organisations involved with Flood Risk Management and these will continue to be developed. Data has been sourced from these partners and a schedule is provided in Chapter 3.

8.2 All agencies are committed to ensuring that we manage data for the benefit of the people of Leeds and ensuring that better information is available for assessments of flood risk is an essential part of this.

8.3 The data used in the preparation of this PAR has complied in general with the guidance provided in Annex 5 - Data Standards of the Annexes to the Final Guidance published by the Environment Agency.

8.4 Data is being stored on the Council's secure data networks to ensure they are only used for Flood Risk Management. Also they are registered as to the sources of the information, its quality and any restrictions on its use.

9 COMMUNICATIONS WITH PARTNERS

9.1 Yorkshire and Humber Learning Alliance

9.1.1 Under the Flood & Water Management Act 2010, LLFA's have the lead responsibility to investigate flood incidents to the extent it considers it necessary or appropriate.

9.1.2 Consequently, It is essential that all partner agencies work closely to ensure that the available resources are used to their optimum.

9.1.3 To facilitate this, a working group has been set up as part of the Yorkshire & Humber Learning Alliance - an informal working group of all the interested parties within the Yorkshire and Humber region - to draft guidance for how flood related issues should be dealt with by the various partners.

9.2 Other Stakeholder Engagement

9.2.1 Local Flood Action Groups

Within the Leeds area there are a number of active Local Flood Action Groups which are community based. Leeds City Council Flood Risk Management Section and Emergency Planning Teams work closely with these groups – both in the formation of them and also with onward support to them in their operation. These groups are a vital component in the onward management of flood risk.

9.3 Partnerships

9.3.1 Leeds City Council Flood Risk management Section has set up formal and informal partnership groups, at which stakeholders faced with the management of, flood risk can meet to determine and develop policies and strategies. The Formal arrangements are:

- Leeds City Council Flood Risk Management Group –

  An internal Leeds City Council group, with officers from most Departments present to examine policy.

- Planning and Flood Risk –

  Includes Leeds City Council officers from; Planning, Development Control, Emergency Planning, and Flood Risk Management. External organisations represented are; Yorkshire Water and the Environment Agency.

- Technical Standards and Guidance -

  Consisting of; Leeds City Council officers from Flood Risk Management and Highways. The external organisations represented are; Yorkshire Water and the Environment Agency.

10 EXISTING MITIGATORY ACTIONS

10.1 Risk-Assessed Inspection and Maintenance

10.1.1 Leeds City Council has a scheduled risk based programme of maintenance for watercourses and grids. There is a regular and routine system of inspection and maintenance works carried out. Where issues arise outside this system, then maintenance is prioritised, dependent upon the assessed risk of potential flooding.

10.1.2 Also, crucial to the efficient drainage of the District, are the approximately 150,000 gullies on the Highway Network. These are maintained on a regular cycle by Leeds City Council's Environment & Neighbourhoods Team. The multitude of connecting pipes are then maintained by the Highways Services.

10.1.3 The Environment Agency has a system to inspect and maintain all Main Rivers. Similarly, where the potential flood risk increases they will inspect, and add the location to the regular maintenance schedule.

10.1.4 Yorkshire Water has an extensive programme of maintenance and improvement works that are undertaken on an annual programme.

10.2 Capital Programme of Improvements

10.2.1 Leeds City Council has carried out a number of flood alleviation works – these have included watercourse improvements and household protection schemes.

10.2.2 The Environment Agency has a programme of flood alleviation schemes, which includes a number within the Leeds District.

10.2.3 Yorkshire Water has a programme of sewer improvements, which they undertake.

10.3 Development Control

10.3.1 Planning and Flood Risk

The Council's Planning and Flood Risk Management Teams work very closely on ensuring that proposed developments mitigate the risk of flooding related to their construction, in accordance with the guidelines within Planning Policy Statement (PPS) 25. As part of this Supplementary Planning Guidance Note has been developed with regard to Sustainable Drainage Systems (SuDS) – this requires developers to consider the use of SuDS to mitigate flood risk.

10.3.2 Additionally the Flood Risk Management Team has produced a 'minimum standards' flowchart for development drainage schemes.

10.3.3 Planning as part of the LDF has drawn up new guidance for developers on flood risk matters, this is contained within the Natural Resources and Waste Development Plan Document.

11 EMERGENCY RESPONSE

11.1 West Yorkshire Major Flood Incident Plan

11.1.1 Leeds City Council's Emergency Planning Team has taken the lead in drafting West Yorkshire's Major Flood Incident Plan, which sits beside the Council's own Emergency Plan documents. This was recently tested as part of the Watermark exercise.

11.2 Community Flood Action Plans

11.2.1 The Emergency Planning Team has also a programme of preparing Community Flood Action Plans together with various community based Flood Action Groups. The following communities have Flood Action Plans prepared or are in the process of being prepared:

- Collingham
- Dunhills estate
- West Garforth
- Methley
- Thorner
- Wortley Beck

11.3 Reservoir Emergency Plans

11.3.1 The Council's Emergency Planning Team is in close contact with the EA's Reservoirs Team in ensuring that there are Emergency Plans for all the main reservoirs in the District.

11.4 Leeds City Council Sandbag Policy

11.4.1 The Council may provide sandbags to householders and other parties to reduce the risk of property damage during major flooding. To ensure they are deployed to maximum effect, sandbags are issued in the following order:

- Vulnerable individuals or establishments;
- Residential properties and
- Businesses or other non-residential properties.

11.5 Call Centres – Leeds CC, Yorkshire Water, and EA Floodline

11.5.1 All these agencies have call centres that will during flood events take calls from the public – providing advice and assistance where possible. These are also an important source of data as to where flooding is occurring and after the event to record information.

11.6 Severe Rainfall Warnings

11.6.1 There is a standard protocol for the receipt of severe rainfall warnings, where it is expected that this could lead to a major flood event. In the first instance the various partners will discuss how they intend to react and whether Control Centres should be set up or just to put staff on standby for any possible event.

12 PROPOSED FLOOD ALLEVIATION SCHEMES

12.1 Leeds City Council

12.1.1 The Council's Flood Risk Management Team are currently looking at a programme of flood alleviation schemes, these include:

- West Garforth recreation ground (local levy)
- Leeds Road (Allerton Bywater) pumping station (local levy)
- Ramsden Street (Kippax) flood alleviation scheme (local levy)
- Station Road (Morley) culvert renewal scheme

12.2 Environment Agency

12.2.1 The EA have a number of flood alleviation schemes under consideration at present, these include:

- Leeds flood alleviation scheme
- Wyke Beck flood alleviation scheme
- Collingham Beck flood alleviation scheme
- Farnley Wood Beck flood alleviation scheme

12.3 Yorkshire Water

12.3.1 Under their DG5 programme YW have a number of major schemes under consideration and also a large number of smaller schemes that come under their revenue funding.

