

Nottinghamshire Preliminary Flood Risk Assessment

- Preliminary Assessment Report
and identification of any Flood Risk
Areas

Final June 2011

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Cover picture

The photograph shows flooding in Southwell, Nottinghamshire from a combination of the Potwell Dyke (Ordinary Watercourse), surface water and local sewer systems. Such flooding highlights the nature of local flood risk, which we now have a pivotal role in managing as a Lead Local Flood Authority.

Executive Summary

The Flood Risk Regulations (2009) transpose the EC “Floods Directive” into UK law and in the first instance require Nottinghamshire County Council as Lead Local Flood Authority to prepare and publish a Preliminary Flood Risk Assessment (PFRA). The PFRA is a high level screening exercise to identify areas where flood risk is significant (known as Flood Risk Areas). The PFRA requires the preparation and publication of a Preliminary Assessment Report (PAR) on past and future flooding, including consideration of the consequences of that flooding and the identification of Flood Risk Areas. The PFRA covers the risk of flooding from local sources, namely Ordinary Watercourses, surface water (overland runoff) and groundwater. It does not consider directly flooding from Main Rivers, such as the River Trent. We have been liaising with communities, Elected Members and partner organisations throughout the development of the PFRA. This report includes the contents of the Preliminary Assessment Report and also addresses whether there are any areas where the flood risk is significant in accordance with the nationally defined thresholds.

A Flood Risk Area is a location where flooding is deemed significant (in a national context for reporting to Europe). In Flood Risk Areas the Regulations require LLFAs to prepare Flood Risk and Flood Hazard Mapping and complete a Flood Risk Management Plan. The threshold for significance used to determine Flood Risk Areas has been set by the Minister, one of the indicators for this assignment being that 30,000 people could be affected by local flooding at a particular location.

To assist LLFAs the Environment Agency has published maps showing the locations of indicative Flood Risk Areas for England and Wales. Reference to this mapping showed that nowhere in Nottinghamshire was identified as exceeding the national thresholds. As part of the process of preparing the PFRA we have reviewed the national mapping and data using the information we have collated as part of the PFRA and identified the potential for Nottingham and the surrounding urban areas to be considered as a Flood Risk Area. However, at this time we consider that working jointly with Nottingham City Council through our respective Local Flood Risk Management Strategies provides the most effective, flexible approach for managing local flood risk, in terms of activities and timescales.

This is not to say that localised flooding in Nottingham is insignificant. The flooding in June 2007 clearly highlighted how vulnerable our communities are to localised flooding. The Flood Risk Regulations are not the only route for managing localised flooding and clearly in this first round of assessment the Government has focussed on those areas at highest risk of flooding nationally. We are required to produce a Local Flood Risk Management Strategy for the County under the Flood and Water Management Act (2010) and this is likely to be the most appropriate, flexible and a much quicker route to managing localised flooding. Through the PFRA we have started to consider how we might prioritise those areas at greatest need across the County.

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Appendices and Annexes

Appendix A: Information available for the PFRA

Annex 1 Records of past floods and their significant consequences (spreadsheet)

Annex 2 Records of future floods and their consequences (spreadsheet)

Annex 3 Mapping

Annex 4 Review checklist (spreadsheet)

Mapping Annex

The following mapping has been developed to support the Preliminary Flood Risk Assessment and is presented in the Mapping Annex.

Map reference	Map shows	Link to PFRA Report
A	Topography in Nottinghamshire	Chapter 1
B	Past flood events in Nottinghamshire	Chapter 4
C	Records from the Confirm Highways Asset Management System	Chapter 4
D	Records from the Fire Service	Chapter 4
E	Records from Severn Trent Water	Chapter 4
F	Flooding in 2007	Chapter 4
G	Locally Agreed Surface Water Information for Nottinghamshire	Chapter 5
H	Areas Susceptible to Groundwater Flooding	Chapter 5
I	People that could be affected by flooding	Chapter 5
J	Critical services that could be affected by flooding	Chapter 5
K	Non-residential properties that could be affected by flooding	Chapter 5
L	Agricultural land that could be affected by flooding	Chapter 5
M	Environmental sites that could be affected by flooding	Chapter 5
N	Cultural heritage sites that could be affected by flooding	Chapter 5
O	Places where flood risk is an issue 'blue squares'	Chapter 6
P	Comparison of past and future flooding	Chapter 6
Q	Nottingham as a possible Flood Risk Area	Chapter 6

Abbreviations and definitions

AEP	Annual Exceedence Probability
AMP	Asset Management Plan
AStSWF	Areas Susceptible to Surface Water Flooding
BC	Borough Council
6 C's	Derbyshire County, Derby City, Leicestershire County, Leicester City, Nottinghamshire County and Nottingham City
CFMP	Catchment Flood Management Plan
Cllr	Councillor
COMAH	Control of Major Accident Hazard
CONFIRM™	Highways Asset Management System used by Nottinghamshire County Council
DC	District Council
DG5	Register kept by Water Company
EA	Environment Agency
EU	European Union
FCERM	Flood and Coastal Erosion Risk Management
FRA	Flood Risk Area
FRMP	Flood Risk Management Plan
FMfSW	Flood Map for Surface Water
GHG	Greenhouse gas
GIS	Geographical Information System
IDB	Internal Drainage Board
INSPIRE	EU Directive for spatial data
HAMS	Highways Asset Management System
LCLIP	Local Climate Impacts Profile
LLFA	Lead Local Flood Authority
LLPG	Local Land and Property Gazetteer
LRF	Local Resilience Forum
LSG	Local Street Gazetteer
OS	Ordnance Survey
NCC	Nottinghamshire County Council
RMA	Risk Management Authority
PAR	Preliminary Assessment Report
PFRA	Preliminary Flood Risk Assessment
PPC	Pollution Prevention Control
PPS25	Planning Policy Statement 25
SAB	Sustainable Drainage Systems Approving Body
SFRA	Strategic Flood Risk Assessment
SUDS	Sustainable Drainage Systems
SWMP	Surface water Management Plan
TAN15	Technical Advice Note 15
UK	United Kingdom
UKCP09	United Kingdom Climate Projections 2009
USRN	Unique Street Reference Number
WaSC	Water and Sewerage Company

1. Introduction

1.1 Scope of report

The Flood Risk Regulations (2009) transpose the EC 'Floods directive' into UK law and require Lead Local Flood Authorities (LLFAs) to complete a Preliminary Assessment Report (PAR) on past and future flood risk from local sources of flooding. The Regulations also require the LLFA to identify significant Flood Risk Areas. These two actions make up the Preliminary Flood Risk assessment (PFRA) which Nottinghamshire County Council as LLFA for the County must complete by June 2011.

Flood risk = probability x consequences

Flood Risk is defined as the combination of the probability of flooding occurring (which is often expressed as a return period or Annual Exceedence Probability) and the potential consequences should that flooding occur (for example on people, homes, business, critical infrastructure and services and the environment [including sites of cultural heritage]). For the purposes of this report we have expressed flood probability as an Annual Exceedence Probability (AEP). Hence a flood with a 1% AEP has a 1 in 100 chance of happening in any one year or a return period of 100 years. Return periods can be misleading however as they suggest that such a flood might not happen again for another 100 years.

This PFRA covers the risk of flooding from local sources, namely:

- Surface runoff - meaning water on the surface that has not yet entered a watercourse, drainage system or public sewer.
- Groundwater - meaning water below the ground that is in direct contact with the ground or subsoil.
- Ordinary watercourses – includes lakes, ponds and other areas of water that flow into an Ordinary Watercourse. Ordinary Watercourses are those that are not defined as Main River by the Water Resources Act (1991) and shown on the Environment Agency's Main River map.



As part of the PFRA the Preliminary Assessment Report has considered past flooding and where future flooding may occur across the County and the consequences this might have for people, properties and the environment, including cultural heritage. To comply with the Regulations the PFRA considers whether the flood risk in any part of Nottinghamshire and that shared across the County Borders as appropriate is considered 'significant' in a national context (for reporting to Europe). Where a 'Flood Risk Area' is identified there are future requirements under the Flood Risk Regulations for LLFAs to prepare Flood Risk and Hazard Mapping and a Flood Risk Management Plan. The threshold for significance that determines the locations of Flood Risk Areas has been set by the Minister, one of the indicators to define the threshold being that 30,000 people could be affected by local flooding (note that this does not include flooding from Main River).

The PFRA does not consider flooding directly from Main Rivers, such as the River Trent, large raised reservoirs, burst water mains or from any part of a sewerage system unless the flooding from the sewers is caused by an increase in the volume of rainwater. It has considered where there may be interactions between other sources of flooding. Under the Flood Risk Regulations, the Environment Agency are obliged to consider flooding from Main Rivers, the Sea and Reservoirs. They have exercised an exception clause and will not be producing a PFRA. This means that they will prepare Flood Risk and Hazard Mapping and undertake Flood Risk Management Plans for the respective flood sources for the entire area under their responsibility.

The flooding in June 2007 clearly highlighted how vulnerable our communities are to localised flooding. Now that the County is a Lead Local Flood Authority we have new roles and responsibilities, duties and powers to help manage flood risk from localised sources across the County. The Flood Risk Regulations are not the only route for managing localised flooding and clearly in this first round of assessment the Government has focussed on those areas at highest risk of flooding nationally. We are required to produce a Local Flood Risk Management Strategy (LFRMS) for the County in accordance with the provisions of the Flood and Water Management Act (2010). The LFRMS is likely to be the most appropriate, flexible and efficient means of managing localised flooding. Using the information collected for the PFRA we have started to consider how we might prioritise those areas at greatest needs across the County to inform the preparation of the LFRMS.

1.2 Aims and objectives

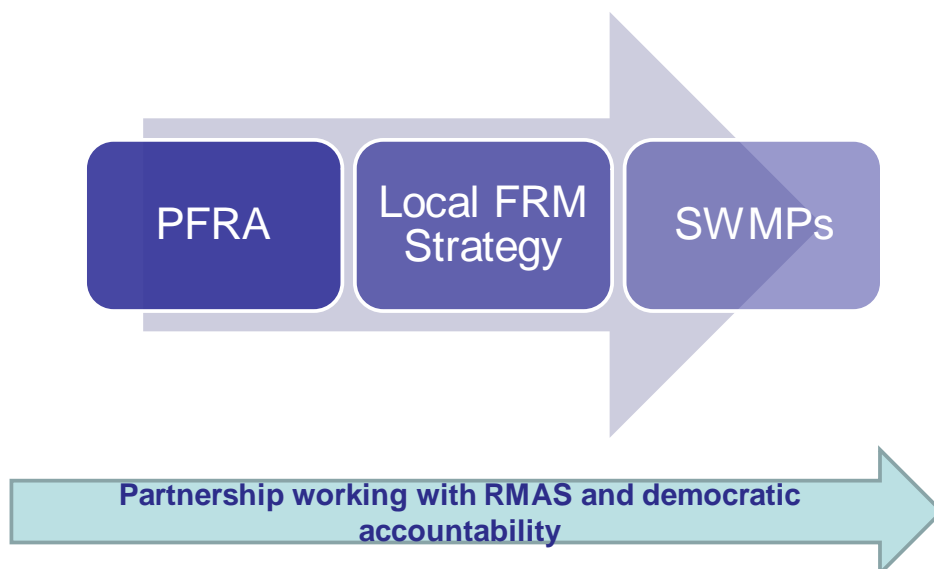
The first stage of the PFRA is to prepare the Preliminary Assessment Report which essentially describes a broadscale and strategic assessment of flood risk across the County so that we can answer the question "where is local flood risk significant in national terms?". This is to inform the identification of 'significant' Flood Risk Areas.

The objectives of the PFRA have been to:

- Work with the Risk Management Authorities (RMAs) across the County and our neighbouring LLFAs to better understand the distribution of local flood risk across the County,
- Bring together information on past flooding and its consequences, to understand where it has had significant harmful consequences,
- Bring together information on flooding that may happen in the future 'future flooding', to understand where it may have possible harmful consequences,
- Use the information as evidence to decide if there should be any Flood Risk Areas in Nottinghamshire that meet the national thresholds,
- Develop the PFRA in such a way that there is a clear feed forward into the Local Flood Risk Management Strategy, and
- Set up a system to collate, store and maintain flooding information within Nottinghamshire County Council, making the best available use of current systems and with regard to the EU INSPIRE Directive.

The Nottinghamshire PFRA does not attempt to assess flood risk in great detail at all locations across the County and set priorities for future action. Rather it is the first step in a process of assessing flood risk and bringing together data and understanding from across the County to underpin our work as a Lead Local Flood Authority. Figure 1-1 shows how we intend the PFRA to fit into the long term framework of developing strategies and plans, each with increasing level of detail and supported by both partnership working and local democracy through the role of Elected Members and by working with our local communities.

