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# Preliminary Flood Risk Assessment

## Preliminary Assessment Report

**June 2011**

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Cheshire East Council

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# Executive Summary

This report has been prepared to assist Cheshire East Council (CEC) in meeting their duties to manage local flood risk and deliver the requirements of the Flood Risk Regulations (2009) and the Floods and Water Management Act (2010). CEC is defined as a Lead Local Flood Authority (LLFA) under the Regulations, and has a number of Duties under the recent legislation.

The Preliminary Flood Risk Assessment (PFRA), comprising this document and the supporting spreadsheet, represents the first stage of the requirements of the Regulations.

The PFRA process is aimed at providing a high level overview of flood risk from local flood sources, including surface water, groundwater, Ordinary Watercourses and canals. As a LLFA, CEC must submit their PFRA to the Environment Agency for review by 22nd June 2011. The methodology for producing this PFRA has been based on the Environment Agency's Final PFRA Guidance and Defra's Guidance on selecting Flood Risk Areas, both published in December 2010.

The Environment Agency has used a national methodology, which has been set out by Defra, to identify indicative Flood Risk Areas across England. Of the ten indicative Flood Risk Areas that have been identified nationally, none are located within CEC's administrative area. The Flood Risk Regulations therefore require CEC to:

- Collate and review existing data relating to historic and predicted future flood risk;
- Confirm areas across East Cheshire where local flood risk exceeds a locally determined threshold (in this case, where more than 80 houses are affected, 5 non-residential properties, or one piece of Critical Infrastructure).

Furthermore, the Environment Agency require CEC to agree and confirm a surface water mapping dataset that best represents the risks from surface water flooding within CEC's administrative area.

In order to develop a clear overall understanding of the flood risk across East Cheshire, flood risk data and records of historic flooding were collected from several different local and national sources. This included the Environment Agency, water and sewerage companies, emergency services and other risk management authorities.

Information relating to a number of historic flood events, caused by flooding from local sources, was collected and analysed. However, comprehensive details on flood extents and consequences of these events were largely unavailable.

From the information received, two events were identified that had 'significant harmful consequences'. These have therefore been included in Annex 1 of the Preliminary Assessment Spreadsheet (see Annex 1 of this document). Other data collected is recorded in the mapping provided as part of this PFRA document. This data indicates that historic flood risk within the area is mainly from rivers, surface water runoff and sewers. There appears to be little risk from groundwater flooding.

An assessment of future flood risk (flood risk that it is predicted may occur in the future) has found that there is a risk of flooding from local sources across Cheshire East in some areas, particularly from fluvial and surface water sources. Based on national surface water modelling undertaken by the Environment Agency (for a flood event with a 1 in 200 chance of flooding in any given year), it has been assessed that there are 36,400 properties, including 27,200 residential properties, at risk from surface water flooding in the future.

To progress CEC's approach to flood risk management, ongoing work post-PRFA submission will be designed to meet its objectives under the recent legislation, and include:

- Continuing to develop links with adjacent LLFAs and other bodies responsible for flood risk management;
- Using data collected to produce a manageable GIS database, controlled centrally, for use on future development control queries, investigation, planning etc;
- Assessments to identify the flood risk management prioritisations over the entire CEC area;
- Development of a Local Flood Risk Strategy;
- Development of an Asset Register that will be linked into CEC's existing Highways database;
- Setting up arrangements to record and (where appropriate) investigate future floods.
- Adopting and approving Sustainable Urban Drainage Systems (SUDS)

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# Glossary

| | |
|---|---|
| AStSWF: | Areas Susceptible to Surface Water Flooding; |
| CEC: | Cheshire East Council; |
| CFMP: | Catchment Flood Management Plan; |
| Defra: | Department for Environment, Food and Rural Affairs; |
| DG5: | OFWAT Directive Guidelines No. 5 (for Water Companies) for annual level of service indicators for properties at risk of sewer flooding; |
| EA: | Environment Agency; |
| FMfSW: | Flood Map for Surface Water; |
| FWMA: | Flood and Water Management Act; |
| GIS: | Geographical Information Systems; |
| IPCC: | Intergovernmental Panel on Climate Change; |
| LGF: | Local Government Forum; |
| LLFA: | Lead Local Flood Authority; |
| NRD: | National Receptor Dataset; |
| OEFRPG: | Operational Emergency Flood Response Plan Groups; |
| OFWAT: | Water Services Regulation Authority; |
| PFRA: | Preliminary Flood Risk Assessment; |
| PPS25: | Planning Policy Statement 25: Development and Flood Risk; |
| RFDC: | Regional Flood Defence Committee; |
| SAB: | SuDS Approving Body; |
| SFRA: | Strategic Flood Risk Assessment; |
| SuDS: | Sustainable Urban Drainage System; |
| SWMP: | Surface Water Management Plans; |
| UKCP09: | United Kingdom Climate Projections 2009; |
| WAG: | Welsh Assembly Government. |

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# 1 Introduction

## 1.1 Preliminary Flood Risk Assessment

Following the findings of the Pitt Report in 2008[1], the Government produced the Flood and Water Management Act 2010 (FWMA) to help manage flood risk in a more holistic way. The Act defines a lead role for local authorities in the management of local sources of flooding such as surface water; the Environment Agency retains its role in managing flood risk from main rivers and coastal sources.

In addition to this, the Government introduced the Flood Risk Regulations in 2009. These regulations transpose the ECC Floods Directive (Directive 2007/60/EC) into law.

Under the FWM Act, Cheshire East Council is designated a Lead Local Flood Authority (LLFA) and has been assigned a number of duties under law. A full description of these duties is provided in Section 2.

In particular, under the Flood Risk Regulations, the LLFA has a duty to prepare a number of documents, including:

- Preliminary Flood Risk Assessment (PFRA);
- Flood hazard and flood risk maps;
- Flood Risk Management Plans.