13 SELF-HELP STRATEGY

13.1 Advice Sheets on Self-Help (LCC/YWS/EA)

13.1.1 There is various guidance available to the public, which during flood events is supplemented by other information on health and safety.

Some examples are:

- Groundwater problems
- Property level flood protection
- National Flood Forum

14 ANNEXES

14.1 Annex 1: Records of past floods and their significant consequences (Preliminary Assessment Spreadsheet)

14.1.1 Please refer to Annex 1 of the Preliminary Assessment Spreadsheet attached with this report. Data for this section was retrieved from the Flood Risk Management Flooding Incident database for events dating from 2001 to 2010. Only those events which are considered to have 'significant harmful consequences' have been entered. Chapter 5 of this report provides some further detail on this aspect.

14.2 Annex 2: Records of future floods and their significant consequences (Preliminary Assessment Spreadsheet)

14.2.1 Please refer to Annex 2 of the Preliminary Assessment Spreadsheet attached with this report. Only those events that may have 'significant harmful consequences' have been entered . Further information is presented in Chapter 6 of this report.

14.3 Annex 3: Review of Indicative Flood Risk Areas (Preliminary Assessment Spreadsheet)

14.3.1 As there is no Indicative Flood Risk Area within the Leeds LLFA area, this spreadsheet has not been submitted.

14.4 Annex 4: Review Checklist

14.4.1 Please refer to Annex 4, attached to this report. This contains the Review Checklist that has been provided by the Environment Agency to act as a checklist for reviewing PFRA submissions.