Figure 1-1 Strategic flood risk management studies in Nottinghamshire (LLFA led)



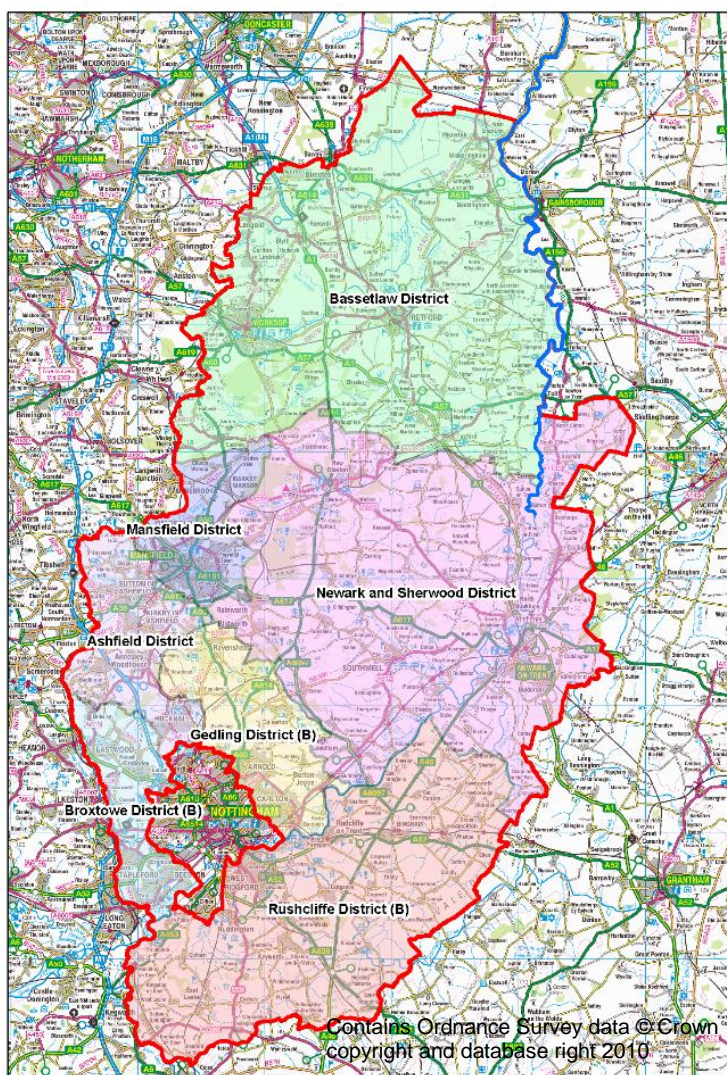
The Local Flood Risk Management Strategy will set objectives and measures that we can take forward to manage flood risk for all areas of the County. It will identify the likely locations of future Surface Water Management Plans (SWMPs). We consider that Surface Water Management Plans will be used to deliver the strategy in critical locations where flood risk is high, the sources of flooding are complicated and further investigation is justified. In these locations we will undertake detailed options appraisal within a partnership collaborating with other relevant RMA's to prepare realistic and achievable Action Plans. It is noted that in many places such detailed work is not likely to be justified or necessary, for example where the flood risk is relatively low and partners can identify quick wins, such as supporting applications for Property Flood Protection grants, or changing the camber of a local road to divert water into a field instead of nearby houses. Even where flood risk is higher, such solutions may be more appropriate and particularly so where the mechanisms of flooding are very complicated and it is likely that a capital scheme would quickly become prohibitively expensive.

Structural solutions to flooding are only one example from a toolbox of actions that we can choose from. We have a wide range of options to choose from and these will be delivered by working both across service areas within the County Council and wider organisations, including the seven District and Borough Councils, Internal Drainage Boards (IDBs), the Environment Agency and Water Companies (WaSCs). Non-structural solutions, including spatial planning in the form of sustainable planning for new development (policy planning) and development control and emergency planning, such as supporting communities to become more resilient to flooding will be key components our response to flood risk both now and going forward.

1.3 Welcome to Nottinghamshire

Nottinghamshire is a County in the East Midlands, which covers an area of around 2,087km². In Nottinghamshire services for our local communities are shared between the County and District/ Borough Councils, and in some instances Parish or Town Councils. The Boroughs in Nottinghamshire are Broxtowe, Gedling and Rushcliffe. The Districts are Ashfield, Bassetlaw, Gedling and Newark and Sherwood. The City of Nottingham is a unitary Council created in 1998, which nestles within the wider area of Nottinghamshire.

Figure 1-2 Nottinghamshire Districts and Boroughs



The County has a population of 776,600¹ and the main urban centres are Nottingham (part of the urban area is covered by Ashfield District Council (Hucknall), Broxtowe Borough (Beeston and Stapleford), Gedling Borough (Arnold and Carlton) and Rushcliffe Borough (West Bridgford)), Mansfield, Sutton-in-Ashfield, Newark, Worksop and Retford.

The County is largely drained by the River Trent which flows northwards into the Humber Estuary, although a small part of the County to the north east drains into the River Witham and over towards the East Coast. The floodplain of the River Trent is relatively flat and flooding has caused major damage and disruption in the past, such as in 1947 and more recently in 2000. The flooding of June 2007 highlighted the vulnerability of Nottinghamshire to more local sources of flooding, such as surface water and the sewer and highway drainage networks becoming overwhelmed and being affected by backing up from Main Rivers and Ordinary Watercourses.

Map A shows how the elevation of the County varies, from the steep topographic ridge that runs through Gedling Borough to the undulating hills of the south and west to the low lying areas that are in some cases artificially drained to the north and east. Considered against the

¹ Mid 2009 estimate, Source: Office for National Statistics licensed under the Open Government Licence v.1.0.

pattern of urban areas, this means that areas such as Nottingham, Mansfield and Sutton-in-Ashfield are likely to be particularly vulnerable to surface water flooding, due to the high coverage of impermeable surfaces, hilly landscape and nature of urban watercourses, which in some cases have been culverted over time as our urban centres have expanded. Future development, such as that being driven forward by the Greater Nottingham and Newark and Sherwood Growth point initiatives has the potential to increase flood risk, if not carefully managed.

This is not to say that our rural communities are not affected by localised flooding and flooding in these areas can be influenced by upstream land management promoting rapid runoff during storm events and the limited capacity of many of the smaller watercourses and the highways drainage and sewer network (where one exists). In low lying areas, Internal Drainage Boards (IDBs) have been set up to manage the special drainage characteristics of these areas. Such areas often rely on pumped drainage and flood waters can pond and take longer to disperse.

The pattern of flooding is further complicated by the underlying geology. Nottinghamshire lies within a broad belt of sedimentary rocks, which dip gently eastwards, from the Pennine axis of Derbyshire towards Lincolnshire and the North Sea basin. There are coal measures to the west, which has influenced the distribution of past mining activity. In places the solid geology is overlain by drift geology of former glacial and river deposits, such as gravels, many sites of which have been excavated over time including Attenborough Lakes. In areas underlain by clays and less permeable drift geology, there is likely to be a faster response to rainfall.²

The condition and location of drainage assets also has an important local influence on flooding and indeed many of the localised flooding incidents reported to us and our partners are related to blockage, failure or mis-connection of the local drainage network, including culverted watercourses, surface water sewers and highway gullies. The historic handover of local services from former urban and rural district councils, the sewerage agency role to water companies and the development of housing in the past by the Coal Authority means that in many places the ownership and in some places location of the drainage network is unclear and/ or unknown. As a County Council we do our best to investigate and resolve such difficulties and we have systems in place to store historical drainage designs and map the locations of our highway drainage network.

As a County Council, our local communities are represented by 67 Elected Members (Councillors) and we have a lead Elected Member who represents both the County and Nottingham City Council on the Midlands Region Regional Flood Defence Committee (which under the provisions of the Flood and Water Management Act will become a Regional Flood and Coastal Committee). The portfolio holder for Transport and Highways covers flooding issues on the Council Cabinet and flooding is scrutinised by the Communities and the Environment Standing Committee. The main issues in the PFRA were considered by the Standing Committee on the 11th April 2011.

² Source of geology information <http://www.nottinghamshire.gov.uk/mlp-geologymap.pdf>

2. Lead Local Flood Authority responsibilities

2.1 Introduction

2.1.1 Flood Risk Management

Flood risk management is a cross-cutting activity that sits across a range of functions in local government, including Highways, Spatial Planning, Emergency Planning and Sustainability and Climate Change. The County Council in some circumstances also has responsibilities as a Riparian Land Owner and intends to lead by example.

Following the flooding of summer 2007 the government commissioned an independent review chaired by Sir Michael Pitt. The final report, published in June 2008, highlighted the gaps with respect to responsibility for local sources of flooding. The report made a total of 92 recommendations, including that:

Recommendation 2	"The Environment Agency should progressively take on a national overview of all flood risk, including surface water and groundwater flood risk, with immediate effect"
Recommendation 14	"Local authorities should lead on the management of local flood risk, with the support of the relevant organisations".
Recommendation 17	"All relevant organisations should have a duty to share information and cooperate with local authorities and the Environment Agency to facilitate the management of flood risk."

The following legislation has brought forward recommendations from the Pitt Review, notably:

- The Flood Risk Regulations (November 2009)
- The Flood and Water Management Act (April 2010), which is being commenced in stages and for which the full implementation timeframe is not yet available. The most recent stages were commenced in April 2011.

Both of these pieces of legislation have significant implications for the County Council in terms of resources, skills and capacity for flood risk management. To meet the requirements a team is currently being built up around the existing County Drainage Manager role. The County Drainage Manager has been in post since May 2007 and has been pivotal in Nottinghamshire County Councils response to the flooding of summer 2007, working in close partnership with Districts, Boroughs, Internal Drainage Boards, Severn Trent Water and the Environment Agency to help reduce the impact of future flood events on our local communities.

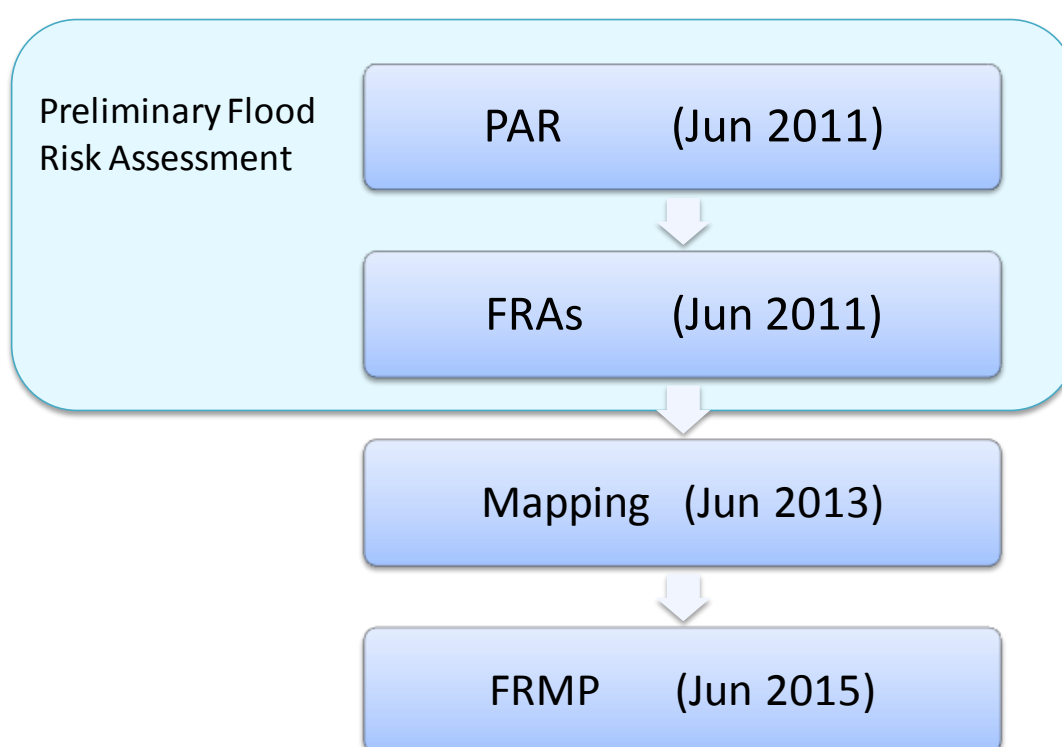
Prior to the implementation of the Flood and Water Management Act (2010) we were already making substantial levels of commitment to investigating flooding problems in partnership with all other organisations. Multi agency partnerships are currently working on flooding problems in areas such as Woodborough, Oxtun, Lowdham, Bleasby, Sutton on Trent, Egmont, East Stoke, Southwell, Thurgarton, North Leverton, East Markham and Retford. There is significant Elected Member interest and involvement in all these areas and in other communities affected by flooding. Flooding has been the subject of frequent scrutiny reviews, including a review of 2007 floods.

We cannot manage flooding on our own, since rainfall and runoff do not respect administrative, political or organisational boundaries. Our Strategic Plan 2010-2014 recognises that 'The success of our plan relies on us working well together with local people and organisations.' One of our priorities is 'to promote the economic prosperity of Nottinghamshire and safeguard our environment'. This complements our Sustainable Communities Strategy 2010-2020, as part of one of the six priorities 'Making Nottinghamshire Greener' includes undertaking flood risk management.

2.1.2 Flood Risk Regulations (2009) and the PFRA

The Flood Risk Regulations (2009) transpose the EC “Floods Directive” into UK law and in the first instance require the County Council to prepare and publish a Preliminary Flood Risk Assessment (PFRA). The PFRA is a high level screening exercise to identify areas where flood risk is significant (known as Flood Risk Areas). The PFRA requires the preparation and publication of the Preliminary Assessment Report (PAR) on past and future flooding. The PFRA must include consideration of the consequences of that flooding and the review and identification of Flood Risk Areas. The development of the PFRA is also linked to the first stage of the preparation of the Local Flood Risk Management Strategy required under the Flood and Water Management Act (2010).

Figure 2-1 Requirements and timescales for The Flood Risk Regulations



2.1.3 Flood and Water Management Act (2010)

The Flood and Water Management Act received Royal Assent in April 2010 and is now in the process of a phased commencement being conducted by the new government. The phasing of the commencement of the Act is programmed to reflect available funding, skills and capacity in LLFAs and coordination with any further consultation or legislation that may be necessary. Table 2-1 outlines the key implications in the Act for Nottinghamshire as a LLFA and summarises which sections have now been enacted up to May 2011. NCC as a Highways Authority maintains its role under the Highways Act (1980) in providing highways drainage.

Table 2-1 Summary of implications for NCC as a LLFA under the Flood and Water Management Act (2010)

Sections of the Flood and Water Management Act	Legislation status as of April 2011*
Formal definitions for many flood related issues that have not previously had a clear legal status. For example there are now formal definitions for things such as surface water runoff, culverts, features that affect flood risk, etc	Commenced
Enables local partnerships between the LLFA and Risk Management Authorities to deliver local flood risk management. This includes delegation between RMAs but not the development of the Local Flood Risk Management Strategy	Commenced
LLFA Scrutiny of RMAs	Commenced
Develop, maintain, apply and monitor a Local Flood Risk Management Strategy	Commenced
Investigating flood incidents to the extent considered necessary or appropriate	Commenced
Maintaining a register of structures and features that have a significant effect on flood risk	Commenced
Designation of third party assets and powers of enforcement where they serve a significant flood risk management function	Not yet commenced
Powers to do work to manage flood risk from surface water and groundwater	Not yet commenced
The Environment Agency, local authorities and IDBs will be able to carry out environmental works to manage water levels to provide leisure, habitat and other environmental benefits.	Not yet commenced
Sustainable Drainage Systems Approval Body (SAB)	Not yet commenced
Introduces a risk based approach to reservoir management	Not yet commenced
Consenting and enforcing powers for certain works affecting flows in Ordinary Watercourses	Not yet commenced

*Is not intended to cover those requirements commenced only in minor part

The implementation of the Act is a complicated task in a two tier setting, since many of the functions carried out by local government sit across two tiers (and in some instances three tiers, including town and parish councils). The following are areas where there is involvement of more than one level of local government:

- Spatial Planning, with Highways Development Controls, Minerals and Waste Planning and County Council development Development Control sitting at County level, but the majority of planning functions with respect to policy planning and development control sitting within District and Borough Councils,
- Emergency planning, response and recovery being shared across first and second tiers as appropriate, with the main driver being the Civil Contingencies Act (2004) and
- Drainage, with the Highways Drainage function sitting at County level and land drainage responsibilities under the Land Drainage Act (1991) sitting largely with Borough and District Councils and Internal Drainage Boards.