Table 1-A indicates the work required to meet the requirements of the Flood Risk Regulations. This PFRA aims to meet the first two requirements.

| | | |
|---|---|---|
| 22nd June 2011 | Prepare **Preliminary Flood Risk Assessment** Report | The PFRA should focus on local flood risk arising from surface water, groundwater, ordinary watercourses, and canals. |
| 22nd June 2011 | On the basis of the PFRA, identify **Indicative Flood Risk Areas** | **Indicative Flood Risk Areas** are a defined term, and are areas of nationally significant risk affecting 30,000 people or more. The PFRA is also required to record "locally significant risk areas" which are flood areas, above a locally determined threshold of affected people, and having significant harmful consequences. |
| 22nd June 2013 | Prepare **Flood Hazard Maps** and **Flood Risk Maps** for each Flood Risk Area | Used to determine the level of hazard and risk within each **Indicative Flood Risk Area** (affecting 30,000 or more people). |
| 22nd June 2015 | Prepare **Flood Risk Management Plans** for each Flood Risk Area | These are Plans setting out how the flood risk and hazard, identified by the Hazard and flood maps, are to be managed. |

**Table 1-A: Elements of Work required under the Flood Risk Regulations, 2009.**

[1] Pitt Review (2008) Learning lessons from the 2007 flood

## 1.2 Aims and Objectives

### 1.2.1 Aims

The PFRA is a high level screening exercise, using readily available data, to locate areas where there is a risk of flooding from:

- *Ordinary Watercourses*
- *surface water runoff*
- *groundwater*
- *canals*

As described in Table 1-A, areas where the risk of local flooding is significant, affecting more than 30,000 people, are deemed Indicative Flood Risk Areas. If these areas are found to exist within the Local Authority Boundary, then they may warrant further examination at a later stage through the production of Flood Risk and Hazard maps and Flood Management plans. The PFRA will also seek to identify "Locally Significant Flood Risk Areas". These are areas that the LLFA deems to be significant, although not as significant to warrant classing it as a Flood Risk Area.

The aim of this PFRA is to provide an assessment of local flood risk across the study area, including information on past floods and the potential consequences of future floods, and in so doing, satisfy the first two requirements of the Flood Risk Regulations, 2009 shown in Table 1-A.

### 1.2.2 Objectives

The objectives of this PFRA are as follows:

- *Identify relevant partner organisations involved in future assessment of flood risk and summarise means of future and ongoing stakeholder engagement;*
- *Describe arrangements for partnership and collaboration for ongoing collection, assessment and storage of flood risk data and information;*
- *Provide a summary of the systems used for data sharing and storing, and provision for quality assurance, security and data licensing arrangements;*
- *Summarise the methodology adopted for the PFRA with respect to data sources, availability and review procedures;*
- *Assess historic flood events within the study area from local sources of flooding (including flooding from surface water, groundwater and Ordinary Watercourses), and, where possible, the consequences and impacts of these events;*
- *Establish an evidence base of historic flood risk information, which will be built upon in the future and used to support and inform the preparation of CECs Local Flood Risk Strategy (a requirement of the Flood and Water Management Act, as described in Section 2.1.2);*
- *Assess the potential harmful consequences of future flood events within the study area;*

- *Review the provisional national assessment of indicative Flood Risk Areas provided by the Environment Agency and provide explanation and justification for any amendments required to the Flood Risk Areas.*

## 1.3 Study Area

The study area for this PFRA is the administrative boundary of CEC. This includes the following eight town councils:

1. Alsager;
2. Bollington;
3. Congleton;
4. Knutsford;
5. Middlewich;
6. Nantwich;
7. Poynton;
8. Sandbach.

The administrative boundary of Cheshire East stretches from Audlem in the south to Disley and Poynton in the North. The administrative area of Cheshire East covers approximately 1,116 km$^2$, and currently has a population of 358,900[2]. CEC is predominately rural and contains the railway town of Crewe, the old mill towns of Macclesfield, Bollington and Congleton and the market towns of Nantwich, Knutsford and Sandbach, as well as Middlewich, Wilmslow, and smaller settlements such as Poynton, Alderley Edge, Holmes Chapel and Prestbury. The geographical extent of the study area is illustrated in Figure 1 below, and is shown in greater detail in Figure 1 of Appendix A.


**Figure 1 Cheshire East Council Administrative Boundary**

CEC is bounded to the west by Cheshire West and Chester Council, and eight other councils including Shropshire Council, Newcastle-under-Lyme Borough Council, Staffordshire Moorlands District Council, High Peak District Council, Stockport

[2] http://www.cheshireeast.gov.uk/about_cheshire_east/cheshires_changing_boundaries.aspx

Metropolitan Borough Council, Trafford Metropolitan Borough Council, and Warrington Borough Council.

The eastern extent of CEC lies within the Peak District National Park boundary.

CEC has good transport and communication links to large cities including Manchester, Liverpool and Birmingham. The M53, M56 and M6 motorways provide national transport links to the north and south of the UK. The A51 provides a direct link to Chester and North Wales, and the A500 links to Stoke-on-Trent and the West Midlands. The West Coast Mainline (railway) travels through CEC. The rail hub based in Crewe provides access into and out of the area providing a rail gateway to the Northwest with links to London, Scotland, Birmingham and Manchester, in addition to more local stations across Cheshire East.

The major rivers within the CEC administration boundary include the River Wheelock, Crocco, Dane, Bollin, Dean, Weaver and Gowy. These are Main Rivers, managed by the Environment Agency North West Region. The area lies within the North West River Basin District.

The Shropshire Union Canal, Llangollen Canal, Bridgewater Canal, Macclesfield Canal, and the Trent and Mersey Canal are present in the CEC study area, and are managed by British Waterways.

The water company that serves the administrative area is United Utilities.

# 2 Lead Local Flood Authority Responsibilities

## 2.1 Introduction

The preparation of a PFRA is just one of several responsibilities of LLFAs under the new legislation. This section provides an overview of other responsibilities CEC are obliged to fulfil under their role as a LLFA.

### 2.1.1 Coordination of Flood Risk Management

In his Review of the summer 2007 flooding, Sir Michael Pitt stated that "the role of local authorities should be enhanced so that they take on responsibility for leading the coordination of flood risk management in their areas". As the designated LLFA, CEC is therefore responsible for leading local flood risk management across the study area.

Local flooding comes from a number of sources – surface water (runoff before it enters a sewer), groundwater, ordinary watercourses and canals. It is the responsibility of the LLFA to coordinate the response to flooding from these sources.