15 FIGURES

Fig 1.2 Humber Basin Map

Fig 1.3 Main River Catchments

Figure 1.4 Main Rivers and Ordinary Watercourses

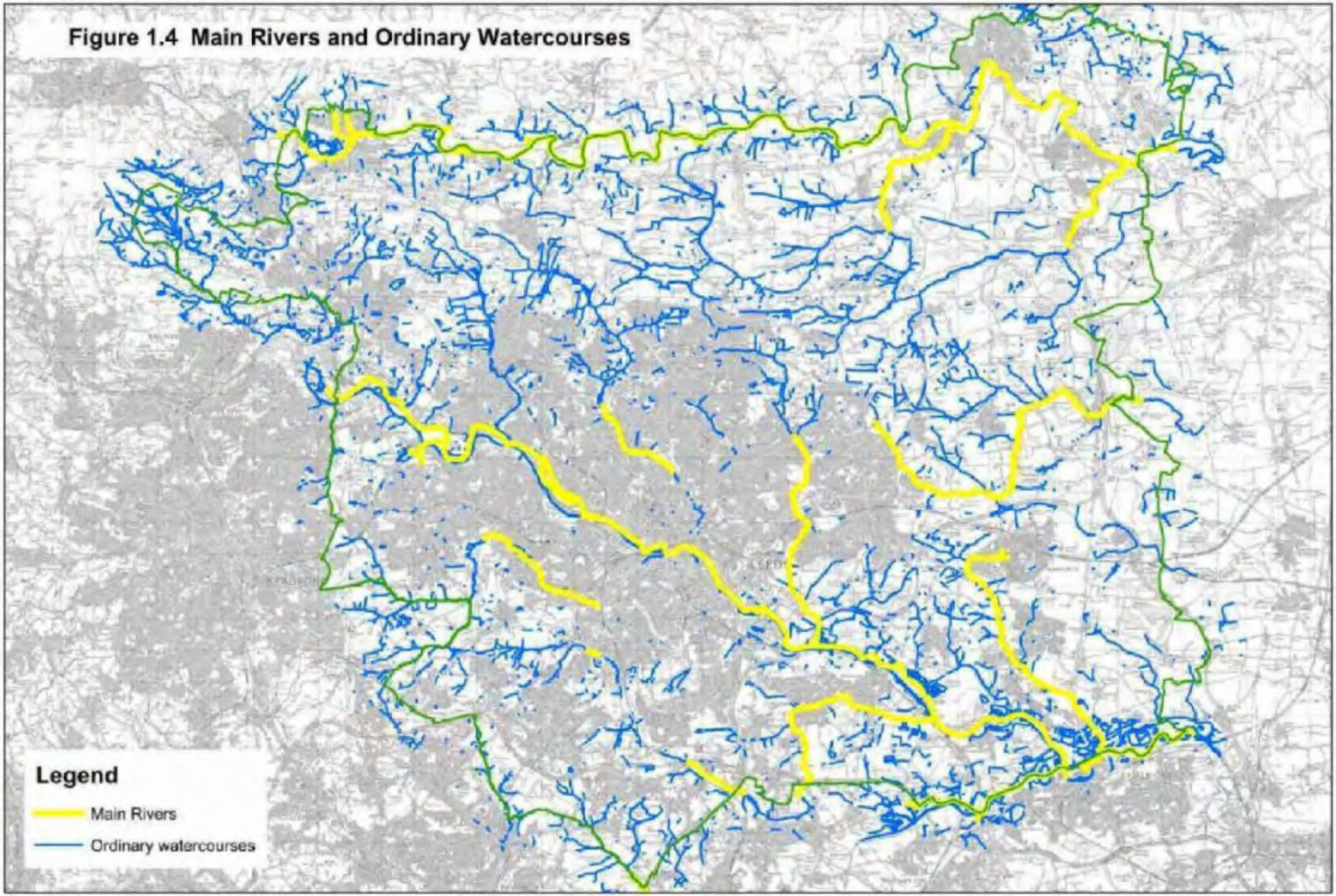


Figure 1.5 Catchments of principal waste water treatment works

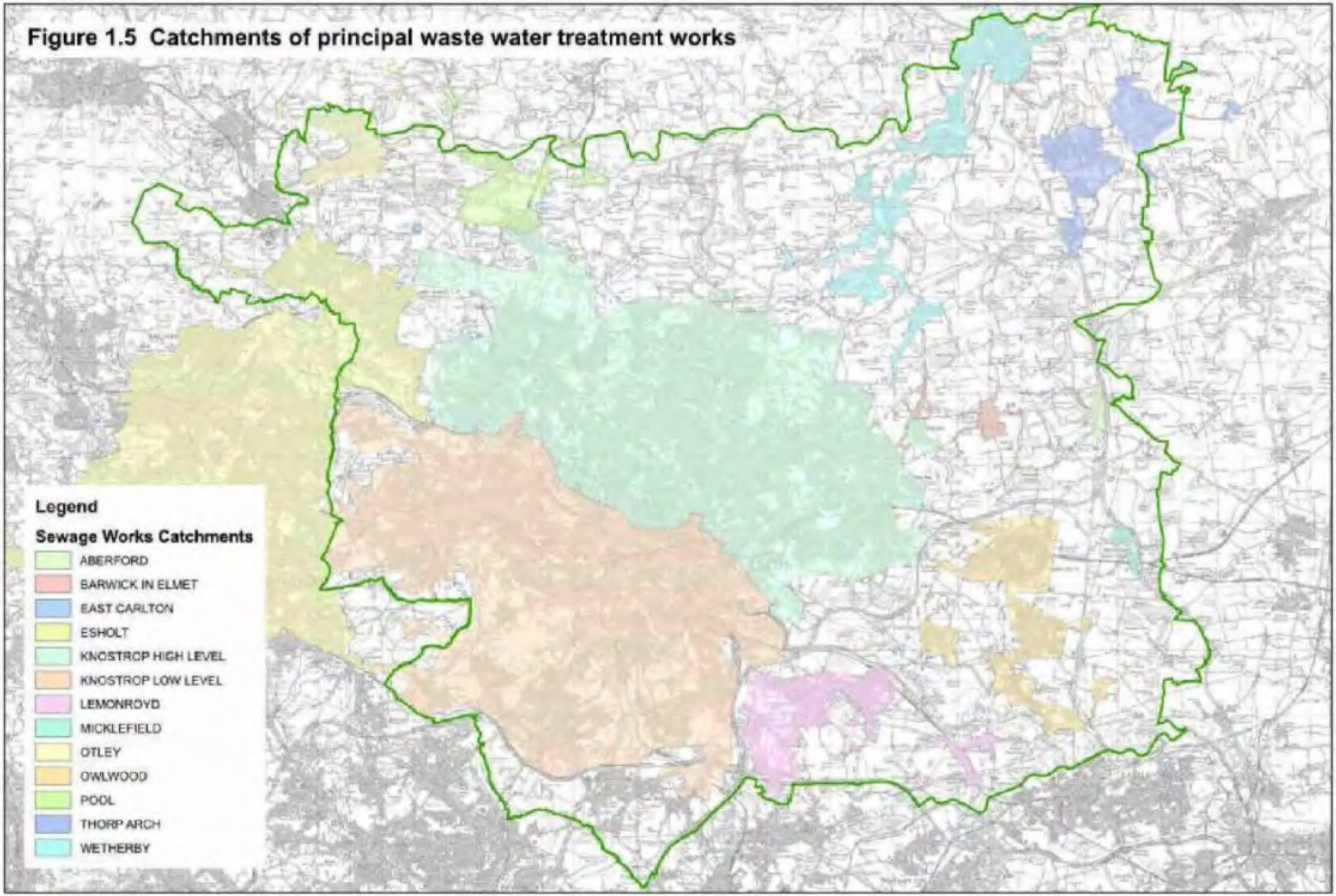


Figure 2.1 Leeds CC flooding incident records (2001-10)