It is important to note that the Flood and Water Management Act has not attempted to change the majority of these functions and indeed allows for delegation of responsibilities between Risk Management Authorities as appropriate. Table 2-2 summarises the new responsibilities that different organisations across Nottinghamshire will now have under the Flood and Water Management Act.

Table 2-2 Roles and responsibilities under the Flood and Water Management Act

Risk Management Authority	Strategic Level	Operational Level
Environment Agency	Strategic overview for all sources of flooding National Strategy Reporting and general supervision	Main rivers Sea Reservoirs
Lead Local Flood Authority (County Council)	Input to the National strategy Produce Local Flood Risk Management Strategy	Surface Water Groundwater
Four District and three Borough Councils Internal Drainage Boards	Input to the National and Local Strategies	Ordinary watercourses Potential delegation for other local sources

2.2 Governance and Partnership

2.2.1 Risk Management Authorities in Nottinghamshire

Table 2-3 shows the organisations in Nottinghamshire that are now Risk Management Authorities. As a LLFA, Nottinghamshire County Council is also classed as a RMA.

Table 2-3 Risk Management Authorities (RMAs) in Nottinghamshire

District or Borough Councils	Internal Drainage Boards	Water Companies	Other
<ul style="list-style-type: none"> Ashfield District Bassetlaw District Broxtowe Borough Gedling Borough Mansfield District Newark and Sherwood District Rushcliffe Borough 	<ul style="list-style-type: none"> Fairham Brook Finningley Hatfield Chase Isle of Axholme and North Nottinghamshire Water Level Management Board Kingston Brook Laneham Newark Area Tickhill Upper Witham 	<ul style="list-style-type: none"> Anglian Water (note drainage function is only in part of Newark and Sherwood District) Severn Trent Water 	<ul style="list-style-type: none"> Environment Agency Highways Agency

2.2.2 Neighbouring LLFAs

Rainfall and surface runoff do not respect administrative, political or organisational boundaries and this is demonstrated in Nottinghamshire by our shared integrated urban drainage issues with Nottingham City Council, which is also a unitary authority and Lead Local Flood Authority. In addition, to a lesser extent, we have catchment boundaries shared with Derbyshire (County), Rotherham (Unitary), Doncaster (Unitary), North Lincolnshire (Unitary), Lincolnshire (County) and Leicestershire (County).

We recognise the importance of working across our County borders, not only to reduce the likelihood and consequences of flooding to our local communities but also to understand how we can best manage flooding to reduce the risk elsewhere. In doing this we must 'learn from each other' at this time and share ideas as we collectively take on the roles and responsibilities associated with acting as a Lead Local Flood Authority.

We have been working in particularly close partnership through the East Midlands LLFA group, facilitated by the Environment Agency, including the '6 C's' Derbyshire County, Derby

City, Leicestershire County, Leicester City, Nottinghamshire County and Nottingham City and also Lincolnshire. We have also been keen to share experience across a wider area, including Staffordshire, Oxfordshire and Northamptonshire.

2.2.3 Nottinghamshire and Nottingham Strategic Flood Risk Management Board

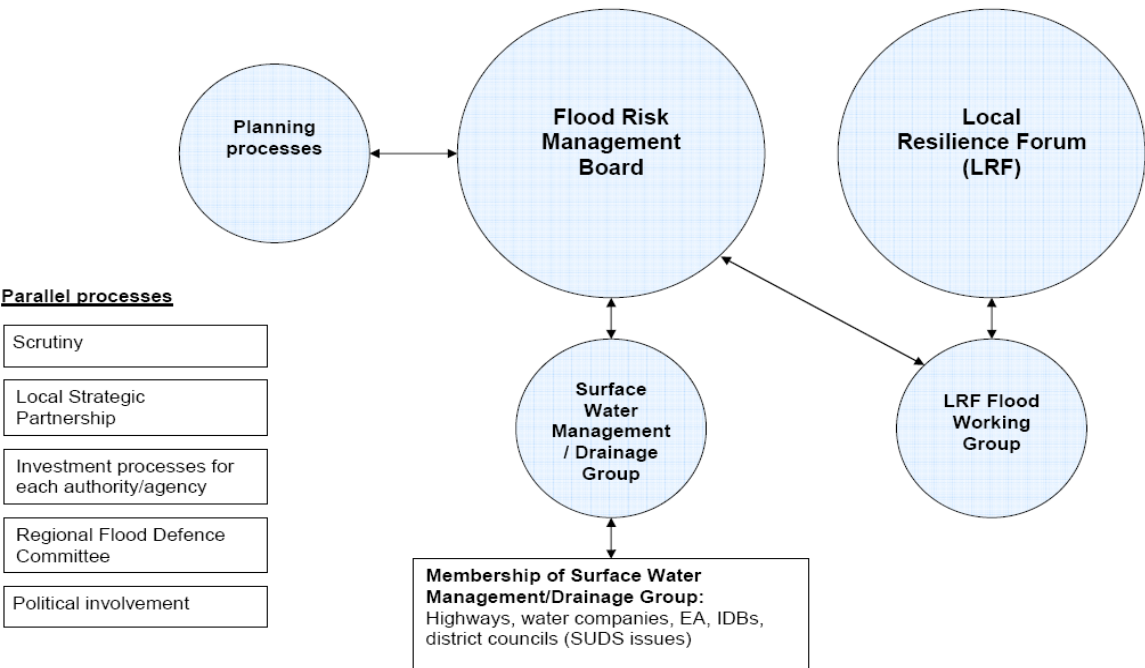
A Cabinet Report has recently been approved that will enable the establishment of a joint Strategic Flood Risk Management Board with Nottingham City Council. This would be set up in a similar way to those operating in other parts of the Midlands, such as the joint Board covering Leicester, Leicestershire and Rutland.

The Board will run in parallel to the Nottingham and Nottinghamshire Local Resilience Forum, with the focus of the Board being to manage and reduce existing flood risk and provide strategic advice and direction, alongside guidance on resources and the prioritisation of activities. The Board will operate at a Strategic level, with membership of Senior Officers from NCC, District and/ or Borough Councils, IDBs, Severn Trent Water and the Environment Agency. The Board will be chaired by the same Elected Member who represents Nottinghamshire County Council on the Regional Flood and Coastal Committee.

It is the intention that a Surface Water Management/ Drainage Group, with representation from NCC (Highways), all Districts and Boroughs, Water Companies, the Environment Agency and IDBs will be established and will report to the Strategic Flood Risk Management Board. This will build on the strengths of existing groups, such as the Bassetlaw Drainage Co-ordination Group and operational meetings. The structure and set up of this group or set of groups is currently being reviewed by the County Council.

Figure 2-2 Proposed set up of the Nottinghamshire and Nottingham Strategic Flood Risk Management Board

Nottinghamshire and Nottingham Strategic Flood Risk Management Board



2.3 Communication with partners and the public

In keeping with the aims of localism and the ideal of the ‘big society’ we intend that local flood risk management in Nottinghamshire will not be ‘top down’ process and we wish to work closely at local level with our partners and communities to manage flood risk together. This is not new and we are practised at working closely with Districts, Boroughs, Internal Drainage Boards and local community flood groups, such as Parish Councils to take action as appropriate to reduce flood risk.

During the course of preparing the PFRA, in September 2010 the County Council wrote to all 199 Parish and Town Councils / Meetings and also the 67 Elected Members. The purpose of this letter was to request a list of known problem locations from a drainage perspective. This information has been used to inform the PFRA.

We have been working with partner organisations to raise awareness of the new roles and responsibilities for local flood risk management, collect data and engage them in the development of the PFRA and Local Flood Risk Management Strategy. On the 17th February 2011 we held a joint workshop with the City Council at which we invited representatives from the Districts and Boroughs, Internal Drainage Boards, Environment Agency and Severn Trent Water. Cllr Laughton as the lead member for flooding also attended. The objectives of this workshop were to:

- Provide an update on emerging legislation, national consultations and how the City and County are taking forward the Lead Local Flood Authority role,
- Engage delegates in the Preliminary Flood Risk Assessment process and how this will inform the Local Flood Risk Management Strategy and potential Surface Water Management Plan work,
- Discuss and gain opinion on the opportunities and challenges for partnership working, and
- Gain feedback on the above to feed into work undertaken by the Lead Local Flood Authorities and their partners in the future when undertaking Local Flood Risk Management work.

The outcomes from the workshop will feed into our programme of work for local flood risk management, including the Local Flood Risk Management Strategy, Duty to Investigate and the Register of Structures and Features.

At the workshop we asked how the PFRA should set up the process for the Strategy, and responses included:

- Having political and managerial buy-in, structures and people in place, clear defined roles
- Using the links and partnerships established for the PFRA to continue working together
- Having a common method of data collection/storing and sharing and having high quality data
- Identifying critical or vulnerable sites
- Reflecting the needs of urban and rural communities.

We have done our best to consider these when preparing the PFRA. Where further detail is required beyond the scope of the broadscale and strategic assessment performed for the PFRA, we will carry forward responses so they inform our Local Flood Risk Management Strategy.

Figure 2-3 Joint workshop with stakeholders in February 2011



We intend that the Local Flood Risk Management Strategy that we will develop will truly be Nottinghamshire's and not Nottinghamshire County Council's strategy. To achieve this we need to engender understanding of flood risk across the County with our partners, Elected Members and local communities, alongside acceptance of what measures we can take to manage the risk by working together in an integrated manner. To this end we are looking into developing an engagement strategy to underpin the work required to prepare the Local Flood Risk Management Strategy.

3. Methodology and data review

3.1 Methodology

The PFRA has been carried out in accordance with the methodology set out in the Environment Agency's Preliminary Flood Risk Assessment Final Guidance (December 2010). The stages of development of the PFRA are shown in Table 3-1.

The PFRA has brought together information on past and future flooding so that the indicative Flood Risk Areas supplied could be reviewed. It has always been the intention of the County Council that this piece of work should be comprehensive and thorough so that it serves as a sound footing for the Local Flood Risk Management Strategy.

Table 3-1 Schedule of development of PFRA

Date	Activity
August 2010 and ongoing action	Development of governance and partnerships. Collation of data on past floods from other organisations, including Parish Councils.
August 2010 – January 2011	Stage 1 Report: Scoping data availability and capacity report. 'Flood risk management roadshow' and meetings with Districts, Boroughs, IDBs and Water Companies. Determine data system
November 2010 – March 2011	Data collation. Start assessment of flood risk based on available data on past and future floods. Determine locally agreed surface water information.
February 2011	Joint Local Flood Risk Management Workshop with Nottingham City Council.
February 2011 – May 2011	Drafting Preliminary Assessment Report (described in this document). Extract information for Annex spreadsheets. Identify Flood Risk Areas (including joint meeting with Nottingham City Council and the Environment Agency)
April 2011	Scrutiny Review of main issues.
May – June 2011	Complete Preliminary Assessment Report and Annex spreadsheet and sign off in accordance with County Councils Schedule of Delegation ER2.11 by Group Manager Transport Policy and Programmes.

This PFRA contains all the information required for the Preliminary Assessment Report and also addresses whether there are any areas where the flood risk is nationally significant. As such it satisfies the two stages of the PFRA requirements as described in the Flood Risk Regulations.

3.2 Information gathered and the availability and limitations

Flood related information exists in a number of different formats (both hard and digital) across a number of different service areas. Information has been collected from various different organisations over time for different purposes. The majority of past flooding information

relates to the summer floods of 2007. Appendix A summarises the data that was readily available for the PFRA. Much greater detail has been recorded in the data register that supports the data management system for the PFRA.

Data requests were sent to many of our partner organisations at the end of November 2010. A large amount of data has been received and for the purpose of the PFRA a 'cut off' has now been applied as it will not be possible to assess any further data within the specified time available. At this time it is understood that there is potentially a lot of data that might be available on assets. This asset data will feed through into the Nottinghamshire Local Flood Risk Management Strategy and Register of Structures and Features and thus will be used for the management of local flood risk.

A large number and variety of organisations have been approached and not all had or held data that could be made readily available. Such organisations will be contacted again in the future, where their specific input is needed for our local flood risk management activities. Another review of organisations will also be undertaken to identify further and in some cases more locally specific organisations that are likely to hold information, including Anglian Water who only cover a small part of Nottinghamshire and Nottingham Express Transit, who operate the Nottingham Tram. It is considered that the appropriate information has been collated for the purpose of the PFRA and any further data would only add to the detail rather than affect the decisions that are taken.

The River Witham and River Trent Catchment Flood Management Plans (CFMPs) have been reviewed for information on local sources of flooding and potential interactions between systems and background information has been used to supplement the PFRA as suitable. Such documents will be critical to the development of the Nottinghamshire Local Flood Risk Management Strategy as they outline the long term direction for sustainable flood risk management on a catchment basis.

3.3 Data quality

We have been provided with a wealth of information for the Preliminary Flood Risk Assessment from organisations across the County. As is common for any flood risk management study we have addressed the underlying assumptions, resolution and limitations that lie behind the data (known as data quality) and the hence the impact that this may have on decisions that are being made.

We developed two systems to manage data quality:

- A data register which has scored data quality based on the method presented in the Multi-Coloured Manual and reproduced in the Defra SWMP Guidance.
- In relation to past flooding events we have carried out a 'condensing' exercise where information has been brought together so that we could consider the consequences of past flood events across the County. The data came from a range of different sources, with some data being specific at property level, but much of it at street or even settlement level only. Hence we developed a resolution field so that data is not taken out of context in the future (for example settlement data taken to mean the point location itself that actually flooded or multiple sources of point data representing the same flood event being taken to mean multiple incidences of flooding to the settlement).

