



Cheshire West  
and Chester

## Preliminary Flood Risk Assessment Report

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		Originated by	Checked by	Reviewed by	Approved by
<b>ORIGINAL</b>	<b>D00</b>	NAME <i>R.H. Lewis</i>	NAME <i>E.L. Balfour</i>	NAME <i>ED. Bell</i>	NAME <b>Not Approved</b>
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## Executive Summary

Under the Flood Risk Regulations, 2009 (FRRs) and Flood and Water Management Act, 2010 (FWMA), Cheshire West and Chester Council (CWAC) has been designated a Lead Local Flood Authority (LLFA). Both the FRRs and FWMA extend a number of Duties to LLFAs with the principal aim of managing flood risk from local sources.

The PFRA is the first step in the management of local flood risk and the production of one is imposed in the FRRs. The PFRA is a document which gives a high level overview of the flood risk from local sources through a review of past flooding incidents and the predicted extents of future flooding, based on the outputs of computer models.

Local sources of flooding, for the purposes of the PFRA, are:

- **Surface runoff** – water that flows over land following a heavy rainfall event, before it enters a natural watercourse or an artificial drainage network
- **Ordinary Watercourses** – out of channel flows from small watercourses such as streams, brooks and drainage ditches that are not regarded to be Main River by the Environment Agency
- **Groundwater** – water that flows out from the ground due to high water tables locally or regionally
- **Canals** – water that leaves canals due to the failure of structural elements of the canal such as weirs and banks. Canals can also act to channel flood water from other sources, usually rivers, to areas remote from the original flood

The results of the review are used to determine whether the level of flood risk is severe enough to be reported at both a European and National scale. The Department for Environment, Food and Rural Affairs (Defra) has identified that a Flood Risk Area containing a cluster of over 30,000 people would be considered of European importance.

With regards to flooding of national importance, no specific guidance has been issued. It has been left up to each LLFA to decide what it considers as a past flood with '*significant harmful consequences*' at a local level. In conjunction with several neighbouring LLFAs, CWAC has decided that a flood of '*significant harmful consequences*' would have one or more of the following characteristics:

- *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.*

A review of information on past flood incidents from various sources including utilities companies, British Waterways, the Emergency Services and CWAC engineers suggests that there have been no flooding events from local sources that are deemed to have had '*significant harmful consequences*'.

An analysis of data available on future flood risk has found that there could be flooding with adverse consequences as a result of surface water flooding. Modelling outputs provided by the Environment Agency indicate that up to 28,900 properties could be at risk from surface water flooding in a 0.5% (1 in 200) annual probability rainfall event. However, these properties are not in clusters, and therefore the scale of risk is not sufficient for CWAC to be considered a 'Flood Risk Area', reportable at a European Level.

The information recorded in this PFRA will be used to guide flood risk management in CWAC in the coming months and years. The first major piece of work will be the development of a 'Local Flood Risk Management Strategy'. The Strategy will be developed and implemented by CWAC with the aim of creating a plan to manage flood risk from local sources. The Strategy will be based upon guidance from the Environment Agency, which is due to be issued later this year.

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## Abbreviations

Abbreviation	Full Name
AFRA	Area Flood Risk Assessment
AStSWF	Areas Susceptible to Surface Water Flooding
CFMP	Catchment Flood Management Plan
CWAC	Chester West and Chester Council
DEFRA	Department for Environment, Food and Rural Affairs
DG5	OFWAT Directive Guidelines Nr 5 (for Water Companies) for properties at risk of sewer flooding
EA	Environment Agency
FMfSW	Flood Map for Surface Water
FWMA	Flood and Water Management Act 2010
GIS	Geographical Information Systems
IPCC	Intergovernmental Panel on Climate Change
LDF	Local Development Framework
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
RFDC	Regional Flood Defence Committee
SAB	SuDS Approving Body
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Urban Drainage System
UKCP09	United Kingdom Climate Projections 2009;
WAG	Welsh Assembly Government;

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## 1 Introduction

Jacobs Engineering UK Ltd was commissioned in March 2011 by Cheshire West and Chester Council (CWAC) to produce a Preliminary Assessment Report, detailing the findings of the Preliminary Flood Risk Assessment (PFRA) completed in accordance with guidance produced by the Environment Agency in 2010<sup>1</sup>.

This document is a Draft Preliminary Assessment Report for CWAC comment.

### 1.1 Background

The need to produce a PFRA is related to two pieces of legislation. Information on this legislation is provided below.

#### 1.1.1 Flood Risk Regulations 2009

Between 1998 and 2004, Europe suffered over 100 major damaging floods, including the catastrophic floods along the Danube and Elbe rivers in summer 2002. Severe floods in 2005 further reinforced the need for concerted action. Since 1998 floods in Europe have caused some 700 deaths, the displacement of about half a million people and at least €25 billion in insured economic losses.