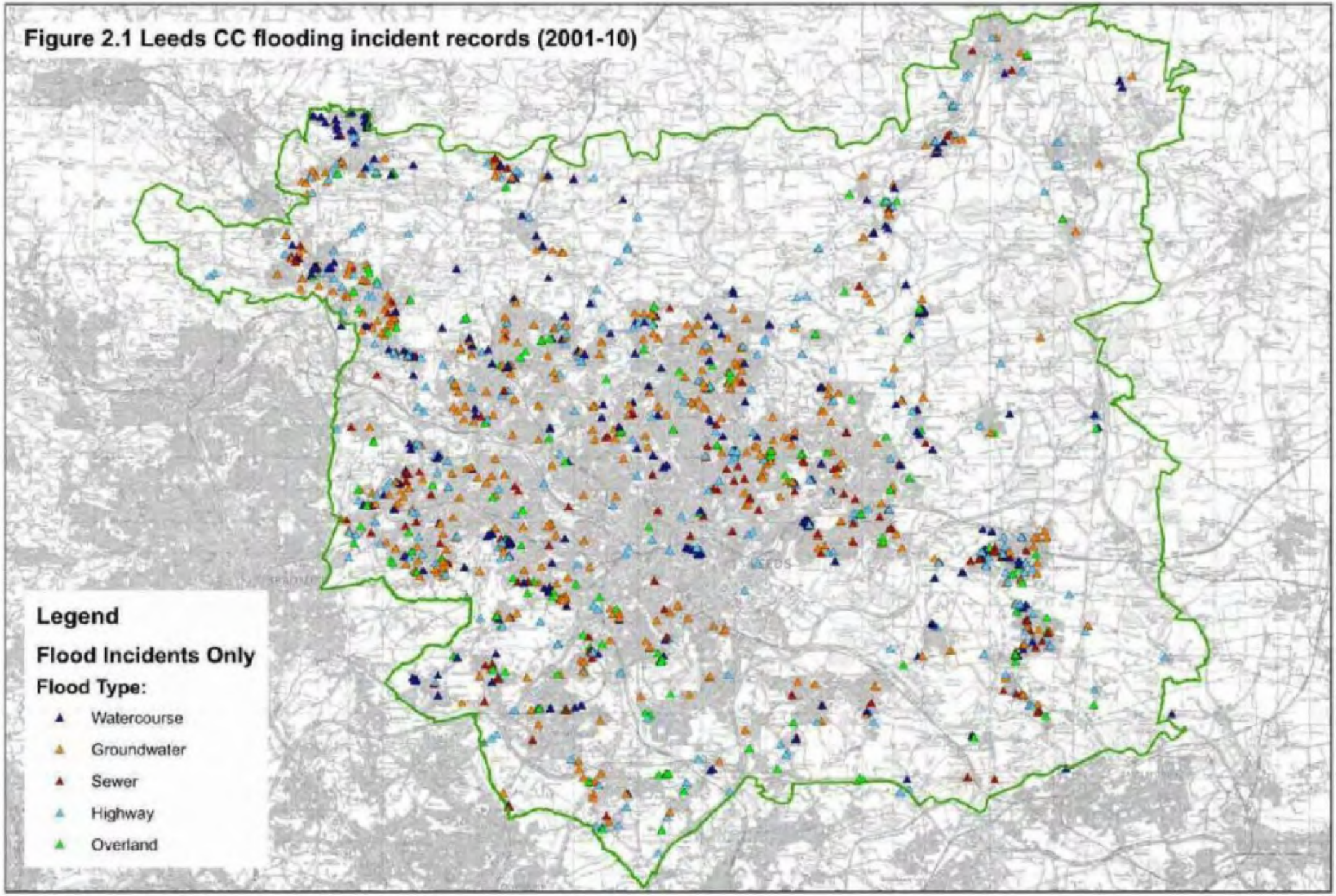
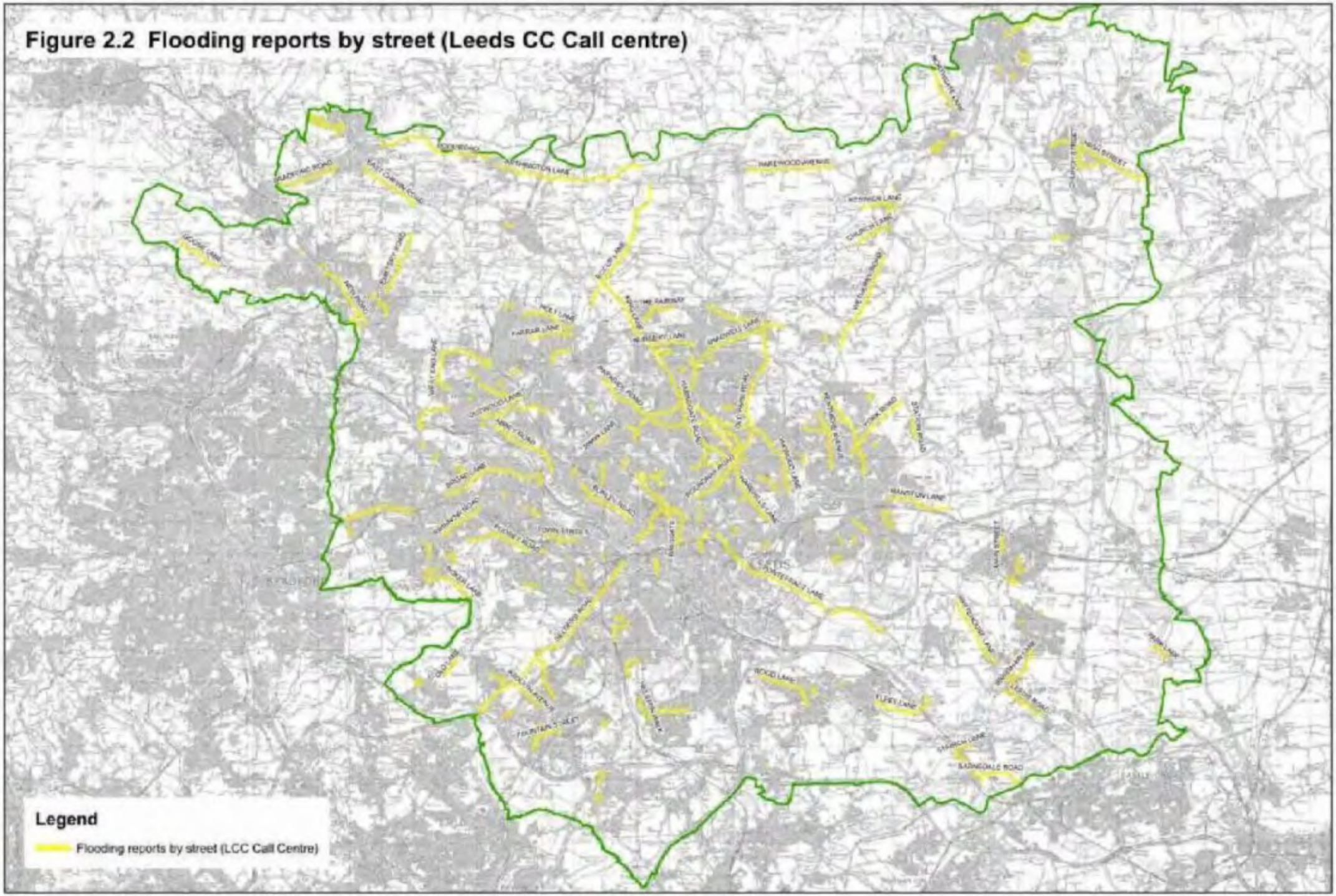


Figure 2.2 Flooding reports by street (Leeds CC Call centre)