The main issues affecting the PFRA in terms of data are:

3.3.1 Information associated with past flooding

- The main data limitations from the perspective of the PFRA are with the recording of past flooding information. Prior to the Pitt Review (2008), there was uncertainty regarding responsibility for collecting data on local sources of flooding and little incentive for any party to collect such data. Non-main river sources, many of the flooding records are descriptive, incomplete, or not geographically referenced, and recording of the consequences is not clear.

- Interactions between different sources of local flooding and between local sources and Main River sources are common and it is often difficult to determine exactly what source is responsible for any impact. A good example here is the flooding of 2000 and being able to determine what was flooded from the River Trent and tributaries that are Main River and other 'local' sources.
- Very little information is available on the probability of past flooding and estimating this can be problematic. This is since much flooding from local sources is the result of very heavy and localised rainfall, which is not always picked up in the rain gauge network.
- The pattern of past flooding that we have shown in the PFRA is intrinsically linked to availability of records of past flooding and record keeping amongst the different organisations. There has been little incentive for keeping records from local sources of flooding in the past, except perhaps largely in the case of Ordinary Watercourses by our District and Borough Councils and Internal Drainage Boards. The detail and quantity of information available is linked to both the frequency of flooding, resources available to record collect, store and maintain information and the systems that have been historically used to store information. Much information is available as 'personal working knowledge' and we are considering the best way to capture this information across the County to inform further work.
- Such issues are not uncommon and similar issues have been reported for the River Trent Catchment Flood Management Plan and Nottingham City Surface Water Management Plan.

3.3.2 Information associated with future flooding

Information on future flooding is largely based on predictive computer flood modelling techniques and whilst the hydraulic theory that sits behind these models has been the subject of much research over time, including that observed from physical models, a model is only ever a simplification of reality. The quality of the output from the model will only ever be as good as the quality of the data that goes into a model and the assumptions and decisions that have been made about the modelling.

The output from a model should always be viewed in the context of the data that has been used and the assumptions that have necessarily been considered. The Environment Agency's Areas Susceptible to Surface Water Flooding and Flood Map for Surface Water mapping products are a case in point – they use the same type of modelling but the data and assumptions are different. The Flood Map for Surface Water modelling included for example, buildings and an allowance for water to pass into the drainage network and the outputs are different to the earlier product the Areas Susceptible to Surface Water Flooding, for which other assumptions were made.

However, for strategic purposes models are the best way of estimating how flood risk might change in the future as a consequence of the effects of climate change. It is important with respect to preparing the Local Flood Risk Management Strategy to focus on identification of the scale of response that might be required to adapt to the changes brought about by climate change so that communities do not face unacceptable levels of risk.

3.4 Data licensing, restrictions and security

In order to protect data from unauthorised use, change, copying or loss and cover Intellectual Property Rights, the vast majority of data that is used to inform flood risk management is shared under license agreements. Accordingly license agreements have been established as appropriate. In some instances such agreements may limit the use of the information provided for the PFRA for further use.

Much of the information on flooding is sensitive, particularly where this related to information on individual properties that have been affected, for reasons of property blight and also related to the quality of the information, since many records of past flooding are anecdotal and incomplete. Predictive mapping for future flood events is reliant on the underlying assumptions and level of detail that any flood modelling study will necessarily take, since

modelling is a simplification of reality. Hence it is common to describe flooding locations by street or community and show flood mapping at a scale at which individual properties cannot be identified, especially where this is being used in a strategic context, such as to inform the PFRA.

A data management system has been put in place by the Consultant that supported the County Council to develop the PFRA based on a central data register spreadsheet. This was handed over to the County Council in June 2011 and data collection, storage and maintenance is a key work area for the Flood Risk Management Team. Data security is an important consideration of such a system.

With regard to the systems that have been used to share and store information, this has come from our partners and internally in a variety of formats, both digitally and paper based and information has been shared in person, by email, on removable digital media and using JBA Consulting's secure file sharing website JBarn. The County Council can see the value of setting up a secure web based system to share information, such as the one used by our neighbouring County Derbyshire and will investigate such systems going forward. There is also the potential for sharing GIS data with other organisations using a geoserver application and/ or through common access through our Highways Asset Management System Confirm™.

In keeping with requirements under the Flood and Water Management Act (2010), including the Local Flood Risk Management Strategy, Duty to Investigate and Register of Structure and Features we intend to use the initial work done for the PFRA as a platform to develop a long term integrated management approach. This will cover the collection, storage and maintenance of flood related data and information within the County Council to support two way sharing of data and information with our partners, both within and external to the County Council itself. It will need to be compatible with others as far as is reasonably possible and suitable (for example the Nottingham City SWMP GIS database) since the organisations we need to work have a multitude of different systems for managing information and even within the County Council we use different systems across service areas. This will need to be consistent with the INSPIRE Directive (2007).

3.5 Quality assurance

The PFRA has been quality assured both within the County Council and by our consultants JBA Consulting. The Environment Agency PFRA checklist has been used to assure quality, and the Environment Agency have also reviewed the document. The main issues in the PFRA were considered by the Communities and Environment Standing Committee on the 11th April 2011. As stated our data management system has established a process which assigns quality standards to the data collected.

4. Past flood risk

4.1 An overview of past flooding in Nottinghamshire

Whilst we recognise that information on past flooding in Nottinghamshire is in many instances incomplete, anecdotal and the pattern of flooding largely linked to record keeping, it gives us important and useful information which we have highlighted in Table 4-1. For the PFRA the information has been used to highlight past events that had significant harmful consequences. For the Local Flood Risk Management Strategy we will need a greater level of detail and collating the information during the course of preparing the PFRA has been a useful exercise.

Table 4-1 Information on past flooding

Past flooding information tells us...	Comment
Where flooding has happened	But not always the exact location, especially as we go back further through the historical record.
When flooding happened	But not always the exact date. Additionally information on the duration of flooding is not well recorded. Information on the probability of flooding is rarer, although many with working experience will be able to provide an estimate of how frequently somewhere floods.
Why flooding has happened	The sources of flooding are sometimes noted but water often comes from multiple sources and assumptions about where the water has come from might have been made.
How flooding happened	Information on the mechanisms of flooding may be provided e.g. related to culverts or bridges. Information might also be available on work that has been undertaken since to alleviate flooding. In some cases flooding may have been due to a rare occurrence of circumstances and is unlikely to happen again.
What happened	Information on flood consequences is often missing or incomplete but where it is available is extremely useful as an actual observation of the impacts that flooding has had.

Information on past flooding has been collated from around 15 different organisations in a number of different formats. A large amount of GIS processing has been undertaken by our consultants, JBA Consulting, to condense this into a summary of flood years for settlements across Nottinghamshire. The summary was based upon settlements because the level of detail on the flooding location varies between sources, with much of the information only providing the name of the settlement affected. The summary information was prepared with the intention of bringing together the information on flooding that exists from several sources that are likely to have picked up the same event. It has summarised the information based on 'flood years' because detailed information on the dates of flooding has not always been available. Map B presents this information in the form of number of 'flood years' for settlements across the County.

With regard to nationally available information, the Environment Agency's Historic Flood Map was reviewed. This shows that extensive areas of Nottinghamshire have been affected by flooding in the past, although this appears to be largely in relation to Main River flooding and there were limited attribute information associated with the data. The British Hydrological Society Chronology of British Hydrological Events was also used. The PFRA hence relies on

local data, which is of better resolution and more suitable for local flood risk management purposes, albeit with limitations rather than national data.

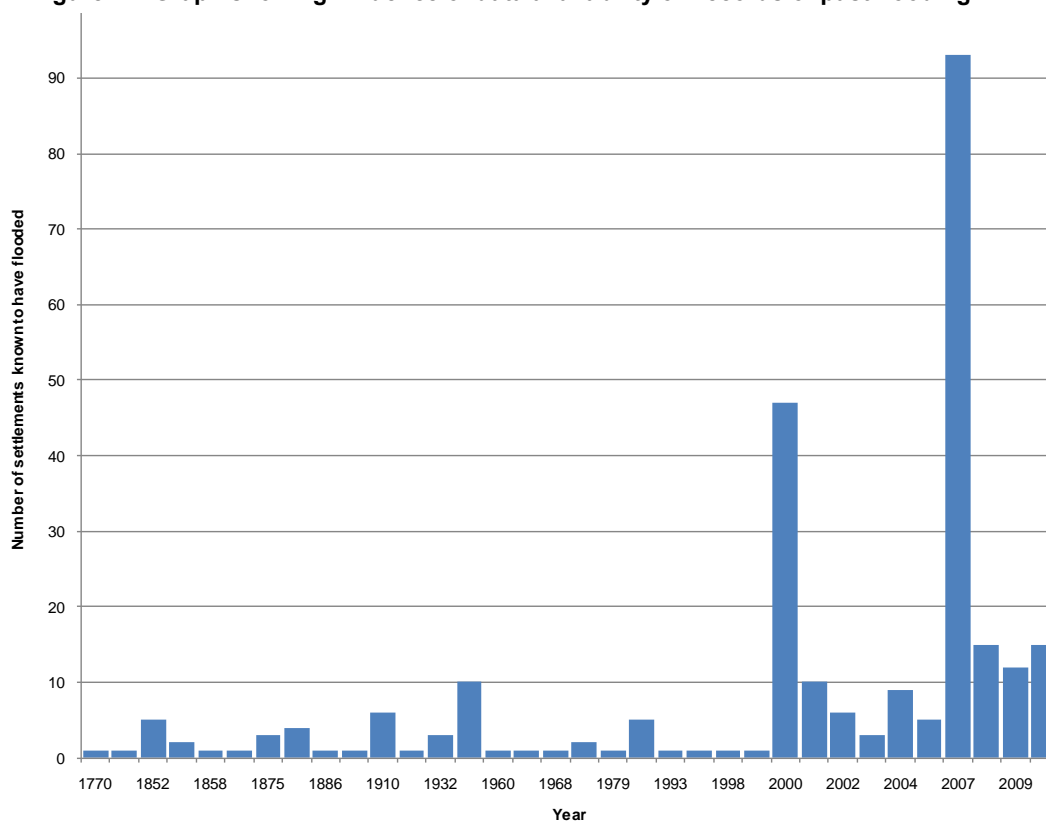
Large datasets from the Confirm™ Highways Asset Management System (HAMS) related to calls taken by the Customer Service Centre and the Parish and Elected Member survey of 2010, and Nottinghamshire Fire and Rescue Service and from Severn Trent Water have been presented separately on Maps C, D and E respectively.

In relation to key messages that these maps show:

- Map B shows that the distribution of flood events is largely related to the availability of information. Information was particularly lacking for the Boroughs of Broxtowe, Gedling and Rushcliffe. The Greater Nottingham Strategic Flood Risk Assessment (SFRA), which covers these three Boroughs, Erewash and Nottingham City, did collate information on other sources of flooding but this information could not be easily used in the PFRA because it is largely lacking information on dates. However, this information would be beneficial to the Local Flood Risk Management Strategy. Attention can also be drawn to the floodplain of the River Trent, which traces a line from Nottingham north east to Newark and then north and into North Lincolnshire. This highlights the difficulties in separating out different sources of flooding especially during large fluvial flood events, such as 2000 and 2007, when there are complex interactions with local sources of flooding.
- The records from the Confirm HAMS shown on Map C show particular concentrations of flood, blocked drain or manhole related records in Burton Joyce, Newark-on-Trent, Retford, Southwell, Worksop and the Arnold, Carlton and West Bridgford areas of Nottingham. In relation to the Parish Council, Town Council and Elected Member survey of 2010, this map will bear some relation to the spatial distribution of the response.
- The records from the Nottinghamshire Fire and Rescue Service shown on Map D show particular concentrations of incidents in Lowdham, Mansfield, Newark-on-Trent, Nottingham, Retford, Sutton-on-Trent, Walkeringham, Worksop and Treswell. This map should be viewed with caution since it shows both domestic and climate related floods incidents. It was not possible to filter these for the PFRA (domestic flooding can be caused by burst pipes or tanks inside houses).
- The records from the Severn Trent Water shown on Map E show particular concentrations of locations affected in Annesley Woodhouse, Mansfield, Newark-on-Trent, Retford, Worksop and the Arnold, Carlton and West Bridgford areas of Nottingham.

Figure 4-1 summarises the number of settlements that are known to have flooded over different 'flood years'. Much like Map B, the information is skewed related to the availability of information. More information is available over recent years, although the earliest record dates back around 240 years. Patterns can be drawn to the handover between various organisations over time, such as urban and rural district councils in the 1970s and the handover of the agency role for Severn Trent Water from District and Borough Councils which has been staged over a number of years. The handover of roles and responsibilities could have resulted in the loss of personal working knowledge, incompatibility of systems and potential loss of information, especially going back through the historical record when much of this was paper based. The length of service of officers working in various organisations also has an effect upon the availability of information.

Figure 4-1 Graph showing influence of data availability on records of past flooding*



*This plot is based on flood event information from a variety of sources that were available at the time. It is possible that flood events or settlements may have been missed; therefore the values are not absolute figures and should be taken as indicative only. Earliest known recorded flood event: 1770

Whilst a substantial quantity of information has been collated for the purpose of preparing the PFRA this Preliminary Assessment Report only describes information that is considered to be 'relevant'. It was not felt necessary or appropriate to reproduce the full details of past flooding information across the County for the purpose of the PFRA. It is our intention that all the information collected for the PFRA will feed forward and be used in the Local Flood Risk Management Strategy and to inform the other work we will undertake given our new powers and duties as a LLFA as appropriate. Thus the focus of historical information has been to pick out those larger events for which we have a greater amount of information on the consequences of flooding. Information on flooding in these events is reproduced in Table 4-2.

Information on the actual extent of past flooding and flow conveyance routes is available in some instances through the post flood investigative reports that have been undertaken primarily for Bassetlaw District Council, Newark and Sherwood District Council and Newark Area Internal Drainage Board. This information has already been considered where it exists through such detailed studies which in turn have made locally detailed recommendations for flood risk management actions and/or may have informed locally detailed flood modelling and mapping. Where suitable, such mapping has been included in the Locally Agreed Surface Water Information for Nottinghamshire which we have covered in Chapter 5. Information from these studies has informed the collated flood history shown on Map B.