As stated previously, the Environment Agency are the lead organisation responsible for managing flooding from Main Rivers and the sea. The water company remains responsible for flooding from sewers, except where it is wholly or partly caused by rainwater entering the system. Floods or raw sewage, caused by blocking of a sewer, for example, are not covered by the regulations, neither is flooding from burst water mains.

Much of the local knowledge and expertise that CEC will need to enable it to coordinate the management of local flooding will reside within other partner organisations. It is crucial that the Council forges successful partnerships with these organisations to ensure effective coordination.

In order to contribute to the provision of a co-ordinated and 'common sense' approach to flood risk management across the study area, CEC have developed a number of work groups and forums to liaise with our most important stakeholders at the appropriate organisational level.

CEC has set up a Flood and Water Management Task Group, which includes representatives from the Environment Agency, and United Utilities. The task group includes key staff from the following departments within CEC: Emergency Planning, Building Control, Highways, GiS, Greenspaces, Finance and Environmental Planning.

As well as setting up the Task Group, CEC has set up strategic partnerships with Cheshire West and Chester Council, Warrington BC, Halton BC and St Helens BC, to ensure that lessons are learnt and knowledge is shared. The partnership also serves to ensure consistency amongst the councils, so that data can be shared in an effective manner.

The Flood Task Group and the Strategic Alliance between councils will be developed in the future as more of the requirements of the legislation become enacted.

It is recognised that members of the public may also have valuable information to contribute to local flood risk management more generally across the Cheshire East Council area. Stakeholder engagement can bring significant benefits to local flood risk management including building trust, gaining access to additional local knowledge and increasing the chances of stakeholder acceptance of options and decisions proposed in future flood risk management plans. As such, plans for public engagement will form part of future flood management strategies.

### 2.1.2 Further Responsibilities

Aside from forging partnerships and coordinating and leading on local flood management, there are a number of other key responsibilities that have arisen for Lead Local Flood Authorities from the FWMA and the Flood Risk Regulations. These responsibilities include:

**Investigating flood incidents** – LLFAs have a duty to investigate and record details of flood events, over and above a locally agreed significance threshold, within their area. This duty includes identifying which authorities have flood risk management functions and what they have done or intend to do with respect to the incident, notifying risk management authorities where necessary and publishing the results of any investigations carried out.

**Asset Register** – LLFAs also have a duty to maintain a register of structures or features which are considered to have an effect on flood risk, including details on ownership and condition as a minimum.

**SuDS Approving Body** – LLFAs are designated the SuDS Approving Body (SAB) for any new drainage system, and therefore must approve, adopt and maintain any new sustainable drainage systems (SuDS) within their area.

**Local Strategy for Flood Risk Management** – LLFAs are required to develop, maintain, apply and monitor a local strategy for flood risk management in its area. The local strategy will build upon information such as national risk assessments and will use consistent risk based approaches across different local authority areas and catchments.

**Discharge Consents** – LLFAs will be required to administer Discharge Consents under the Water Act. They will provide consent to developments or works that have an impact on Ordinary Watercourses, and take enforcement action against unconsented works.

**Works powers** – LLFAs have powers to undertake works to manage flood risk from surface runoff and groundwater, consistent with the local flood risk management strategy for the area.

**Designation powers** – LLFAs, as well as district councils and the Environment Agency have powers to designate structures and features that affect flooding or coastal erosion in order to safeguard assets that are relied upon for flood or coastal erosion risk management.

**Duty to Cooperate and Share information** – LLFAs, as well as other Flood Authorities (Environment Agency , Water Company, other LLFAs) have a duty to cooperate with each other, and also the power to request information, in connection with flooding, of any person or body.

# 3 Methodology and Data Review

## 3.1 Introduction

The PFRA is a high-level screening exercise used to identify areas where the risk of flooding is considered to be significant and warrants further examination and management through the production of flood risk and flood hazard maps and flood risk management plans.

The approach for producing this PFRA is based upon the Environment Agency's PFRA Final Guidance, which was released in December 2010. The PFRA is based on readily available or derivable data and with this in mind; the following methodology has been used to undertake the PFRA.

## 3.2 Methodology

### 3.2.1 Data Collection from Partner Organisations

Data from the following authorities and organisations is used for the preparation of this PFRA:

- *Environment Agency;*
- *Utilities companies (United Utilities);*
- *British Waterways;*
- *Cheshire Fire and Rescue Service.*

Table 3-A catalogues the relevant information and datasets held and used by partner organisations and provides a description of each of the datasets.

| | Dataset | Description |
|---|---|---|
| Environment Agency | Areas Susceptible to Surface Water Flooding (AStSW) | The first generation national mapping, outlining areas of risk from surface water flooding across the country with three susceptibility bandings (less, intermediate and more). |
| | Flood Map for Surface Water (FMfSW) | The updated (second generation) national surface water flood mapping which was released at the end of 2010. This dataset includes two flood events (with a 1 in 30 and a 1 in 200 chance of occurring in any given year) and two depth bandings (greater than 0.1m and greater than 0.3m). |
| | Flood Map (Rivers and the Sea) | Shows the extent of flooding from rivers with a catchment of more than 3km$^2$ and from the sea. Flood events with a 1% and 0.1% chance of occurring in any year are represented. |
| | Areas Susceptible to Groundwater Flooding | Coarse scale national mapping showing areas which are susceptible to groundwater flooding. |
| | Groundwater Emergence Maps | National mapping showing areas which have a high probability of groundwater emergence |
| | National Receptors Dataset | A national dataset of social, economic, environmental and cultural receptors including residential properties, schools, hospitals, transport infrastructure and electricity substations. |
| | Indicative Flood Risk Areas | Nationally identified flood risk areas, based on the definition of 'significant' flood risk described by Defra and WAG. |
| | Historic Flood Map | Attributed spatial flood extent data for flooding from all sources. |
| | Weaver Gowy CFMP and Upper Mersey CFMP | CFMP's consider all types of inland current and future flooding, from rivers, groundwater, surface water and tidal flooding and are used to plan and agree the most effective way to manage flood risk in the future. |
| CEC | Historical flooding records | Historical records of flooding from surface water, groundwater and ordinary watercourses. |
| | Anecdotal information relating to local flood history and flood risk areas | Anecdotal information from authority members regarding areas known to be susceptible to flooding from excessive surface water, groundwater or flooding from ordinary watercourses. |
| | Strategic Flood Risk Assessments (SFRA) | SFRA's may contain useful information on historic flooding, including local sources of flooding from surface water, groundwater and flooding from canals. |
| | Historical flooding records | Historical records of flooding from surface water, groundwater and ordinary watercourses. |
| | Multi-agency flood response plans | Regularly updated plans used by emergency responders, which hold details of historic flood locations and critical infrastructure |
| Water Company | DG5 Register | DG5 Register logs and records of sewer flooding incidents in each area. |
| Fire and Rescue | Incident response register | Issue logs of all events recorded by the Cheshire Fire & Rescue Service Department relating to flooding. This includes internal floods such as burst pipes and sewerage problems. |