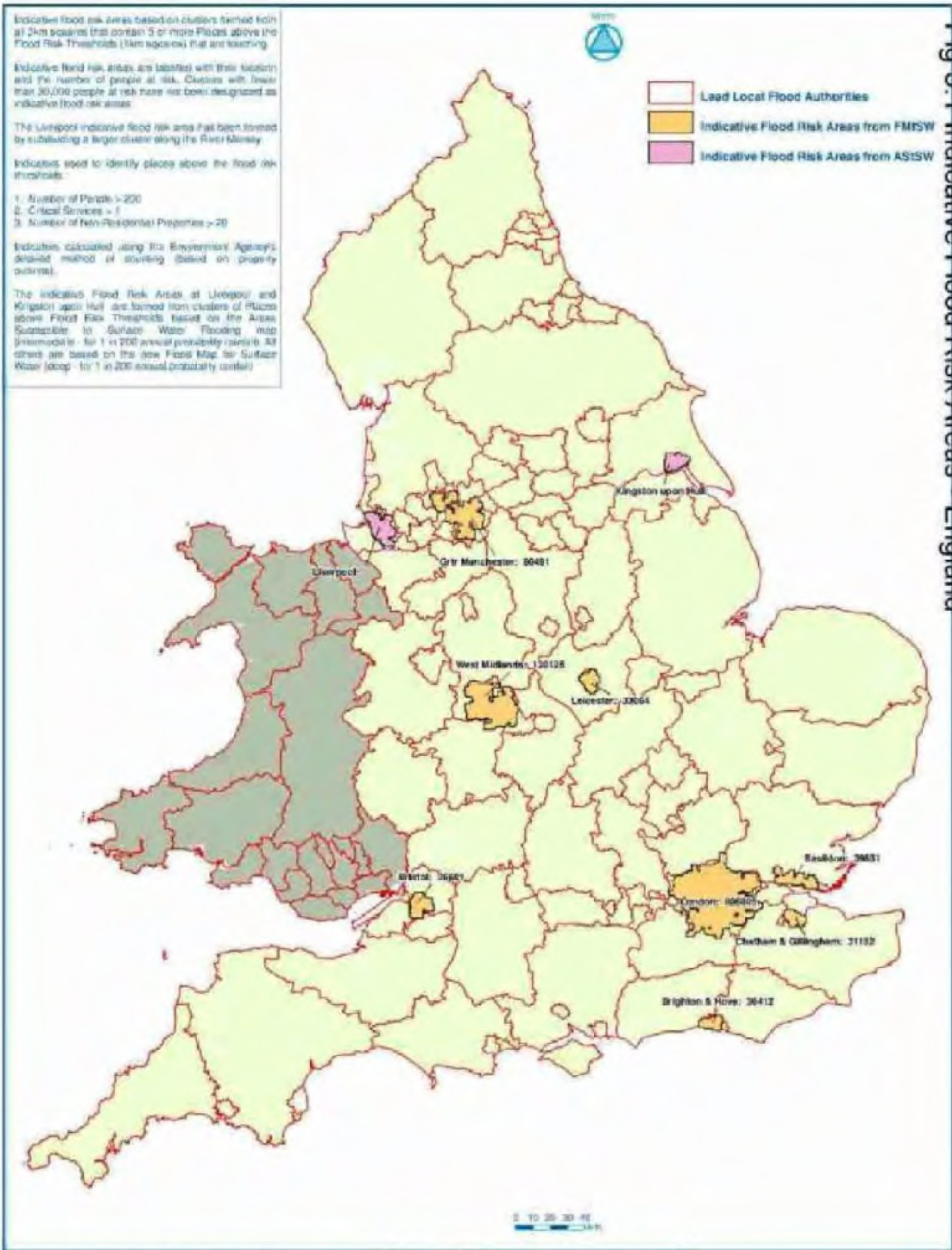


Fig 3.1 Indicative Flood Risk Areas – England

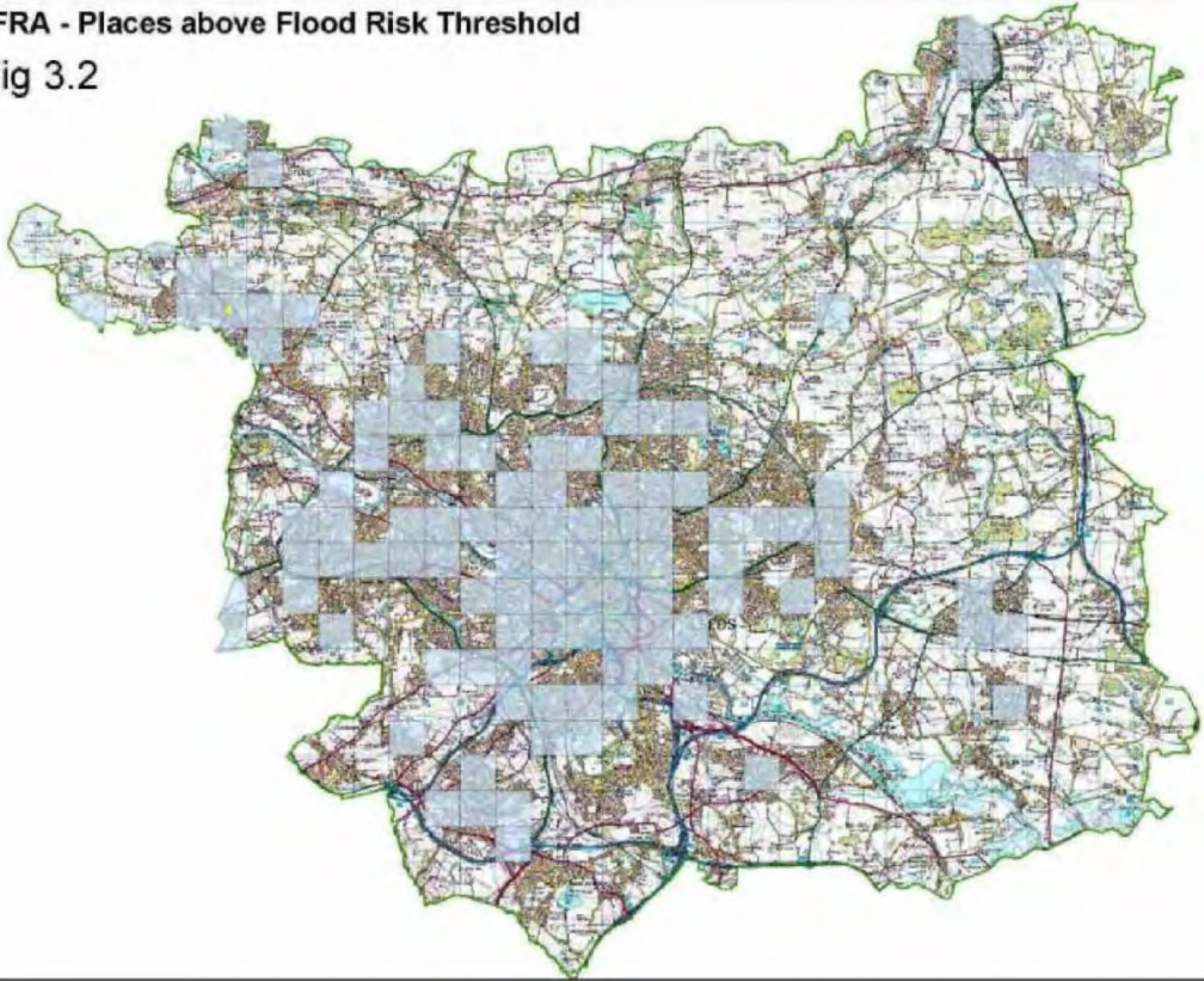
Indicative Flood Risk Areas for England

These are to be used by Lead Local Flood Authorities as part of the process for identifying Flood Risk Areas under the Flood Risk Regulations as set out in the Environment Agency and Defra & WAG guidance on PFRAs.