Our assessment of past flooding has highlighted a large number of challenges associated with collating and storing consistent information on past flooding in a County setting with twenty one RMAs, a large number of additional integral stakeholders, such as Nottingham City Council as LLFA and Nottinghamshire Fire and Rescue Service and 151 Parish Councils, 10 Town Councils and 38 Parish Meetings.

For the purposes of the PFRA we have aimed to analyse and present a large amount of historical information in the most efficient way possible with a future update mechanism in

mind. We are developing a system that supports our Duty to Investigate under Section 19 of the Flood and Water Management Act (2010) that should provide for the consistent collection of information on actual flood events going forward.

4.1.1 Surface water and Ordinary Watercourses

Many of the recorded incidents of flooding in the County have been due to intense rainfall events leading to surface water runoff exceeding the capacity of local drainage, Ordinary Watercourses and associated structures such as culverts. Surface water flooding in Nottinghamshire has many causes including rapid runoff after rainfall, complicated interactions between overland flows, drainage systems in multiple ownership and various condition and open/ culverted watercourses and certain agricultural practises. For example, the Nottingham City SWMP recognises that flooding in Nottingham often occurs very rapidly after intense rainfall, leaving little time for reactive action to be taken.

There are a number of what are understood to be former Critical Ordinary Watercourses in the County. This makes the attribution of flood sources complicated and this should be borne in mind when assessing flood risk from Ordinary Watercourses in the County and particularly when referencing older reports for locations such as Lowdham and Balderton.

The District, Borough and IDB role in relation to land drainage and Ordinary Watercourses has in many cases encouraged relatively detailed records to be kept of flooding from local sources. The event(s) which had the biggest impact on receptors, and was best recorded, occurred collectively in June/ July 2007 and affected many settlements across the north, east and west of the County. This event was also a major fluvial flood on rivers such as the River Ryton at Worksop and River Idle at Retford, so there was interaction with Main River sources and it is therefore difficult to be certain about the exact number of properties and infrastructure flooded by non-Main River sources alone.

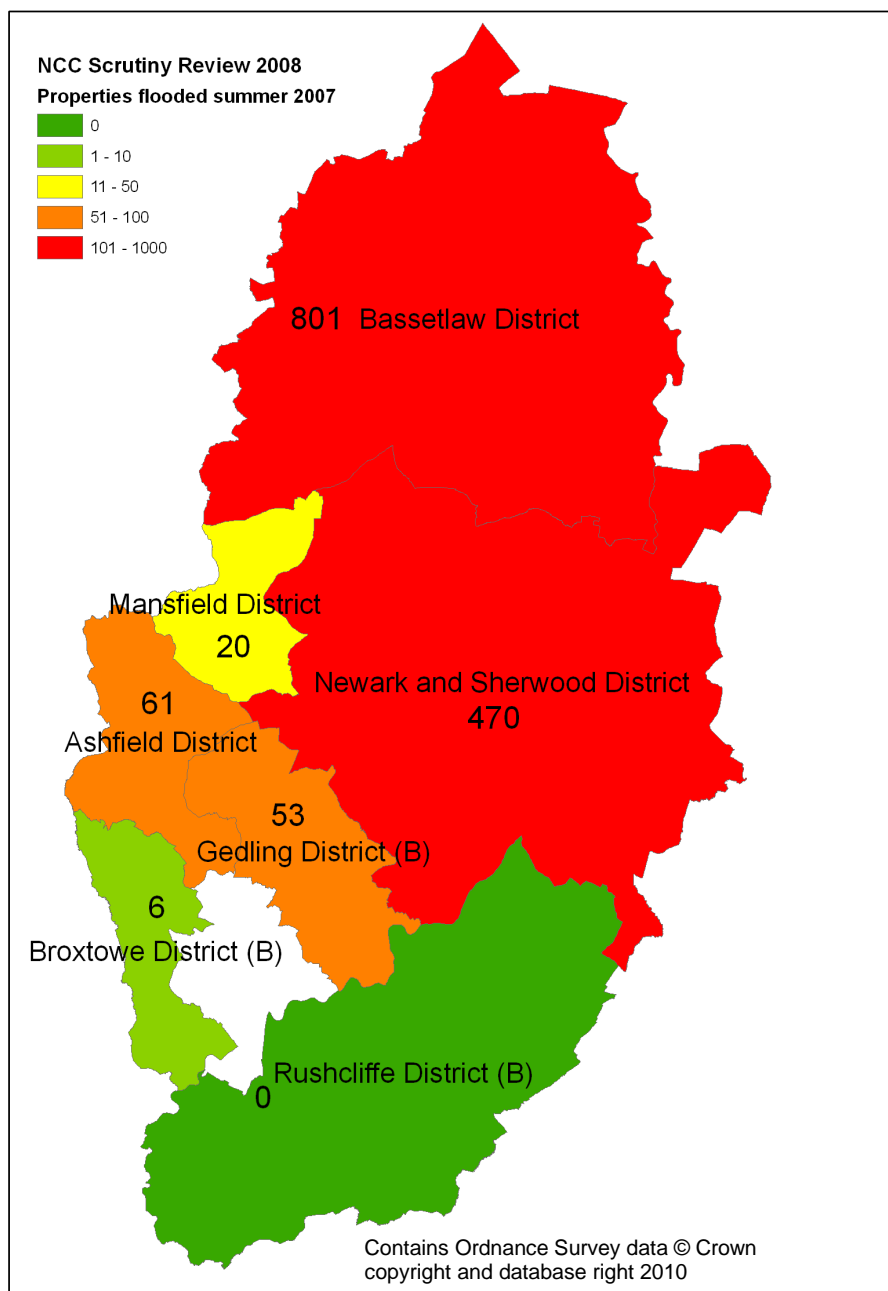
The estimated number of properties flooded per District in summer 2007 is shown on Figure 4-2 and collated information for the summer 2007 floods from a number of different sources is shown on Map F. The flooding affected residential properties, businesses, schools and local infrastructure including roads, electricity substations and sewage works. Access into many of the villages in Nottinghamshire was affected as roads were flooded and a police helicopter was used at North Leverton. A number of schools were severely damaged and there were a number of power failures.

The impact on the people of Nottinghamshire and local communities was immense and the flooding has been described as 'the most significant natural disaster the Newark and Sherwood District area has experienced since 1947' (Newark and Sherwood District Council, 2009). Beyond the immediate damage to properties, there have been harder to quantify consequences for human health, including trauma, worry and anxiety and economic impact to businesses both within and beyond flooded areas. It has been suggested that the rainfall for May, June and July had 0.6 – 0.5% AEP (175/200 year return period).

The River Witham CFMP reports that around 26% of flood records in the catchment are from surface water or sewers. It identifies the following surface water flooding mechanisms: surface water runoff and backing up of drainage systems, blockage of surface water drainage network or ditches during high rainfall and high rainfall or local groundwater levels causing ponding in low lying areas. It identifies parts of the Upper Witham catchment in Nottinghamshire as being at low risk of surface water flooding.

The River Trent CFMP reports that around 20% of flood records in the catchment are from surface water flooding. The CFMP notes that surface water flooding can be caused by rainfall runoff, insufficient drainage capacity, in "steeper upland areas", "older urban areas" with large impermeable areas and farming practises. It also recognises the potential for flooding when surface water is prevented from outfalling to watercourses when there are high water levels. It recognises this as a problem downstream of Nottingham, where surface water needs to outfall through embankments into the River Trent. It also recognises that flooding from blocked culverts and screens is an issue in the CFMP area.

Figure 4-2 Properties flooded in summer 2007 by District/ Borough



It is interesting to observe the effect of flood history on the perception of the risk of flooding from surface water and local watercourses. The flooding of June 2007 did not cause any major flooding to the south of the County and yet it is known that flooding had a major impact in settlements to the south of the County in the early 1980's. Had this PFRA been undertaken 25 years ago then it is likely that more detailed information on this flooding would have been readily available and this Chapter would show a different pattern of flooding. This perhaps highlights the difficulties in relying solely on past flooding information to inform the understanding of flood risk across the County.

4.1.2 Groundwater

Our summary of historical data has revealed little instance of groundwater flooding in Nottinghamshire, although this is likely to be due in part to groundwater flooding being disguised amongst other sources of flooding, including from Main Rivers, where it is likely to rise up through the gravels of the River Trent floodplain. The allocation of a source of flooding in our historical records has in many cases been based on assumptions and it is not clear whether the source has been correctly identified. It is understood that there are high groundwater levels in parts of the County, including Ashfield and groundwater flooding has been reported at Bleasby, Staythorpe and Egmont in Newark and Sherwood, although this is likely to be inter-related with the wider flooding experienced in 2007. Groundwater and watercourse issues have also been identified at Hucknall where it is understood from the Greater Notts SFRA that flood gates have been put on properties.

The Environment Agency PFRA Guidance identifies that groundwater rebound is an issue in Nottingham. The Draft Nottingham Surface Water Management Plan identifies that there are several spring fed watercourses in the City and that former tanning, bleaching, brewing, chemical, mining and lace-making industries made extensive use of groundwater held within the underlying sandstone. There is some evidence that ground water levels are recovering as extraction has stopped or is declining and the City Council has received reports of flooded basements and cellars that have historically been dry.

Groundwater flooding is not recognised in the River Trent CFMP as a significant problem across the entire CFMP area, apart from some local areas. That related to the underlying geology could occur in the sandstones of Sherwood Forest but many of the springs that do form when water levels are high do not cause significant flooding. The River Trent CFMP recognises flooding through alluvial gravels and sands “does occur within the main Trent valley where aggregate extraction is undertaken, causing occasional flooding in unexpected areas, but more generally just resulting in areas which routinely tend to become more water logged when river levels are high”. The flood records for the River Witham CFMP only identify one groundwater flooding incident, which is not in Nottinghamshire.

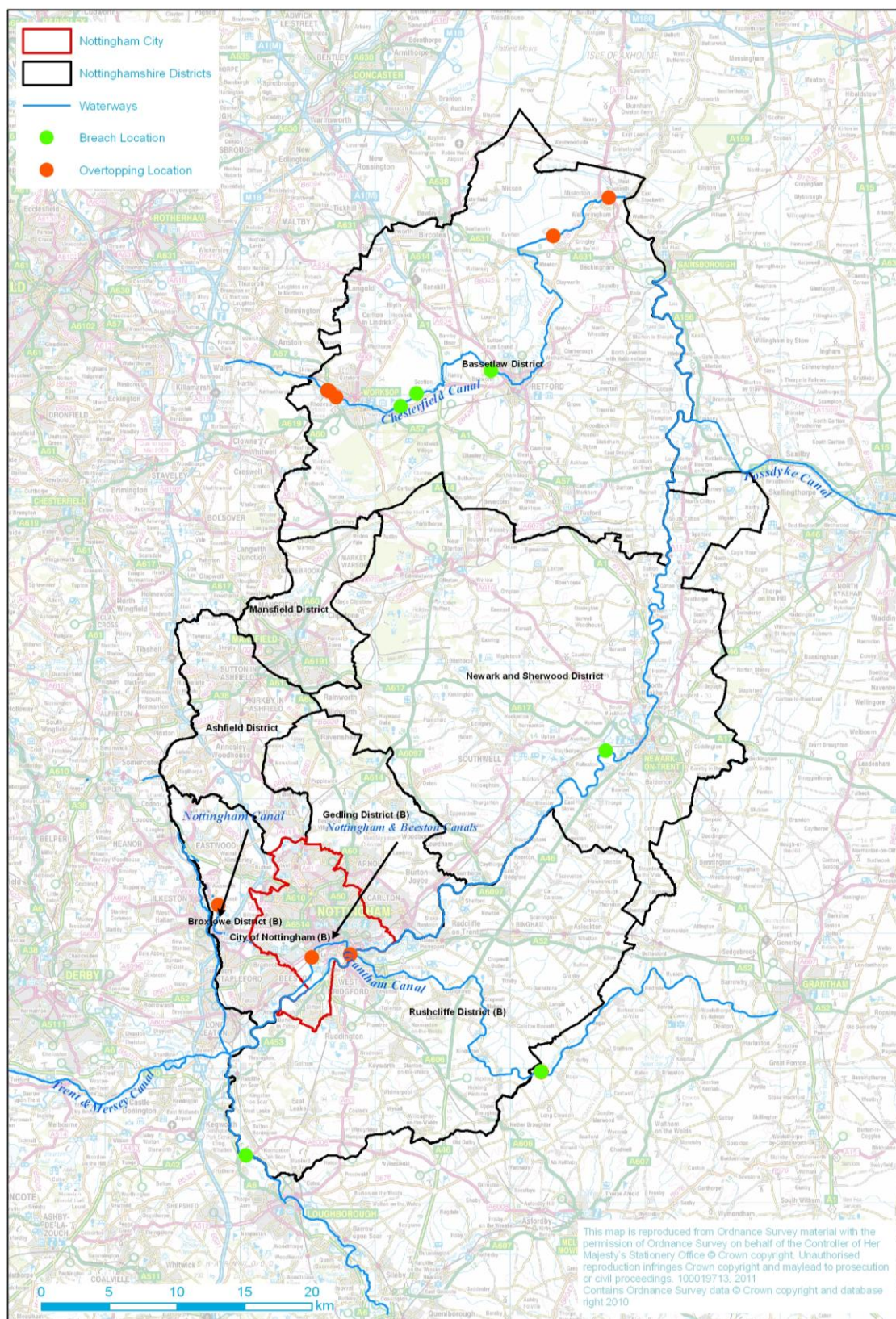
On the basis of the evidence collected we consider that in future there will be a need to pay closer attention to the collection of data on groundwater and groundwater flooding.

4.1.3 Canals

The industrial legacy of Nottinghamshire means that we have a network of navigable or previously navigable waterways in the County that are largely now used for recreation purposes. Flooding from canals can be caused by overtopping from excess water entering the canal or breach of canal embankments. Waterways are shown on Figure 4-3 and artificial waterways include the Erewash, Nottingham, Beeston, Grantham, Chesterfield and Nottingham Canals. The majority of these are managed by British Waterways. Most of the instances of overtopping or breach in Nottinghamshire are related to the Chesterfield Canal.