**Table 3-A Relevant information and datasets**

### 3.2.2 Data Limitations

A brief assessment of the data collection process is included in this chapter to provide transparency with respect to the methodology. By flagging up the issues identified in the data collection phase it is hoped this could serve as a catalyst to improve the collection of flood risk data going forward. A number of issues arose during the data collection process, as described below:

#### (a) Inconsistent Recording Systems

The lack of a consistent flood data within the recording system across CEC has led to inconsistencies in the recording of flood event data. This has resulted in incomplete, or sometimes nonexistent, flood record datasets. Further information on addressing this issue in the future is included in Chapter 7.

#### (b) Incomplete Datasets

As a result of the lack of consistent flood data recording arrangements (as described above), some of the datasets collated are not exhaustive and it is felt that they are unlikely to accurately represent the complete flood risk issues in a particular area. The corresponding gaps in flood data will hinder also the identification of accurate flood risk areas.

#### (c) Varied Quality of Data

Based upon the data collected from all sources described above, there was found to be varied quality in historic flood records and information. However under Section 21 of the Flood and Water Management Act 2010, lead local authorities will have a duty to investigate and maintain a register of flooding incidents. At present Cheshire East Council are working with the neighbouring authorities to produce consistent records across the area, and as such improve the quality of the data collected for future assessments.

#### (d) Records of Consequences of Flooding

Very few organisations were able to provide accurate details of the consequences of specific past flood events. This made assessing the consequences of historic flooding difficult.

### 3.2.3 Quality Assurance, Security and Data Restrictions

Data collected was subject to quality assurance measures to monitor and record the quality and accuracy of acquired information and datasets. A data quality score was given, which is a qualitative assessment based on the Data Quality System provided in the Surface Water Management Plans (SWMP) Technical Guidance document (March 2010). This system is explained in Table 3-B.

| Data Quality Score | Description | Explanations | Example |
|---|---|---|---|
| 1 | Best possible | No better available, not possible to improve in the near future. | High resolution LiDAR<br>River/sewer flow data<br>Rain gauge data |
| 2 | Data with known deficiencies | Best replaced as soon as new data are available | Typical sewer or river model that is a few years old. |
| 3 | Gross assumptions | Based on experience and judgment. | Location, extent and depth of much surface water flooding<br>Operation of un-modelled highway drainage.<br>'Future risk' inputs e.g. rainfall, population. |
| 4 | Heroic assumptions | An educated guess. | Ground roughness for 2d models. |

**Table 3-B Data Quality System from SWMP Technical Guidance (March 2010)**

The use of this system provides a basis for analysing and monitoring the quality of data that is being collected and used in the preparation of the PFRA.

The security of data is also a key consideration when it comes to collecting, collating and storing sensitive data. All data collected is stored on local servers which are password protected. CEC must adhere to these data security measures to ensure that sensitive data is held in a secure manner.

# 4 Past Flood Risk

## 4.1 Introduction

This section summarises the readily available and relevant information on past floods. The PFRA guidance requires floods identified with significant harmful consequences to be reported in the spreadsheet in Annex 1 of this report. 'Significant harmful consequences' are considered to be impacts of flooding that may have negative consequences for human health, the social and economic welfare of individuals and communities, infrastructure, and the environment (including cultural heritage).

The definition of a past flood with "significant harmful consequences" is left to the LLFAs to determine. The level of significance should be chosen so that only relatively harmful flood events are included in the PFRA. Such flood events are those that would be deemed significant when considered from a national perspective.

However, all flood events affecting property or people are significant to CEC, and justify being evaluated. The Local Flood Management Strategy, which will be produced following this PFRA will identify and seek to address these. For the purposes of this PFRA, the definition of "Significant" has been defined by CEC (in common with the other LLFAs in the Strategic Alliance) as a flood affecting:

- *80 houses (200 people using an average of 2.5 people per property) or more, or*
- *5 non-residential properties;*
- *1 piece of Critical Infrastructure.*

Past floods that meet the above criteria are reported in the spreadsheet of Annex 1. Other floods that do not meet the criteria, or for which the consequences are not known, are not included in the Annex, as per the PFRA guidance, but their locations are plotted on the relevant figures. The following sections discuss the "Significant" events, and other events that are known to have occurred.

## 4.2 Surface Water Flooding

Surface water flooding, in the context of the PFRA, is ponded or flowing water that sits above ground level. This may be a result of heavy rainfall which is unable to infiltrate into the ground, or is prevented from discharging into a drainage system or river channel, due to its volume, intensity, or because the receiving river/drain is already full. This is known as pluvial flooding. Pluvial flooding also includes overland flows from the urban/rural fringe entering the built up area.

Whilst pluvial flooding from heavy rainfall can occur anywhere in the Council's area, there are certain locations where these mechanisms are more prominent due to the urban nature of the catchment and complex hydraulic interactions between the tidal systems, urban watercourses, and surface water and combined sewer systems. Surface water flooding is known to be a problem in the urban areas where flooding often occurs following short, intense storms and the capacity of the urban drainage system is exceeded and water flows across the ground[3].