Environment Agency

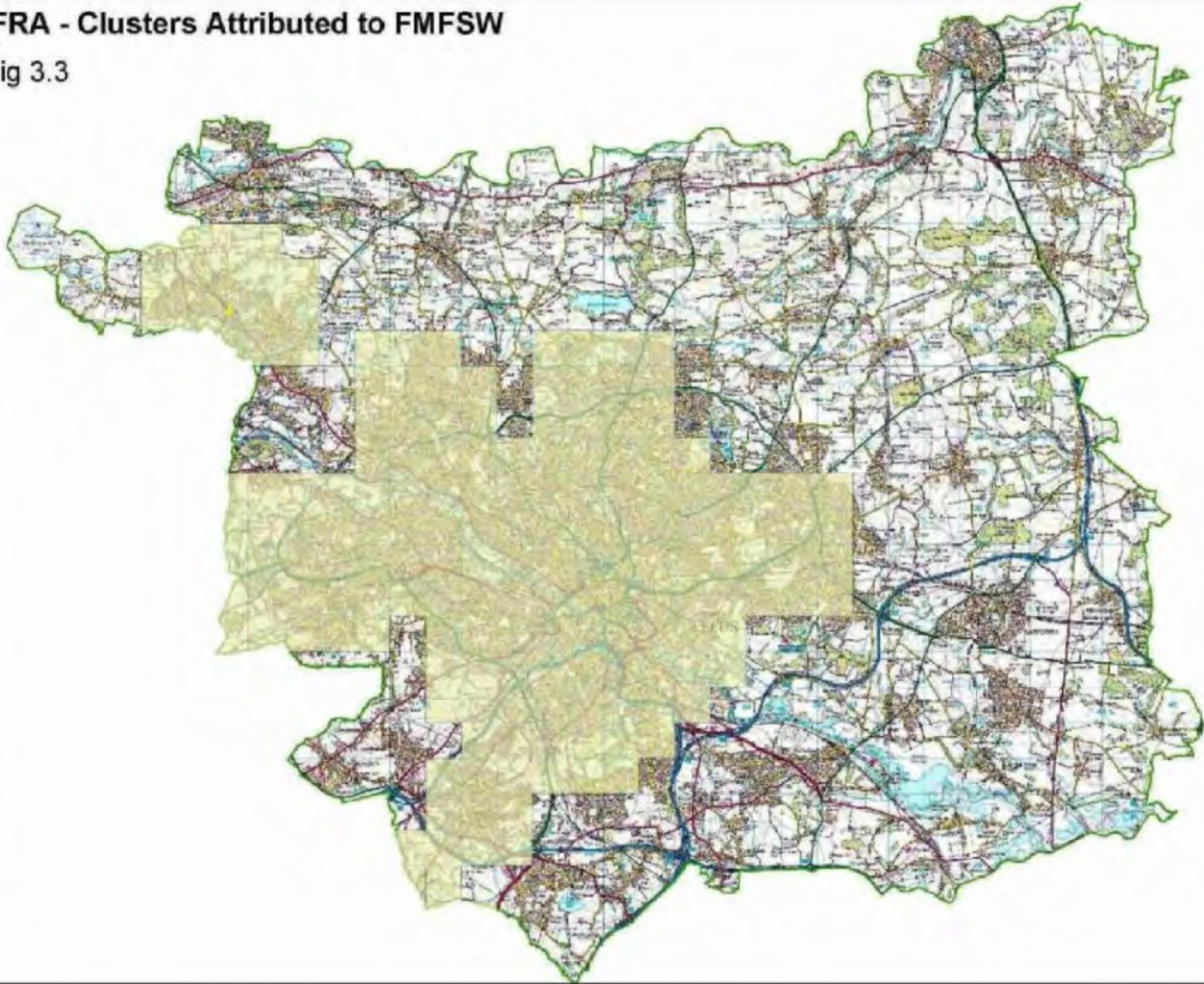
IFRA - Places above Flood Risk Threshold