The Nottingham Canal is a Local Nature Reserve and is generally managed by Broxtowe Borough Council with the BTCV and advice from the Nottinghamshire Wildlife Trust. There are no major flooding issues. On rare occasions, the Canal has overtopped at Cossall and there is the potential for embankment collapse (as with other canals).

Figure 4-3 Canal flooding in Nottinghamshire



4.1.4 Sewer flooding

The drainage network across the County is complex and is generally comprised of:

Network	Ownership/ responsibility*	Comment
Private sewers draining properties and hardstanding	Landowner	Ownership of sewers that drain to the public network due for adoption by water companies starting in April 2012, although the adoption of different parts of the network is complex.
Highway gully network designed to drain roads	Highways authority (County Council or Highways Agency)	In some cases this also drains contributing areas
Sustainable Drainage Systems (SUDS)	Landowner/ management company/ local authority	Uptake expected to increase with new role for County Council as SAB
Surface water sewers that drain properties and roads	Water company where adopted, local authority, landowner, other	In some instances these may be considered to be culverted watercourses.
Foul sewers that take away waste water from properties	Water company where adopted	These have combined sewer overflows to watercourses to relieve pressure during storm events
Combined surface water and foul sewers	Water company where adopted	Some other sewers are likely to act as defacto combined sewers due to misconnections

* Intended to be indicative and not an exhaustive list

The Flood Risk Regulations (2009) and the Flood and Water Management Act (2010) considers flooding from sewers where this is caused by “an increase in the volume of water (including snow and other precipitation) entering or otherwise affecting the system” and not failure e.g. pumping stations or blockage.

The water companies use the DG5 Register to prioritise spending on schemes to alleviate sewer flooding, which are taken forward into Business Planning (known as Price Reviews) and the Asset Management Plan (AMP) period 5 years cycles of investment (we are currently in AMP5 2010-2015). The water company maintain the DG5 Register as a live document. The DG5 Register is part of a larger register of all incidents, including those that are likely to occur less frequently and all those reported to them (including where the source of flooding may not be sewer related). It is important to note that the DG5 is a record of flooding that has happened and not properties at risk of sewer flooding. It is also not a record of all past flood incidents related to sewer flooding reported to the water company because properties are removed if a flood alleviation scheme has been completed. Severn Trent Water are currently investing in predictive DG5 modelling.

Information provided by Severn Trent Water in the form of the DG5 Register and mapped in Map E shows locations affected by flooding from the sewer network. Map E shows particular concentrations in Annesley Woodhouse, Mansfield, Newark-on-Trent, Retford, Worksop and the Arnold, Carlton and West Bridgford areas of Nottingham. The DG5 Register has fed into the general understanding of past flooding and has not been used by itself to identify past flooding that is deemed significant.

There is limited information that is readily and consistently available on the capacity of the sewer network across the County. It is known that in West Bridgford (Nottingham), that the sewers have a very limited capacity, which can lead to localised flooding. The causes of flooding in Nottinghamshire are inter-related and in many cases, sewer flooding will only be part of the picture and such flooding may be caused by high water levels in receiving watercourses preventing water outfalling from the network and/ or excess surface water flowing overland entering the sewer network and causing it to surcharge. Because of this it is highly likely that many of the incidences of past flooding bear some relation to the sewer or

another drainage network. Ownership issues compound this and there are instances where the drainage network in particular has been identified as problematic, but ownership cannot be easily ascertained.

4.2 Significant harmful consequences

The Flood Risk Regulations (2009) require us to identify if there has been flooding from local sources in Nottinghamshire that has had significant harmful consequences to human health, economic activity or the environment (including cultural heritage) and might have significant harmful consequences if they were to occur again.

It is understood that such events are those that had significant consequences of the scale that would be reported to Europe, hence had registered on a national scale. The key historical events have been identified as part of the strategic, broadscale context of the PFRA and are reported as required in Annex 1. Such events include the severe flooding of 2000 and 2007, although because flooding often, if not always, comes from multiple sources, actually separating flooding 'from local sources' apart from Main River is problematic. The flooding at Whatton and Aslockton in 1998 is thought to be primarily from the River Smite, which is Main River and hence it has not been included in Annex 1.

Due in part to data availability and quality but mostly related to fully appreciating the meaning of locally significant risk, we wish to work with all of our RMAs, Elected Members and Communities to set in place a system for prioritising flood risk management in the future. Hence we have made no attempt to define significance in terms of property numbers etc. and instead have chosen those events that were clearly significant in the national context. Indeed as part of the Local Flood Risk Management Strategy we intend to use information on past flood events across the County alongside a consistent picture of risk across the County based on information on future flooding to consider and prioritise appropriate responses (both structural and non structural). In doing this we will consider a range of levels of risk, significance and consequences so that we can prioritise our responses and the measures to deliver them.

It is recognised that extensive work has been carried out since the flooding in 2000 and 2007, most notably the construction of flood defences in Nottingham, extensive maintenance work on the County Council highway drainage network at Southwell, Oulton, Lowdham and Woodborough, flood embankments at Barton in Fabis and Gunthorpe and working with communities to increase resilience to flooding, with the provision of community resilience stores across part of the County.

However, should such flooding occur again whilst the impact of the flooding would be lessened it is likely that it would still have a locally significant impact on communities in Nottinghamshire. We are keen to work with communities across the County through our Local Flood Risk Management Strategy to further reduce the impact of future flooding where we can do so. Predictions on the effects of climate change suggest that local flooding incidents will become more severe and the frequency will increase.

Table 4-2 Summary of past flooding in Nottinghamshire

Date*	Location	Source of flooding	Approximate number of properties affected	Source of information	Comments
Unknown	Elston	Ordinary Watercourse	6	Newark and Sherwood DC: Elston Flood Assessment report	Date of flooding is unknown
1983	Clarborough	Ordinary Watercourse	2	Bassetlaw DC: Hydraulic Catchment Studies (Clarborough)	
1998	Whatton and Aslockton	River Smite (now Main River at Whatton and Aslockton)	Approximately 80	Newark Area IDB: Whatton and Aslockton Flood Study Easter 1998 floods report	Estimated probability
2000	Attenborough, Averham, Beckingham, Besthorpe, Bleasby, Burton Joyce, Carlton-On-Trent, Caythorpe, Collingham, East Stoke, Edwinstowe, Farndon, Fiskerton, Garton, Grassthorpe, Gunthorpe, High Marnham, Holme, Hoveringham, Kelham, Laneham, Littleborough, Lowdham, Morton, Newark On Trent, North Clifton, South Muskham, Staythorpe, Stoke Bardolph, Walkeringham, Winthorpe	Main River, Ordinary Watercourse, Surface runoff	318	Newark and Sherwood DC, LCLIP media database	The estimated number of flooded properties varies depending on source
2004	Balderton, Beckingham, Bingham, Carlton-On-Trent, Collingham, Edingley, Newark On Trent, Stapleford, Worksop	Surface runoff	11	Newark and Sherwood DC, LCLIP media database	Source of flooding is based upon what was recorded – there may have been other sources not recorded
2007	Annesley Woodhouse, Bagthorpe, Balderton, Beckingham, Bilsthorpe, Bingham, Bircotes, Bleasby, Blidworth, Brinsley, Bulcote, Burton Joyce, Calverton, Carlton-On-Trent, Carlton In Lindrick, Cauntton, Clarborough, Clayworth, Coddington, Colston Bassett, Cromwell, Cuckney, East Drayton, East Markham, East Stoke, Edingley, Edwinstowe, Egmanton,	Main River, Ordinary Watercourse, Surface runoff	1,411	Ashfield DC, Bassetlaw DC, Mansfield DC, Newark and Sherwood DC, Newark Area IDB, LCLIP media database, Upper Witham IDB	The estimated number of flooded properties varies depending on source

	Epperstone, Fackley, Farndon, Fiskerton, Gamston, Gringley on the Hill, Halam, Harworth, Headon, Hockerton, Hucknall, Huthwaite, Jacksdale, Kelham, Kirkby in Ashfield, Kirklington, Lambley, Langold, Laxton, Little Carlton, Lound, Lowdham, Mansfield, Market Worksop, Milton, Moorhouse, Newark On Trent, Normanton on Trent, North Leverton, North Wheatley, Norwell, Oldcotes, Ollerton, Ompton, Oxton, Pleasley, Radcliffe on Trent, Ragnall, Rampton, Ranskill, Retford, Rhodesia, Rockley, Rolleston, Ruddington, Selston, Shireoaks, Skegby, South Clifton, South Leverton, Southwell, Stanley, Staythorpe, Sturton le Steeple, Sutton in Ashfield, Sutton On Trent, Syerston, Teversal, Thurgarton, Treswell, Trowell, Tuxford, Underwood, Walkeringham, Weston, Whaley Thorns, Woodborough, Worksop				Source of flooding is based upon what was recorded – there may have been other sources not recorded
2008	Carlton, Clarborough, Clayworth, Eaton, Gunthorpe, Harworth, Hayton, Lambley, Mansfield, Oldcotes, Retford, Sutton, West Stockwith, Wiseton, Worksop	Main River, Ordinary Watercourse, Surface runoff	2	Gaite Group of IDBs, LCLIP media database	Numbers of flooded properties for the majority of settlements affected were not included in records or records referred to “several properties” rather than exact numbers

*Events only included where there is reasonable information on flood consequences. The number of properties is intended to serve as an indication only.

5. Future flood risk

5.1 What do we mean by future flood risk?

It seems obvious, but past flooding information only gives us a partial understanding since it is related to where the rain has fallen and by its very nature local flooding is often caused by very intense and localised storms that are unlikely to affect the entire County at the same time. This is further complicated by the availability and quality of past flood event records, as we explored in Chapter 3. There are a number of different datasets that show predictive flooding across the County. These can be considered as showing a more complete picture of where flooding might happen across the County if the rain was to start to fall at any particular location.

It is not unknown for people to be affected by flooding and be unaware of any past instances of flooding. Hence information on future flooding can help us to raise awareness and help our communities understand the nature of flood risks and what they can do to prepare for flooding.

It is predicted that the severity of local flooding will increase as a consequence of the effects of climate change. Accordingly we need to understand how things might change in the future so that we can develop a strategy to keep people and communities safe.

5.2 Summary of relevant information

Table 5-1 shows the datasets that exist that can give us information on where flooding might happen in the future.

Table 5-1 Datasets on Future Flooding for Nottinghamshire

Mapping product	Coverage	Comment
Areas Susceptible to Surface Water Flooding	National	<p>The first generation product released by the Environment Agency.</p> <p>Shows areas that may be affected by surface water flooding. Is based on a bare earth ground model and does not take into account the effect of drainage systems.</p> <p>The modelling is based on a two dimensional ground model that routes water over the surface. Following the principle of 'topography rules' water will collect along natural valleys and depressions. Hence whilst such mapping primarily shows where surface water flooding might happen, it can also show locations where flooding from Ordinary Watercourses and groundwater might occur.</p> <p>Mapping is not suitable for identifying individual properties themselves that could flood.</p>
Flood Map for Surface Water	National	<p>The second generation product released by the Environment Agency.</p> <p>Shows areas that may be affected by surface water flooding. Is based on a ground model that includes buildings and does take into account the effect of drainage systems.</p> <p>The modelling is based on a two dimensional ground model that routes water over the surface. Following the principle of 'topography rules' water will collect along natural valleys and depressions. Hence whilst such mapping primarily shows where surface water flooding might happen, it can also show locations where flooding from Ordinary Watercourses and groundwater might occur.</p> <p>Mapping is not suitable for identifying individual properties themselves that could flood.</p>

Mapping product	Coverage	Comment
Areas Susceptible to Groundwater Flooding	National	Broadscale mapping shows groundwater flood areas on a 1km ² grid. Shows areas that might be susceptible to flooding from consolidated aquifers e.g. chalk, sandstone and permeable superficial deposits. Does not show areas that might be affected specifically by groundwater rebound. Shown on Map H.
Flood Map for rivers and the sea	National	Shows areas that could be affected by flooding from watercourses and the sea. Flood Zones are compatible with Planning Policy Statement 25 and show the undefended case for Flood Zone 3 (1% AEP) and Flood Zone 2 (0.1% AEP). Also contains flood storage areas, raised defences and areas benefiting from major defences. Can be viewed on the Environment Agency website.
GIS analysis of the likelihood of surface water flooding undertaken for the River Witham CFMP	Local	The GIS analysis “provides an assessment of the likelihood of surface water flooding relative to other parts of the catchment. The results give a broad picture and do not necessarily mean that a specific area will experience flooding.” The assessment only covers the part of Nottinghamshire that is in the Witham CFMP area. The mapping identifies parts of the Upper Witham catchment in Nottinghamshire as being at low risk of surface water flooding.
Analysis of the risk for groundwater flooding undertaken for the River Witham CFMP	Local	The assessment used the Defra “groundwater emergence zones” “along with physical, hydrological and environmental data sets to establish the broad level of risk across the CFMP area for groundwater flooding”. The assessment only covers the part of Nottinghamshire that is in the Witham CFMP area. The mapping identifies parts of the Upper Witham catchment in Nottinghamshire as being at low risk of groundwater flooding.
Local studies undertaken for Newark and Sherwood District Council, Bassetlaw District Council and Newark Area IDB	Local	Information on modelled flood levels, extents and/ or the actual extent of past flooding and flow conveyance routes is available in some instances through the post flood investigative reports. This information has already been considered where it exists through such detailed studies which in turn have made locally detailed recommendations for flood risk management actions. It is noted that such detailed studies are highly reliant on the input data available for any modelling that takes place and also that techniques for flood estimate and modelling have changed over time.
Bassetlaw District Council SFRA	Local	Mapping shows flooding from notional breaches in the Chesterfield Canal at Workshop and Retford.

Annex 2 includes detailed records of future floods and the possible consequences. For local records we have only included those used for the Locally Agreed Surface Water Information in line with the Environment Agency decision to only use the main datasets.

5.3 Locally agreed surface water information

Table 5-2 and Map G summarise the datasets that make up the Locally Agreed Surface Water Information for Nottinghamshire, as identified by NCC in March 2011. This is a combination of the Flood Map for Surface Water, Areas Susceptible to Surface water Flooding and local studies for Bassetlaw District Council.