[3] Environment Agency (2009a) Upper Mersey Catchment Flood Management Plan, Summary Report, December 2009

As part of the PFRA process, historical flooding incidents were collected from a number of key flood risk stakeholders and from internal sources. Locations provided from internal consultation within CEC, and from data given in the Crewe and Congleton SFRAs, are provided in Figure 2 in Appendix A. The data from the SFRAs includes Fire & Rescue flooding incidents. The Macclesfield and Cheshire SFRAs were also reviewed, but did not include any information on historic flood events. Specific details of the flood events (72 in total) are unknown, and not all are as a result of Surface Water Flooding, although it is reasonable to assume that the majority of them will be.

## 4.3 Fluvial Flooding

'Ordinary Watercourses' are any watercourses that are not designated a 'Main River' by the Environment Agency and therefore come under the control of CEC. These watercourses can vary in size considerably and can include drains and open ditches, to streams, brooks and small rivers. Ordinary Watercourses in Cheshire East have been identified using the Environment Agency's Detailed River Network (DRN) and are indicated on Figure 3 of Appendix A.

Ordinary Watercourses with known flood risks associated to them were previously known as Critical Ordinary Watercourses (COWs). However, in 2006/7, the Environment Agency reclassified all COWs as Main Rivers and took over responsibility for their maintenance and management, in a process known as enmainment.

However, since the enmainment of COWs, there have been a number of flooding incidents on Ordinary Watercourses not previously thought to have posed a risk. These watercourses remain the responsibility of CEC.

Internal consultations within CEC have revealed 19 historic fluvial events. Their locations are shown on Figure 3 in Appendix A. Two of these flooding events are "significant" when assessed against the criteria presented in Section 4.1, and are indicated as such on the Figure. These are flooding from the River Bollin, which flooded approximately 500 properties in November 1998, and flooding from the River Dane in during the same event, which flooded more than 200 properties. It should be noted that the CFMP records the number of properties affected during the event as 53; an obvious discrepancy in reported consequences. It can be agreed that it was an event that was notable for the large number of properties affected. As the event had significant consequences, further details are provided in the spreadsheet in Annex 1, as required by the PFRA guidance. Little information is known on the consequences of the remaining reported fluvial flood events and so they are not reported in the Annex.

Data on past instances of flooding from the Congleton Strategic Flood Risk Assessment (SFRA) and Crewe SFRA (described under Section 4.2 and shown on Figure 2 in Appendix A), which it is assumed is mostly as a result of surface water flooding, will inevitably include flooding from rivers. However, it is not known which locations this applies to.

The Chronology of British Hydrological Events database[4] has been used to search for other historic fluvial flood events in the study area, the results of which are presented in Appendix B. Available fluvial flooding records range between 1574 and 1892. In addition to this, the Weaver Gowy Catchment Flood Management Plan

[4] http://www.dundee.ac.uk/geography/cbhe/

details floods between 1946 and 2001. Details of these are also provided in Appendix B and in total over 23 flood events are recorded.

## 4.4 Sewer Flooding

Flooding from artificial drainage systems occurs when flow entering a system, such as an urban storm water drainage system, exceeds its conveyance capacity, the system becomes blocked or it cannot discharge due to a high water level in the receiving watercourse.

A sewer flood is often caused by surface water drains discharging into the combined sewer systems; sewer capacity is exceeded in large rainfall events causing the backing up of floodwaters within properties or discharging through manholes.

Some of the sewers across CEC date back to the Victorian times. Since then, the population has grown as the community has expanded. More houses and businesses mean increased discharges and less permeable surfaces for rainwater to drain into. Climate change is also believed to be leading to longer, heavier periods of rainfall. These two factors result in the existing sewers and drains not being able to cope at certain times.

Figure 4 in Appendix A presents the historic sewer flooding incidents as obtained from United Utilities. There have been a total of 271 historic sewer flooding (internal and external) incidents, particularly in the urban areas of Crewe, Sandbach, Alsager, Congleton, Macclesfield, Bollington, Middlewich and Ponyton. There have been 81 incidents of internal sewer flooding, and 190 incidents of external flooding in the past.

## 4.5 Groundwater Flooding

Groundwater flooding is caused by the emergence of water from underground, either at point or diffuse locations. The occurrence of groundwater flooding is usually very local and unlike flooding from rivers and the sea, does not generally pose a significant risk to life due to the slow rate at which the water level rises.

However, groundwater flooding can cause significant damage to property, especially in urban areas, and can pose further risks to the environment and ground stability. There are several mechanisms which produce groundwater flooding including:

- *Prolonged rainfall;*
- *High in bank river levels;*
- *Artificial structures;*
- *Groundwater rebound;*
- *Mine water rebound.*

The Environment Agency's CFMPs do not consider groundwater flooding to be a significant issue in CEC's administrative boundary, as there is little historic evidence to suggest that groundwater flooding is an issue worth further investigation. However, maps showing the Area Susceptible to Groundwater Flooding suggest that groundwater is a potential issue. This is discussed further in Section 6.5.

## 4.6 Canal Flooding

British Waterways is the organisation responsible for the care and enhancement of the nation's 2,200-mile network of canals, much of which dates back to the 1800s.,. There are five canals present in the CEC administrative boundary.

The risk of flooding along each canal is dependent on a number of factors. As they are unnatural systems and heavily controlled, it is unlikely they will respond in the same way as a natural watercourse during a storm event. Flooding is more likely to be associated with residual risks, such as overtopping of canal banks, breaching of embanked reaches or asset (gate) failure. Each canal also has significant interaction with other sources of flood risk, such as the main rivers and the minor watercourses that feed them, or drains that cross beneath them.

Table 4-A presents locations where canal breaches and canal overtopping have occurred in the past.

| Location | Description | Date |
|---|---|---|
| **Past Canal Breach Events** | | |
| Bollington | Piping / Leak failure | 1912 |
| Disley | Culvert Failure | 1941 |
| Disley | Culvert Failure | 1973 |
| Church Minshull | Piping / Leak failure | 1958 |
| Bollington Embankment | Piping / Leak failure | 2001 |
| Baddiley | Culvert Failure | 2006 |
| **Past Canal Overtopping Events** | | |
| Macclesfield | Specific location unknown | Unknown |

**Table 4-A Incidents of historic canal breaches and overtopping events**

Figure 5 in Appendix A presents the distribution of historic canal flooding incidents. There have been a cluster of canal breaching incidents on the Macclesfield Canal at Bollington and Disley.