Fig 3.2



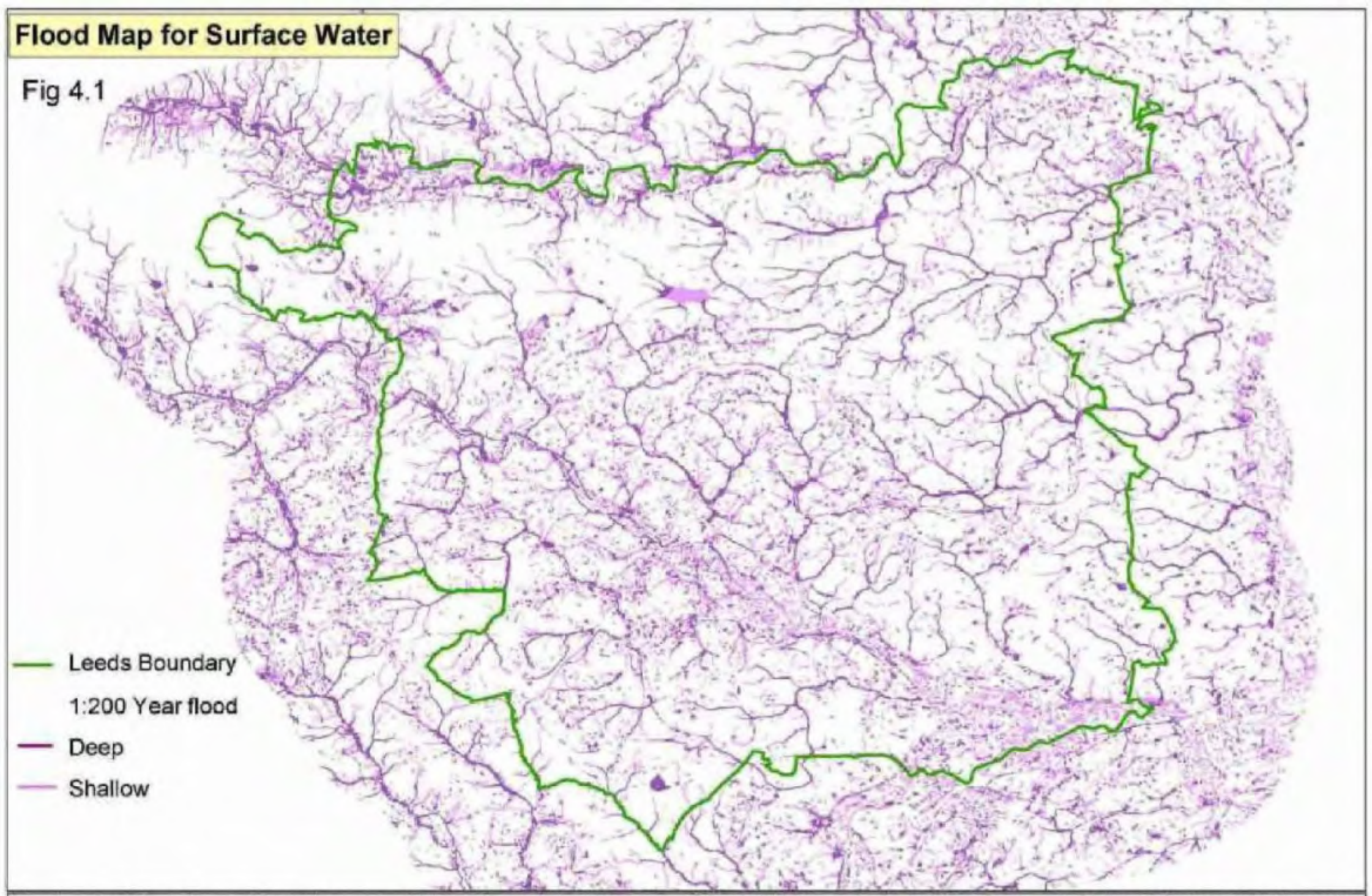
IFRA - Clusters Attributed to FMFSW

Fig 3.3



Flood Map for Surface Water

Fig 4.1



Drainage records shown on this plan (including locations, sizes and depths) are given in good faith, but must not be relied upon for any purpose without verification on site. Please note that any sewerage information incidentally shown on this plan could well be out of date. Copies of the current statutory sewer map must be obtained from Yorkshire Water.

Figure 4.2 Flood risk zones (fluvial flooding)