No consistent and county wide dataset on local drainage capacity was readily available to use for the PFRA. It is noted that such information would need to be in relation to the highway drainage network, sewer network (including both combined and surface water sewers) and culverted watercourses and the ownership of such assets is complex. Collating such information on a County wide scale would be a significant task and is a future consideration for the Register of Structures and Features County will hold. Given the scale of the task such data collection will likely be on a prioritised basis, building on the data that we already hold.

Information on drainage capacity for the highway network is indirectly available through the Gully Emptying Policy, which forms part of the Highways Network Management Plan. In September 2010 the County Council wrote to all 199 Parish and Town Councils / Meetings and also the 67 Elected Members. The purpose of this letter was to request a list of known problem locations within their parish (identified by road classification, town/village, street name, house number etc.) which they believed would benefit from an increased frequency of cleansing, or suggestions of where a 'smarter' approach would be beneficial i.e. emptying gullies on tree lined roads following leaf fall not before. Other suggestions included locations where residential / industrial development works etc. were taking place or near to agricultural / commercial premises whose activities have traditionally affected adjacent highway gullies or drainage systems. The data submitted was used to help form the County's revised Gully Emptying Policy which, when adopted in Year 2011/12, will change the frequency of emptying dependant on location and risk-based need.

Our understanding of flooding mechanisms across the County has informed our choice of Locally Agreed Surface Water Information. To the south and west we have relatively steep areas, including heavily urbanised areas, such as Nottingham, Sutton-in-Ashfield and Mansfield where rapid surface water runoff and complicated interactions with the private, sewer and highway drainage network and culverted and open watercourses can cause surface water flooding and more undulating rural areas where land management practises can contribute to overland runoff. These give way to the flatter and in some cases artificially drained areas to the north and east, particularly those areas that form the natural floodplain of the River Trent and tributaries. Pumping in these areas both reduces the chance of surface water and groundwater flooding but if pumping stations should fail, could cause flooding in a wider area, since in effect there would be no operational drainage system.

Table 5-2 Locally Agreed Surface Water Information for Nottinghamshire

Location	Dataset	Comments
Internal Drainage Districts	Areas Susceptible to Surface Water Flooding (AStSWF) (Intermediate)	Drainage in Internal Drainage Districts is managed by Internal Drainage Boards. By their very definition such areas are relatively flat and low-lying. Water will take longer to collect and disperse in these areas, which are often served by pumped drainage. Hence the AStSWF was felt most representative for these areas. Such areas cover around 25% of the land area of Nottinghamshire.
North Leverton Sturton le Steeple (South) Clarborough Walkeringham	Bassetlaw District Council Hydraulic Catchment Studies Modelling of Village Watercourses	Best available local information (given that techniques for modelling change over time and data availability) Survey undertaken in 2009 and 2010, one dimensional HEC-RAS models built and LIDAR used in many locations
All other areas	Flood Map for Surface Water (1 in 200, deep) (FMfSW)	The FMfSW is the more recent Environment Agency dataset for surface water flooding. Drainage capacity will vary across such a large area but for this strategic study this dataset was felt most appropriate for these areas. It is noted in the Nottingham City SWMP that the lack of regular flooding in most parts of the City indicates that the drainage network works well and that this mapping product may offer a pessimistic view of flood areas in the City. However, on the converse sewers in West Bridgford (south Nottingham, in the County) are known to have low capacity and this demonstrates how drainage capacity can vary even on a relatively small scale. Future modelling work (such as future version of the FMfSW or undertaken for a SWMP) should refine surface water information taking into account drainage capacity information where available, working in partnership with IDBs, Water Companies and Nottingham City Council. Hence the Locally Agreed Surface Water Information should be updated when further locally applicable information becomes available.

It is important to note that the choice of the Locally Agreed Surface Water Information is solely made for the purposes of the PFRA and high level strategic work, including the Local Flood Risk Management Strategy as appropriate. More detailed flood risk studies should use the best available local information and carry out more detailed modelling as appropriate to the level of the study. The Locally Agreed Surface Water Information may not be available and appropriate for other purposes, for reasons including the limitations behind the modelling and mapping and proposed uses should be discussed with the Environment Agency in relation to national datasets and Nottinghamshire County Council/ Bassetlaw District Council for the local studies.

In terms of flood consequences the following datasets have been used as was thought suitable for a strategic assessment of this nature:

- Properties, including residential, businesses and critical services – Local Land and Property Gazetteer (LLPG) – a ‘detailed property count’ based on the footprint of buildings has been undertaken.
- Cultural heritage and environmental sites and agricultural land – National Receptor Dataset provided by the Environment Agency. Listed Buildings based on a ‘detailed property count’. Otherwise point and polygon data used.
- Road and rail – National Receptor Dataset provided by the Environment Agency. Line data used.
- Emergency planning datasets – COMAH provided by the County Council, PCC sites from the National Receptor Dataset. Point data used.

Note that our analysis has been largely based on 1km grid squares and hence where this follows the County border and into Nottingham City will extend into other local authority areas based on Nottinghamshire’s Locally Agreed Surface Water Information and the information available on IDB boundaries for the Nottinghamshire PFRA. Please refer to the appropriate County or Unitary PFRAs for information on the Locally Agreed Surface Water Information for these areas.

5.4 Surface water and Ordinary Watercourses

For the purposes of the PFRA, the Locally Agreed Surface Water Information has also been assumed to reasonably predict areas flooded by exceedence of capacity of Ordinary Watercourses. It was felt that to carry out a separate analysis of Ordinary Watercourses included in the Flood Map for rivers would be unnecessarily time-consuming and would essentially ‘double-count’ many of the properties at risk.

The Locally Agreed Surface Water Information has been analysed to assess the consequences of surface water flooding on receptors (human health, economic activity, environment and cultural heritage). Table 5-3 shows the consequences of surface water flooding across the County based on the Locally Agreed Surface Water Information.

Table 5-3 Consequences of surface water flooding in Nottinghamshire

Consequences to...		Locally Agreed Surface water Information
Human health	People	49,445
	Critical services	158
Economic activity	Grade 1 and 2 agricultural land	25.7km ²
	Non-residential properties	4,358
	Length of road	276km
	Length of rail	25.5km
Environment	Sites of Special Scientific Interest (SSSI)	58
	RAMSAR sites	0
	Special Areas of Conservation (SAC)	1
	Special Protection Areas (SPA)	0
	Pollution Prevention Control (PPC) sites	2
	Control of Major Accident Hazard sites (COMAH)	0
Cultural heritage	World Heritage sites	0
	Scheduled Monuments	62
	Listed buildings	314
	Registered parks and gardens	17

A number of maps have been produced that show the distribution of flood consequences across the County, based on the Locally Agreed Surface Water Information. In relation to key messages that these maps show:

- Map I: People that could be affected are distributed across the County and concentrated in the urban centres of Kirkby-in-Ashfield, Mansfield, Newark-on-Trent, Nottingham, Retford, Sutton-in-Ashfield and Worksop. The map highlights that many of our villages in rural areas are vulnerable to flooding.
- Map J: Critical services are particularly clustered around Mansfield and Nottingham, although there are additional concentrations in rural areas. This is partially related to the way we have considered critical services, which has counted each building once. This was thought to be a reasonable way of using local data because each building in a collection e.g. a school or hospital is recognised as such. Where there are such high concentrations, the consequences of surface water flooding are likely to be particularly severe and disruptive to that locality.
- Map K: Non-residential properties that could be affected are distributed across the County and concentrated in the urban centres of Kirkby-in-Ashfield, Mansfield, Newark-on-Trent, Nottingham, Retford, Sutton-in-Ashfield and Worksop. There are also concentrations in more rural areas including Bingham, Calverton, Cossall, Market Warsop and Ruddington and many of our villages could be affected. The consequences of flooding to business and critical services in rural areas could have more wide ranging consequences than in the larger urban areas, where for example alternative shops, pubs and doctors surgeries are some distance away.

- Map L: Agriculture is an important contributor to the rural economy in Nottinghamshire. This map shows where the higher grade agricultural land could be affected by flooding. Such land is distributed across the County with the highest concentration generally in the more rural districts/ boroughs.
- Map M: Environmental sites that could be affected by flooded are distributed across the County. It should be borne in mind that flooding can have both a positive or negative effect on the condition of conservation sites and that some habitats, such as wetlands might benefit from frequent flooding.
- Map N: Cultural heritage sites that could be affected by flooded are distributed across the County, with a particular concentration around the Dukeries area south of Worksop, which is famous for its historical heritage.

5.5 Groundwater

The geology across the County varies and areas with more porous/permeable geology, notably sandstone and limestone have more potential to store groundwater. In such areas fluctuating groundwater levels are more likely to give rise to ephemeral spring fed watercourses. In other areas underlain by less porous clay, the geology has less potential to store water. This is complicated by overlying drift geology, related to deposits from the last ice age and by the River Trent and tributaries as they have meandered over the floodplain over time, eroding and depositing material and through periodic flooding. Water travels easily through river gravels and groundwater levels are often closer to the surface in river valleys. Flooding on the floodplain of larger river systems is often related to groundwater before water flows overland after the river overtops its banks.

Previous industrial extraction of groundwater across the County may result in rebound in some areas. Coal mining has been a significant contributor to the local economy in the County, particularly to the west, although this industry is now in decline. Pumping associated with mining operations may have ceased as mines close and groundwater levels will take time to adjust, which may cause flooding and/ or potentially pollution in some areas where the water table has been artificially suppressed over time. It is understood that the Coal Authority works with the Environment Agency and others with regard to minewater pollution.

Mine workings have given rise to another source of flooding from spoil heaps which are often fairly impermeable. Rapid runoff may overload drainage ditches and cause flooding to surrounding areas, although many of these in the County have now been restored for parkland, agriculture or golf courses.

Future flooding from groundwater is indicated by the National Areas Susceptible to Groundwater Flooding map, which is shown on Map H. This shows risk of groundwater emergence as a percentage for each 1km square. This shows particular concentrations related to the floodplain of the River Trent as it passes through Nottingham, north eastwards to Newark-on-Trent and then north towards the Humber Estuary and areas around Carlton-in-Lindrick and Hucknall. However it should be noted that this does not take into account all the forms of groundwater flooding to which the County is vulnerable and in particular groundwater rebound following cessation of industrial extraction.

This map is not intended to be used to identify actual areas where groundwater might flow or pond and it is not sensible to attempt to analyse this data for the number of properties at risk, as not all the properties in each 1km square will be susceptible and there is no probability information attached to this data.

The Environment Agency guidance suggests that “unless an area identified as ‘susceptible to groundwater flooding’ is also identified as ‘at risk from surface water flooding’, it is unlikely that this location would actually experience groundwater flooding to any appreciable depth, and therefore it is also unlikely that the consequences of such flooding would be significant.”

We recognise that there are potentially several mechanisms that may cause groundwater flooding in the County, largely related to flooding through alluvial gravels, particularly on the floodplain of the River Trent, the underlying geology and groundwater rebound following

cessation of industrial extraction. We will look into the local flood risk from groundwater flooding in more detail as appropriate as part of our Local Flood Risk Management Strategy.

5.6 Canals

Bassetlaw District Council have modelled the effect of a breaches in the Chesterfield Canal in Worksop and Retford in their Strategic Flood Risk Assessment. The SFRA notes that a “breach could occur at any location where the canal is higher than the surrounding land; these results should be taken as examples of the flood risk if breaches should occur”. The results therefore do not provide a complete picture of areas that could be affected by a breach in the Chesterfield Canal across the District and the volume of water is related to the capacity of the canal in those locations. In addition such flooding can be considered to a residual risk, rather than overtopping of the canal network, which may be related to inflows from watercourses during flood conditions. Therefore although the information is of value we have not used it as part of our Locally Agreed Surface Water Information.

Many of the canals in Nottinghamshire interact with watercourses to some extent, for example the River Ryton and Chesterfield Canal at Worksop or the Nottingham and Beeston Canals and the River Trent in Nottingham. Canals that are in cut or follow natural contours are likely to act as conduits for flood waters and may divert floodwaters from one place to another. Hence the Environment Agency Flood Maps and surface water maps are likely to show the effect of flooding to or from canals in places, although such information has not been analysed in detail for the PFRA.

We will look into the local flood risk from canal flooding, and in particular interactions with local watercourses, in more detail as appropriate as part of our Local Flood Risk Management Strategy.

5.7 Sewer flooding

No predictive information is available on future flood risk from sewer flooding at this time.

5.8 Climate change

5.8.1 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 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 rain storms 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%.

5.8.2 Humber River Basin

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 41cm 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%”

5.8.3 Local information on climate change

UKCP09 predictions for the East Midlands

Climate projections are also available for the East Midlands for the years 2020, 2050 and 2080. Table 5-4 shows the projections under a medium emissions scenario and taking the 50% probability level. Further detail including the range of results produced by UKCP09 is available on the Defra website.

Table 5-4 UKCP09 Medium emissions projections for the East Midlands

	2020s	2050s	2080s
Mean precipitation %	0	0	1
Summer mean precipitation %	-6	-16	-20
Winter mean precipitation %	5	14	19
Mean temperature summer °C	1.4	2.5	3.5
Mean temperature winter °C	1.3	2.2	3

What these tell us is that winter rainfall is likely to increase, which may increase the likelihood of flooding. Flooding in the winter is often caused by slow moving frontal systems, which is more likely to trigger flooding on the larger river systems such as the River Trent with potentially associated groundwater flooding and potentially localised surface water flooding where smaller watercourses and sewers cannot outfall due to ‘flood locking’ on Main Rivers. Higher temperatures in summer may trigger more convective thunder storms, which are more likely to cause flooding from surface water and on smaller watercourses.

Local Climate Impacts Profile

The County Council have prepared a Local Climate Impacts Profile (LCLIP) which has looked in detail at the vulnerability of the local authority to extreme weather to inform future policy and strategy and adaptation responses. The short LCLIP recognises that “*climate projections indicate that we can expect warmer, wetter winters and hotter, drier summers. They also indicate that the frequency of severe weather events will increase. We will need to continue to grow our understanding of the impacts of severe weather and adapt accordingly to reduce the risk to services and communities presented by such changes*”

Flooding in November 2000, July-August 2004, July 2006, June-July 2007 and January 2008 was noted to have had a significant impact on a service area or department of the County Council. The LCLIP notes that repeat flooding has affected Worksop, the A46, Mansfield and Ashfield Regeneration Route and Lowdham. It made a series of proposed actions for climate change adaptation and in relation to flooding this includes a recording programme for severe events, increasing gully clearing, defining responsibility and identifying areas that are repeatedly affected and adapting.