## 4.7 Interaction with Main Rivers and the Sea

The River Mersey Estuary lies outside of the study area, therefore there is considered to be no interaction between fluvial and tidal environments. The tidal limit of the River Gowy extends up to Trafford Bridge, and up to Frodsham on the River Weaver[5] both of which lie outside of the East Cheshire study area, therefore there is considered to be no interaction between fluvial and tidal environments within the Administrative Boundary.

[5] Environment Agency, Weaver Gowy Catchment Flood Management Plan, Summary Report, December 2009.

# 5 Future flood risk

## 5.1 Overview of Future Flood Risk

Whilst analysis of past flooding provides valuable information on the nature and extents of flooding that have occurred in CEC in the past, it does not necessarily inform us about how and where flooding may occur in the future.

Predictions of future flood risk are produced using combinations of hydrological and hydraulic modelling and analysis of past hydrological records to make future predictions. The following sources of flooding have been considered in subsequent sections of this report:

- *Ordinary watercourses (fluvial);*
- *Surface water;*
- *Groundwater;*
- *Canals.*

## 5.2 Surface Water Flooding

The Environment Agency has two national datasets showing surface water flooding which are:

- *Areas Susceptible to Surface Water Flooding (AStSWF);*
- *Flood Map for Surface Water (FMfSW).*

These datasets were used nationally to select the 10 Indicative Flood Risk Areas in England.

These surface water maps are not designed to assess the risks from other sources of flooding. However, as these datasets use a digital representation of the ground topography, they route surface runoff into channels and depressions. As the location of flooding is linked to topography and depressions, flooding from Ordinary Watercourses and groundwater may occur in the same places as flooding from surface runoff.

The overall administrative area of CEC is 1,116 $km^2$, which includes a vast range of land uses, topography, flooding causes/mechanisms, flooding probabilities and flood consequences. Artificial drainage systems within the study area will also vary greatly in terms of capacity, condition and reliability. Furthermore, specific localised features could significantly affect the extent, depth and velocity of surface water flooding. For example:

- *Surface features such as kerbs, ramps and privately owned walls/banks;*
- *Susceptibility of artificial drainage systems, channels and trash screens to blockage during a flood event;*
- *Land use management, such as direction of ploughing of agricultural land, vegetation cover etc;*
- *Steepness and permeability of areas contributing to surface water runoff.*

CEC are required by the Environment Agency to agree an appropriate dataset that represents the risk from surface water in their area. Both the Flood Map for Surface Water (FMfSW) data (Figure 6 in Appendix A) and the Areas Susceptible to Surface

Water Flooding (AStSWF) data (Figure 7 in Appendix A) were reviewed against the available historic flooding information provided by United Utilities and SFRA data. In general only a loose correlation was found between either of the datasets and the historic flooding information. Therefore, for the purposes of this PFRA, the AStSWF dataset has been used as the locally agreed surface Water information. This is because it represents a more conservative assessment of the level of risk, and is therefore more appropriate for a high level strategic study such as the PFRA.

Table 5-A shows the number of properties at risk from surface water flooding in the future (from the AStSWF map, Figure 7 in Appendix A).

| Properties | Total number ofproperties within CEC | Less Risk | Intermediate Risk | More Risk |
|---|---|---|---|---|
| **All** | 557,382 | 34,200 | 13,900 | 1,876 |
| **Residential** | 440,560 | 25,900 | 10,200 | 1,231 |
| **Non-residential** | 116,822 | 8,300 | 3,700 | 645 |

**Table 5-A Properties at risk from future surface water flooding (using Areas Susceptible to Surface Water Flooding dataset)**

The AStSWF maps show potential flooding resulting from a flood event with a 0.5% chance of occurring in any year. Flood depths in areas at less risk are likely to be between 0.1m and 0.3m; in areas of intermediate risk 0.3m to 1.0m; and in areas of more risk over 1.0m. For more frequent events of lesser magnitude, areas identified as being at more risk will flood first.

Property counts are derived from data provided by the Environment Agency or from counts undertaken using GIS software and the National Receptor Database.

The level of future flood risk and the estimated associated consequences are provided in the spreadsheet in Annex 2.

## 5.3 Fluvial Flooding

The river network data was used to identify Ordinary Watercourses and this was cross referenced with the Flood Map for Rivers and the Sea to assess potential future flood risk from this source. Flood Zone 2 extents (having between a 1 in 100 and 1 in 1000 annual probability of river flooding in any year) and Flood Zone 3 (having up to a 1 in 100 annual probability of occurrence in any one year) are shown in Figure 8 of Appendix A. In many areas the extents of Flood Zones 2 and 3 are very similar due to the local topography.

Figure 8 in Appendix A presents the future fluvial flood risk from Ordinary Watercourses in CEC. The main future flood risk is particularly focussed along the River Weaver which flows through Nantwich, the River Dane which flows through Holmes Chapel and Congleton; and on the River Dean near Bollington.

The CFMPs state that flooding will become more frequent in the future which will lead to an increase in the number of properties at fluvial flood risk across the area. Flood risk is expected to increase in the future particularly in Crewe, Nantwich and Congleton. River levels are expected to increase by 0.5m in Congleton, and 0.7m in Nantwich by 2100 for a 1 in 100 annual probability event.

## 5.4 Canal Flooding

The main risks from canals within the CEC administrative area are likely to be;

- ***Areas where the water levels in the canal are elevated above the surrounding topography.*** *In such areas, any overtopping or breaching of canal side retaining structures have the potential to flow over low lying land and pond in natural depressions;*
- ***Areas where the canal is near to the natural river system and flood levels in the river can spill over into the canal system.*** *If this were to occur, then the flood water from the river can be transferred to areas remote from the original spill point.*

Where the above situation could affect people, properties and critical infrastructure, the consequences of flooding will be greater. However, to quantify the impacts needs a detailed understanding of the potential overland flow routes from the canal.

British Waterways are currently working on a study to better understand the future flood risk from canals, which will be available to inform the second cycle of the PFRA process.

Given the above, there is currently no readily available information to assess the future flood risk from canals and no further analysis has been carried out.