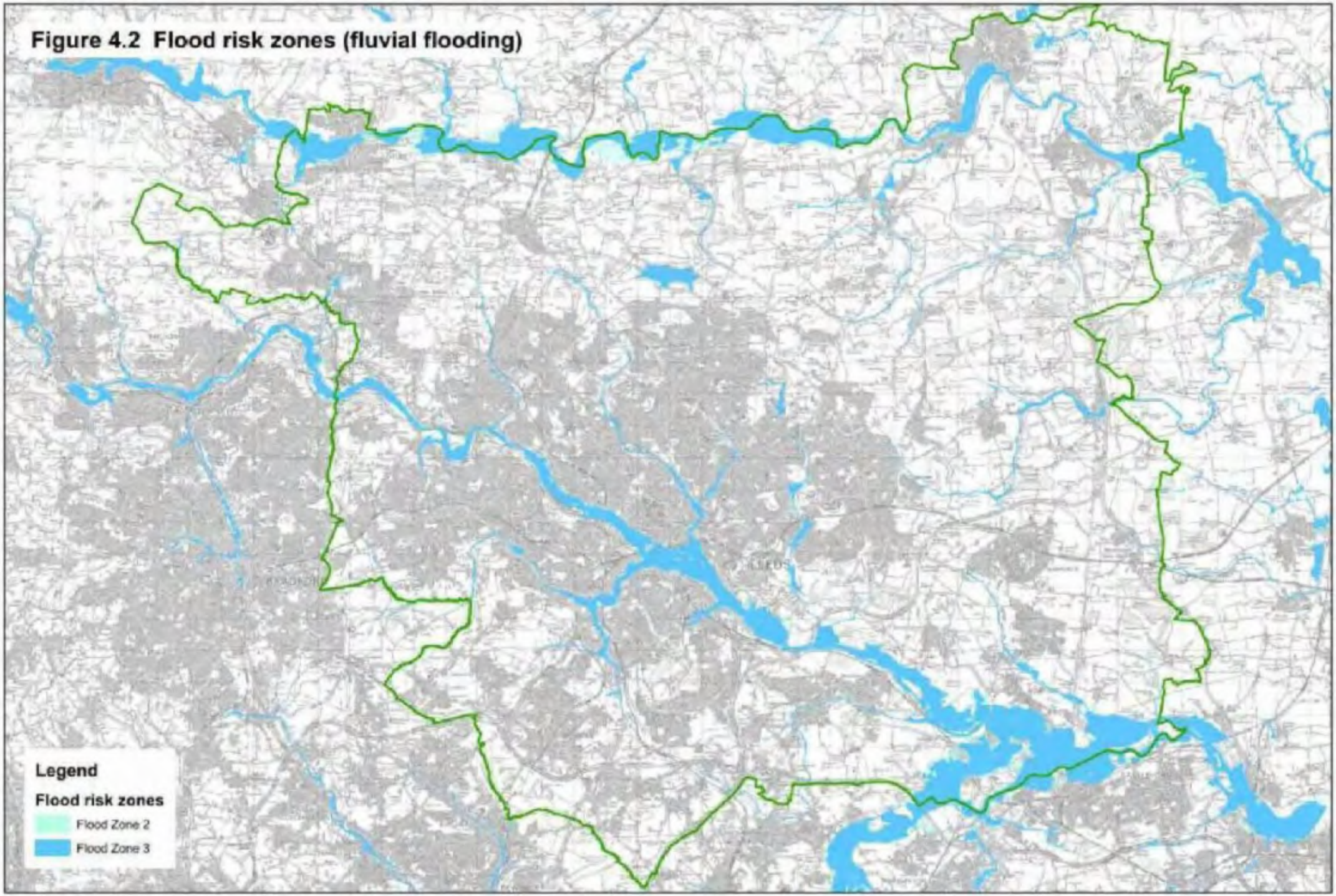


Figure 4.3 Leeds Stratgic Flood Risk Assessment

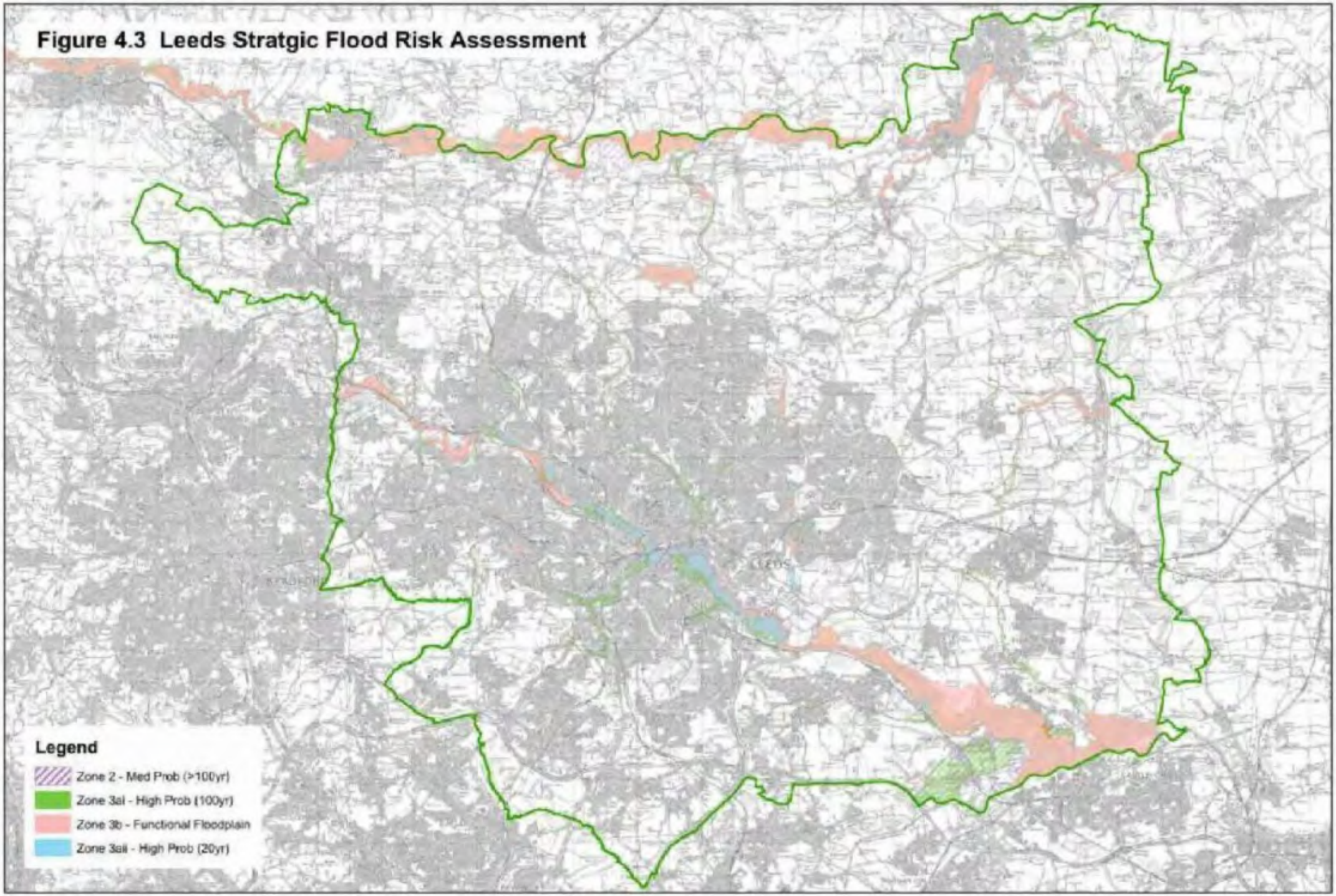


Figure 4.4 Areas susceptible to surface water flooding (EA)

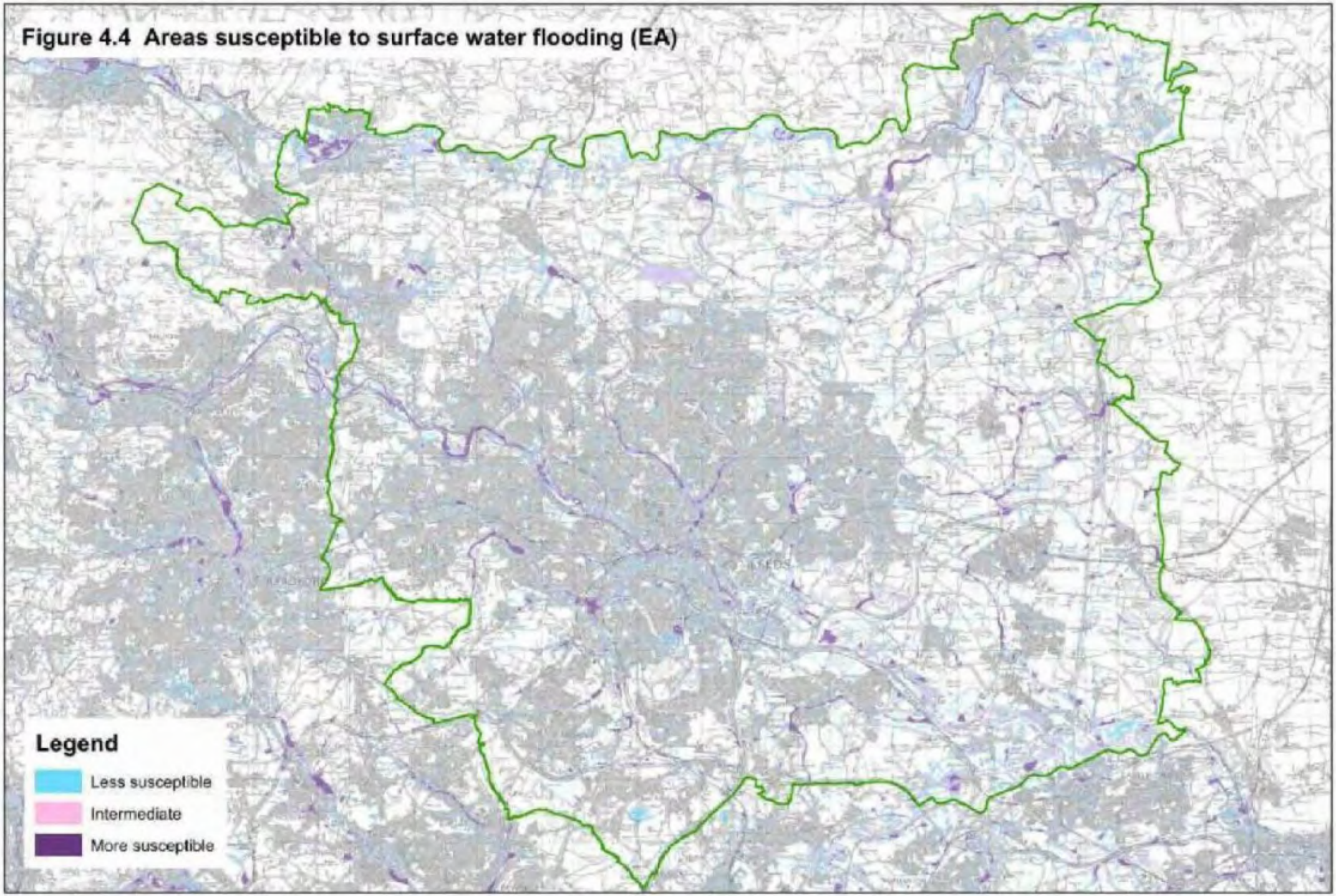


Figure 4.5 Flood extents in June 2007 (EA)