5.8.4 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.

5.8.5 Adapting to Change

Past emission means 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 the key to achieving long-term, sustainable benefits.

Although the broad climate change picture is clear, we have to make local decisions against deeper 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.

5.9 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."

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)."

5.9.1 Local development drivers

The County is divided amongst two sub-regions of the East Midlands, shown on Table 5-5. There are a number of drivers for development in the County, including the 6 C's, Greater Nottingham and Newark Growth Point initiatives.

Our new role as a SUDS Approving Body has not yet been enacted, but will give us a further tool to help manage local flood risk across the County from new development. Through our Local Flood Risk Management Strategy and the Strategic Flood Risk Management Board we will work closely with Planning Authorities to manage flood risk both from and to new development across the County going forward. This may include the development of Surface

Water Management Plans and/ or detailed Drainage Strategies for those locations with particular local flooding issues and development pressure.

Table 5-5 East Midlands Sub-Regions in Nottinghamshire

Sub-Region	Housing Market Area	Districts or Boroughs in Nottinghamshire
Three Cities (Derby, Leicester and Nottingham)	Nottingham Core	Broxtowe, Gedling, Rushcliffe, Ashfield (Hucknall)
Northern	Nottingham Outer	Ashfield, Mansfield, Newark and Sherwood
	North Derbyshire and Bassetlaw	Bassetlaw

6. Identification of Flood Risk Areas

6.1 National assessment

Using the assessment method that has been applied by the Environment Agency using national datasets, nowhere in Nottinghamshire was identified as meeting the national thresholds. The Environment Agency mapping based on national datasets identified that England has 10 indicative 'significant' Flood Risk Areas, the only one in the East Midlands being Leicester. We have used the evidence in this report to review the indicative Flood Risk Areas, in terms of whether there should be Flood Risk Area(s) in Nottinghamshire.

The national thresholds for significance are:

- 30,000 people
- 150 critical services (nominal, number of people is deciding threshold for indicative Flood Risk Areas)
- 3,000 non residential properties (nominal, number of people is deciding threshold for indicative Flood Risk Areas)

6.2 County wide assessment

6.2.1 Past flooding

In terms of past flooding with significant harmful consequences, the pattern of past flooding that we have drawn is largely based on the availability of data and much of the data that is available is anecdotal and incomplete, especially in terms of recording the consequences of flooding. The flooding of June 2007 is best represented in the historical record and clearly highlighted how significant flooding can be to the people in Nottinghamshire. We have made our best efforts to collate the consequences of flooding from this event, but these are not thought to meet the national thresholds.

The Defra Guidance document 'Selecting and reviewing Flood Risk Areas for local sources of flooding' identifies the potential for flood risk areas to be identified on the basis on more frequent flooding, for which the consequences build up over time. However the information on past flooding is known to be incomplete, especially in relation to flood consequences and there is little information available on the number of properties affected or the extent of flooding. Many of our villages and parts of our urban areas have been affected repeatedly by flooding, including but not limited to Balderton, East Markham, Egmont, Lowdham, Oxtun, Retford, Southwell, Thurgarton and Worksop. In many cases the causes of flooding may be largely or partly related to Main River flooding.

For such areas, we intend to work closely with partner organisations, such as the Environment Agency, Districts and Boroughs, IDBs and the Water Companies to effectively manage the risk together and explore appropriate responses further as we develop our Local Flood Risk Management Strategy. This will give us a much more flexible approach in these areas, for which Flood Hazard and Risk Mapping and producing Flood Risk Management Plans would not be likely to be appropriate or proportional responses to the flood risk.

6.2.2 Future flooding

Possible harmful consequences to people, property and critical services

For the purpose of this PFRA and because we have used a combination of different datasets for the Locally Agreed Surface Water Information and to assess the consequences of flooding using the Local Land and Property Gazetteer, we have rerun the 'blue squares' analysis undertaken nationally which presents a combination of flood consequences based on the Locally Agreed Surface Water Information on 1km grid squares. These are known as 'places where flood risk is an issue' and are shown on Map O. The thresholds used for this analysis are the same as the national analysis:

- Number of people at risk > 200
- Number of Critical Services at Risk > 1
- Number of Non-Residential Properties at Risk > 20

For completeness we have compared our past flooding summary map with the 'places where flood risk is an issue' as a comparison between places where the consequences of flooding in future might be highest and those settlements that have flooded in the past on Map P. This map should be treated with caution due to the reasons outlined in Chapters 3 and 4 regarding the limitations of the data presented. It shows that many of the settlements that have been affected by flooding in Nottinghamshire do not cross the thresholds that have been used nationally to identify 'places where flood risk is an issue'. This is not to say that locations not identified as 'places where flood risk is an issue' or indeed anywhere in Nottinghamshire since there are no indicative Flood Risk Areas are insignificant. The Flood Risk Regulations are not the only route for managing localised flooding and clearly in this first round of assessment the Government has focussed on those areas at highest risk of flooding nationally. We are required to produce a Local Flood Risk Management Strategy for the County and this is likely to be the most appropriate, flexible and a much quicker route to managing localised flooding.

A cluster analysis has been carried out to identify clusters of 'places where flood risk is an issue'. The clusters are a collection of 3km by 3km that contains 5 touching 1km grid squares that cross the threshold above. There are only two clusters in Nottinghamshire, which cover the surrounds of Mansfield (covering Mansfield, Mansfield Woodhouse, Sutton-in-Ashfield and the north of Kirkby-in-Ashfield) and Nottingham. Table 6-1 shows the flood risk indicators in these settlements.

Table 6-1 Flood risk indicators using local data for clusters in Nottinghamshire

	People	Critical Services	Non-Residential Properties
Mansfield	9,592	50	1,127
Nottingham	27,093	216	2,407

Mansfield has not been considered further as a Flood Risk Area because it is notably below the national significance thresholds in terms of the number of people affected. We will address local flood risk as appropriate in Mansfield through the Local Flood Risk Management Strategy. Nottingham is considered further in Section 6.3.

It is noted that the Environment Agency's national assessment has also picked up Eastwood, Ilkeston, Gainsborough, Newark-on-Trent and Worksop as clusters. Our assessment has not picked these up and in the case of Eastwood, Gainsborough and Ilkeston is likely to be partly influenced by the County Border and limit of assessment since these clusters are partly in Derbyshire or Lincolnshire. In respect of Gainsborough, the part of Nottinghamshire that falls in the national cluster is limited to a relatively undeveloped area to the west of the River Trent. The national assessment has found all of these areas have less than 3,300 people at risk (based on the Flood Map for Surface Water) which is significantly below the national significance threshold of 30,000 people. Hence we have not looked at these areas further in the PFRA but we will work closely together with all of our bordering local authorities as suitable when we develop our Local Flood Risk Management Strategy.

Possible harmful consequences to other flood risk indicators

In terms of flooding to other infrastructure such as roads and rail, PPC sites, agricultural land and environmental and cultural heritage sites, we recognise the potential for adverse consequences and where we have records, the impact of past flooding. However, flooding to such features may not be significant in a national context and taking them forward under the Flood Risk Regulations to carry out detailed mapping and planning would be unlikely to be proportionate to the risk of flooding. We will look at such consequences again as part of the

Local Flood Risk Management Strategy and work with appropriate organisations and local communities to best manage the flood risk to such features.

6.3 Nottingham

Our analysis of flood risk clusters shows us that Nottingham and the surrounding urban area only just falls below the national threshold for people set for national significance. We have therefore chosen Nottingham to look at in detail, working jointly with Nottingham City Council.

6.3.1 Using local data and looking at flood risk clusters

Map Q shows the revised cluster compared to that provided nationally (for which the consequence data was the National Receptors Database version 1). Table 6-2 shows the difference in flood risk indicators.

Table 6-2 Flood risk indicators for Nottingham cluster

	People	Critical Services	Non-Residential Properties
National Assessment	25,349	96	2,171
Local Assessment	27,093	216	2,407

6.3.2 Using the urban area of Nottingham

A revised assessment of the number of people at risk from surface water flooding has been carried out considering the entire built up urban area rather than political or cluster boundaries.

Map Q shows the urban area of Nottingham as a possible Flood Risk Area and Table 6-3 shows the flood risk indicators for the urban area.

Table 6-3 Flood risk indicators for Nottingham urban area

	People	Critical Services	Non-Residential Properties
Local Assessment	31,134	229	2,679

Using an alternative method clearly shows that Nottingham crosses the national threshold of 30,000 people that could be affected by flooding. This could therefore provide the evidence to put Nottingham forward as a Flood Risk Area. However, at this time we feel that considering Nottingham jointly with Nottingham City Council through our respective Local Flood Risk Management Strategies would be most appropriate in giving us a flexible approach for managing local flood risk, in terms of activities and timescales.

7. Next steps

7.1 Flood Risk Regulations (2009)

The PFRA has not identified any Flood Risk Areas and so it will not be necessary to undertake Flood Risk and Hazard Mapping or prepare a Flood Risk Management Plan.

We will need to repeat the process of preparing a PFRA and identifying Flood Risk Areas for submission in 2017, as part of a six year cycle. To underpin both the next round of Preliminary Flood Risk Assessment and inform other roles and responsibilities, including the development of the Local Flood Risk Management Strategy and Duty to Investigate flood incidents, we are planning to put in place a system in place to consistency record, collect and store flood event information across the range of RMAs in the County. There are clearly challenges here, since a member of the public may call any one of a number of RMAs during a flood event and it is unlikely that we will achieve a single focal point for recording flooding at first point of contact. Protocols and processes for sharing this information and acting as appropriate are therefore needed. We plan to include information that will be mandatory to inform the next round of PFRA in line with guidance issued.

7.2 Local Flood Risk Management Strategy

As was seen in the summer floods of 2007 and other events, flooding can and has caused locally significant consequences to communities in Nottinghamshire. The County Council are proactively planning for our new roles and responsibilities under the Flood and Water Management Act as a LLFA. Partnership working with other Risk Management Authorities and local communities will be the key to managing local flood risk in the future across the County. The PFRA is seen as a key evidence base to feed forward into the Local Flood Risk Management Strategy.

Nottinghamshire's Local Flood Risk Management Strategy will cover:

- Risk Management Authorities
- FCERM functions that RMAs may exercise
- Objectives for managing flood risk
- Measures proposed to meet the objectives
- How and when measures will be implemented
- Costs, benefits and funding of measures
- Assessment of local flood risk
- Review mechanism
- Contribution to wider environmental objectives

The Strategy will be prepared with reference to the recently released Local Government Group Framework and be consistent with the National Flood and Coastal Erosion Risk Management Strategy.

We are currently commencing the initial stages of preparing the Local Flood Risk Management Strategy with our partners and local communities. The strategy matters to everyone, from the various functions within the County Council, to other Risk Management Authorities, including the seven Districts and Boroughs and Internal Drainage Boards to most importantly our local communities. We wish to work collaboratively across organisational boundaries and to support local communities to help themselves where inevitably a limited amount of funding from national and local government cannot stretch. We recognise the need for collective ownership of strategy direction: we can only reduce flood risk across the County if we work together.

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A.Appendix A: Information available for the PFRA

Organisation(s)	Information provided	
County Council	Highways	<ul style="list-style-type: none"> • Highways drainage assets - Bridges and culverts and database of those with flooding issues • Critical services used to inform winter maintenance work • Community Flood Action Groups • Known schemes since flooding of 2007 • Flood photos • Flood related Customer Contact Centre calls • Gully Emptying policy/ hotspots/ general information • Report on climate change impacts on highways • Parish, Town Council and Elected Member survey of drainage hotspots
	Emergency Planning	<ul style="list-style-type: none"> • COMAH sites • Humanitarian Centres • Rest Centres • Designated Filling Stations • Pipelines
	Sustainability and climate change	<ul style="list-style-type: none"> • Local Climate Impacts Profile and spreadsheet • East Midlands Climate Change Predictions
	Waste and Minerals	<ul style="list-style-type: none"> • Strategic Flood Risk Assessment not made available in project timescales
	General GIS	<ul style="list-style-type: none"> • Including OS Mastermap, Local Land and Property Gazetteer, that related to Highways, Schools, roads, railways, environmental and cultural heritage sites
District and Borough Councils*		<ul style="list-style-type: none"> • Assets • List of properties that applied for grants following flooding • Flood related Customer Contact centre calls • Outline, Scoping and/ or Detailed Water Cycle Studies • Level 1 and potentially Level 2 Strategic Flood Risk Assessment(s) • Flood feasibility reports and studies • Historic flooding locations e.g. from 2007 • Site specific Flood Risk Assessments done for Councils • Post flood reports inc Overview and Scrutiny • List of problem areas and estimated costs of solutions • Survey of drainage hotspots

Organisation(s)	Information provided	
Environment Agency		<ul style="list-style-type: none"> • River Witham Catchment Flood Management Plan • River Trent Catchment Flood Management Plan • Fluvial Trent Strategy • Greater Nottingham SFRA • Flood Map and Main Rivers • Detailed River Network • Areas Susceptible to Surface Water Flooding • National Receptor Dataset • Flood Map for Surface Water • Areas Susceptible to Groundwater Flooding • Indicative Flood Risk Areas • Historic Flood Map • PFRA data CD
Severn Trent Water		<ul style="list-style-type: none"> • DG5 Register
Internal Drainage Boards*		<ul style="list-style-type: none"> • Internal Drainage districts • Assets • Flooding records/ incidents (may be in Engineers Reports) • Flood feasibility reports and studies
British Waterways		<ul style="list-style-type: none"> • Asset and flooding information
Nottinghamshire Fire and Rescue Service		<ul style="list-style-type: none"> • Flooding incidents
Highways Agency (A1 Plus)		<ul style="list-style-type: none"> • Flooding locations
Nottingham City Council		<ul style="list-style-type: none"> • Nottingham Surface Water Management Plan Draft

This table shows data provided, some of which has been deferred for use in the Local Flood Risk Management Strategy, as appropriate

* Not all these datasets were provided by all our Districts and Boroughs or IDBs



Offices at
Atherstone
Doncaster
Edinburgh
Haywards Heath
Limerick
Newcastle upon Tyne
Newport
Northallerton
Saltaire
Skipton
Tadcaster
Wallingford
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