## 5.5 Groundwater Flooding

The Environment Agency's national datasets provide an assessment of groundwater risk in terms of the percentage of a 1km$^2$ grid square susceptible to groundwater emergence. This is the Areas Susceptible to Groundwater Flooding (AStGwF). An additional dataset is the groundwater emergence data derived by Defra, which presents the groundwater risk in a different manner.

The future AStGwF risk is shown on Figure 9 of Appendix A. This shows that the probability of groundwater flooding is very high in Nantwich, and parts of Crewe and Knutsford. The probability of future groundwater flooding tends to be lower in the north east of the study area. As discussed in Section 4.5, there does not appear to be a historical risk of groundwater flooding.

The Groundwater Emergence Zone data is shown on Figure 10 of Appendix A. If Figure 9 is compared to Figure 10, it can be seen that the risk indicated by the groundwater emergence plan is significantly lower, and more in line with the lack of historical groundwater flooding. It could therefore be deduced that the groundwater risk is more accurately represented by the groundwater emergence data (Figure 10) and that the risk indicated by Figure 9 is a conservative estimate.

## 5.6 Sewer Flooding

As discussed in Section 4.4, records of sewer flooding have been obtained from United Utilities. Based on information readily available on their websites in their "Strategic Direction Statements" they are proposing to address a significant number of sewer flooding problems by 2015. This is to be achieved through investment in the completion of a number of studies and capital works projects.

## 5.7 Climate Change and Long Term Developments

### 5.7.1 The Impacts of Climate Change

#### 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%.

### 5.7.2 Key Projections for North West River Basin District

CEC lies within the North West River Basin District. The following outlines the key climate change projections for the North West River Basin District.

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

- *Winter precipitation increases of around 14% (very likely to be between 4 and 28%);*
- *Precipitation on the wettest day in winter up by around 11% (very unlikely to be more than 25%);*
- *Relative sea level at Morecambe very likely to be up between 6 and 36cm from 1990 levels (not including extra potential rises from polar ice sheet loss);*
- *Peak river flows in a typical catchment likely to increase between 11 and 18%.*

Increases in rainfall are projected to be greater near the coast than inland.

### 5.7.3 Implications for Flood Risk

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

Wetter winters and more of this rain falling in wet spells may increase river flooding especially in steep, rapidly responding catchments. 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.

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.

### 5.7.4 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 key to achieving long-term, sustainable benefits.

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

### 5.7.5 Long Term Developments

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

In England, Planning Policy Statement 25 (PPS25)[6] 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

[6] Communities and Local Government (2010) Planning Policy Statement 25: Development and Flood Risk. Revised March 2010.

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).

# 6 Review of Indicative Flood Risk Areas

## 6.1 Overview

As described in Section 1.2.1, in order to ensure a consistent national approach, Defra have identified significant criteria and thresholds to be used for defining flood risk areas. Guidance on applying these thresholds has been released in Defra's document *"Selecting and reviewing Flood Risk Areas for local sources of flooding"*. In this guidance document, Defra have set out agreed key risk indicators and threshold values which must be used to determine Flood Risk Areas.

The methodology is based on using national flood risk information to identify 1km grid squares where local flood risk exceeds a defined threshold. Where a cluster of these grid squares leads to an area where flood risk is most concentrated, and, over 30,000 people are predicted to be at risk of flooding, this area has been identified as an Indicative Flood Risk Area. Figure 11 in Appendix A shows the High Risk Areas identified by Defra.

None of the clusters shown affect more than 30,000 people, and therefore there are no Indicative Flood Risk Areas within the CEC boundary, as defined by the criteria set out by Defra.

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# 7 Next Steps

## 7.1 Future Data Management Arrangements

In order to continue to fulfil their role as LLFA, CEC are required to investigate future flood events and ensure continued collection, assessment and storage of flood risk data and information. A central flood data collection spreadsheet will be created and updated with each flood event.

It is crucial that all records of flood events are documented consistently and in accordance with the INSPIRE Directive (2007/2/EC). It is recommended that a centralised database will be kept up to date by CEC, who have the overall responsibility to manage flood data throughout the administrative area. This can be used as an evidence base to inform future assessments and reviews and for input into the mapping and planning stages.

At present the proposed method for flood event data collection and management is being prepared.

## 7.2 Scrutiny and Review Procedures

The scrutiny and review procedures that must be adopted when producing a PFRA are set out by the European Commission. Meeting quality standards is important in order to ensure that the appropriate sources of information have been used to understand flood risk and the most significant flood risk areas are identified.

Another important aspect of the review procedure is to ensure that the guidance is applied consistently; a consistent approach will allow all partners to understand the risk and manage it appropriately. The scrutiny and review procedure will comprise two key steps, namely, Local Authority Review and Environment Agency Review.

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Another important aspect of the review procedure is to ensure that the guidance is applied consistently; a consistent approach will allow all partners to understand the risk and manage it appropriately. The scrutiny and review procedure will comprise two key steps, as discussed below.

The Review Checklist in Annex 4 of this document is used by all LLFA's and the Environment Agency review teams to ensure a consistent review process is applied.

### 7.2.1 Local Authority Review

The first part of the review procedure is through an internal Local Authority review of the PFRA, in accordance with appropriate internal review procedures. Internal approval should be obtained to ensure the PFRA meets the required quality standards, before it is submitted to the Environment Agency. Approval is not, however, required before submission to the Environment Agency on 22nd June, but must be obtained before 18th August 2011.

Within CEC, the PFRA will be taken to the Flood Risk Management Task Group for approval. It will then be taken for approval by an overview and scrutiny committee consisting of Elected Members for the administrative area.

### 7.2.2 Environment Agency Review

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

The Environment Agency will undertake a technical review (area review and national review) of the PFRA. If satisfied, they will recommend submission to the relevant Regional Flood Defence Committee (RFDC) for endorsement. RFDCs will make effective use of their local expertise and ensure consistency at a regional scale. Once the RFDC has endorsed the PFRA, the relevant Environment Agency Regional Director will sign it off, before all PFRAs are collated, published and submitted to the European Commission.

### 7.2.3 PFRA Review Cycle

The PFRA must be reviewed and updated every 6 years. The first review cycle of the PFRA must be submitted to the Environment Agency by the 22nd of June 2017. They will then submit it to the European Commission by the 22nd of December 2017 using the same review procedure described above. Although the requirement is for the PFRA to be reviewed every 6 years, CEC will treat it as a living document and update the information contained within it on a regular basis.

# Appendix A Figures

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# Appendix B Historic Flood Chronology

The following table contains details on historical flood incidents on Main Rivers from the University of Dundee and the Environment Agency's Catchment Flood Management Plans

| Year | Month | Details |
|---|---|---|
| 1574 | 11 | "On the 26th. November, 1574, there was a great flood when the river Weaver broke its banks, flooding 64 houses in the vicinity. The river Weaver "came up to the bridge" according to one eye-witness " [R. Weaver] |
| 1644 | 01 | "The royalist troops had besieged Nantwich on both sides of the river, and a flood had separated their forces." [R Weaver] |
| 1644 | 01 | Nantwich siege:" A sudden thaw caused the River Weaver to flood and Beam Bridge to be broken up" [R Weaver] |
| 1656 | 06 | "Great Flood at Nantwich 1656 June 17" [R Weaver] |
| 1789 | 10 | 1789 October 7 p[34] Nantwich, Cheshire: "Early on the morning of the 7th inst, the banks of the aqueduct of the Staffordshire canal, across the Wincham valley, in this county, gave way, from whence the water rushed down into the river beneath with the greatest impetuousity. Two corn-mills on the same stream below were in imminent danger of being forced down by the vast body of water driving from the canal upon them, but fortunately received much less damage than might have been expected; in consequence of which, and the general heavy rains on the preceding night, there was one of the greatest floods ever remembered on the river Weaver on Wednesday last [7/10/1789]. The water in the river rose from 16 to 18 feet above its usual height. Most of the streets were under a violent current of water, from six to eight feet deep, and almost every avenue impassable except in boats. Several hundred thousand bushels of salt were destroyed, and very great injury done to the salt-houses; the town and salt-works surrounded, and in many places three parts covered with one general inundation, formed a scene beyond description awful" [Weaver] |
| 1799 | 04 | 1799 April 6 p22: "... So deep was the snow in the neighbourhood of Congleton, that the Liverpool coach was entirely buried in it ..." [R. Dane] |
| 1852 | 11 | 1852 November 17 River Weaver flood |
| 1863 | 01 | 1863 January 2 River Weaver flood |
| 1872 | 06 | 1872 June 18 4.27 in. rain at Macclesfield, Cheshire [ha 069, upper Bollin] |
| 1872 | 06 | 1872 June 19 River Weaver flood |
| 1872 | 10 | 1872 October 21 River Weaver flood |
| 1872 | 06 | 1872 June 18 Rainfall observer for Macclesfield noted "Thunderstorm lasting nearly 12 hours; rain for 10 hours, in which the (here) unprecedented fall of 4.27 in. was registered; serious damage by floods in the town and district." [R. Bollin] |
| 1877 | 07 | 1877 July 15 River Weaver flood |
| 1877 | 12 | 1877 December 30 River Weaver flood |
| 1877 | | "In 1877 and 1879 there were again high floods, the river Weaver having risen from seven to eight feet above the normal level; but since the construction of the Dutton sluices, which came into operation in 1881-82, and works of a like nature [i.e. other engineering works on the Weaver] … floods have apparently become a thing of the past." |
| 1879 | | "In 1877 and 1879 there were again high floods, the river Weaver having risen from seven to eight feet above the normal level; but since the construction of the Dutton sluices, which came into operation in 1881-82, and works of a like nature [i.e other engineering works on the Weaver] … floods have apparently become a thing of the past." |
| 1879 | 08 | 1879 August 18 River Weaver flood |
| 1880 | 08 | 1880 August 8 River Weaver flood |
| 1880 | 10 | 1880 October 28 River Weaver flood |
| 1882 | 08 | 1882 August 24 Rainfall observer at Macclesfield (Park) noted (p[18]) "Thunder, heavy rain and floods." [upper Bollin] |

| | | |
|---|---|---|
| 1886 | 05 | 1886 May 14 River Weaver flood |
| 1887 | 06 | 1887 June Rainfall observer at Macclesfield (The Park) noted "....a great amount of evaporation, which resulted in an aridity of the soil never before experienced." |
| 1892 | 12 | "During present week [source dated December 17th, 1892] … [an] enormous body of floodwater also found its way into the river Weaver, but the authorities [due to engineering works which have improved flow in the Weaver]… experienced little or no difficulty in coping with that emergency. At no period during the week has the water risen to a greater height than 19 inches above the ordinary water mark." |
| 1892 | 12 | "Still, there were high floods [around Northwich] in 1872, and the late Judge Hardern, who was holding a county court in the Drill Hall, had to adjourn after having been addressed by advocates standing on chairs, the water which had suddenly overflowed the banks of the [river] Dane [a tributary of the Weaver] having flooded the room." |
| Feb 1946 | | Heavy rain and snowmelt caused flooding on the Weaver at Northwich, affecting 326 properties. Event probability was estimated as being 1%. |
| Feb 1977 | | Heavy rainfall event caused flooding on the River Weaver at Northwich, flooding 15 buildings. Event probability was estimated as being 10%. |
| August 1987 | | Heavy rainfall caused flooding on the River Dane at Congleton, affecting 27 buildings. Event probability was estimated as being 10%. |
| Nov 1998 | | Heavy rainfall caused flooding on the Dane at Congleton and Biddulph. Around 53 properties were affected, and event probability was estimated as being 5%. |
| Oct 2000 | | Heavy rainfall caused flooding from the Weaver Navigation at Nantwich and Northwich. More than 6 properties were affected and the event probability was estimated as being 10%. |
| June 2001 | | Heavy rainfall caused flooding at Sandbach and Northwich from the River Dane and Weaver Navigation. Seven properties were affected and the probability was estimated as being 20%. |

# Annex 1 Past Floods Spreadsheet

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# Annex 2 Future Floods Spreadsheet

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# Annex 3 Flood Risk Areas

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# Annex 4 PFRA Checklist

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