In response to the damage caused by flooding, the European Commission published the European Floods Directive 2007/06/EC. The Directive's aim is to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. It requires Member States to assess the risk from flooding, to map the flood extent and assets and humans at risk in these areas and to take adequate and coordinated measures to reduce this flood risk.<sup>2</sup>

The European Floods Directive was transposed into domestic law with the publication of the Flood Risk Regulations 2009, (FRRs). Under the Regulations Cheshire West and Chester Council (CWAC) has been designated a Lead Local Flood Authority (LLFA).

**The Regulations also state that each LLFA has a duty to prepare a preliminary assessment report into flooding in its area.**

#### 1.1.2 The Flood and Water Management Act 2010

The UK floods of June and July 2007 affected large parts of the country and caused widespread disruption and damage. They also triggered the biggest major emergency response that has been seen in peacetime.

Following the events of 2007, the Government asked Sir Michael Pitt to conduct an independent review of what happened and what can be changed in relation to flood risk management. The Pitt Review<sup>3</sup> was published in 2008 and one of its main recommendations was that local authorities should take a greater role in managing flood risk.

<sup>1</sup> Preliminary Flood Risk Assessment, Final Guidance, Environment Agency, 2010

<sup>2</sup> [http://ec.europa.eu/environment/water/flood\\_risk/index.htm](http://ec.europa.eu/environment/water/flood_risk/index.htm)

<sup>3</sup> Pitt Review (2008) Learning Lessons from the 2007 floods

The Flood and Water Management Act 2010, (FWMA) was produced to take forward many of the proposals contained within the Pitt Review, including an increased role for local authorities in the management of flood risk from local sources.

One of the main requirements of the FWMA is the production of a Local Flood Risk Management Strategy. The aim of the strategy will be to set out a clear vision to manage flood risk that reflects local circumstances such as the level of flood risk and the potential impacts of flooding.

The PFRA will form an important part in the evidence base used to produce the strategy.

## 1.2 Scope of the Preliminary Assessment Report

The Preliminary Assessment Report is a high level summary of significant flood risks from local sources. It is based on readily available information on past flood events and the potential consequences of future floods.

Local sources of flooding for the purposes of the PFRA are:

- **Surface runoff** – water that flows over land usually following a heavy rainfall event, before it enters a natural watercourse or an artificial drainage network
- **Ordinary Watercourses** – small watercourses such as streams, brooks and drainage ditches that are not regarded to be Main River by the Environment Agency
- **Groundwater** – water that flows out from the ground due to high water tables locally or regionally
- **Canals** – water that leaves canals due to the failure of structural elements of the canal such as weirs and banks. Canals can also act to channel flood water from other sources, usually rivers, to areas remote from the original flood

Flood risk from Main Rivers (typically major watercourses), the sea, and large reservoirs ( $>25,000\text{m}^3$ ) is managed by the Environment Agency and is outside the scope of the PFRA.

Flooding from sewers and water supply systems, which is not caused partly or wholly by rainwater, are also outside the scope of the PFRA, and is the responsibility of the relevant utility company.

## 1.3 Aims and Objectives

### 1.3.1 Aims

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.

### 1.3.2 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 CWACs Local Flood Risk Management Strategy and Local Development Framework;*
- *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.*

## 1.4 Study Area

CWAC has a population of 327,500 and an area of 91,664 hectares. Much of the council area is rural with over 75% of land classed as agricultural.

In addition to 'Cheshire East Council' to the east, CWAC is bounded to the west by the Welsh border, to the north by the Mersey Estuary, and to the south by Shropshire.

The main urban areas (shown in Figure 1-A) include the historic city of Chester with a population of 59,000, the industrial towns of Ellesmere Port (63,000), Northwich (21,000), and Winsford (31,000), together with the smaller settlements of Neston, Frodsham, Helsby and Malpas. There are also a number of rural villages across the area,



**Figure 1-A: Cheshire West and Chester Council's Administrative Boundary and PFRA Study Area**

A more detailed map of the CWAC study area can be seen in Appendix A Figure 1.

The principal rivers within CWAC are the River Weaver, River Gowy, River Dee, River Dane, and the River Croco. The River Mersey also flows along part of the northern border of CWAC.

The Shropshire Union Canal, the Trent and Mersey Canal, and the Weaver Navigation are present within the CWAC study area; these are managed by British Waterways. The Manchester Ship Canal also passes through the study area; this is managed by The Manchester Ship Canal Company (a subsidiary of The Peel Group).

The study area is served by three water companies:

- *Welsh Water provides clean water and sewerage services in the west;*
- *United Utilities provides clean water and sewerage in the eastern part of CWAC; and*
- *Dee Valley Water Company provides clean water only to Chester and the surrounding area*

## 2 Lead Local Flood Authority Responsibilities

### 2.1 Introduction

In order to complete the PFRA and to ensure the long-term success in meeting its obligations under the Flood Risk Regulations 2009 and Flood and Water Management Act 2010, CWAC has a responsibility to establish a number of partnerships both internal and external..

These partnerships are essential, as the local knowledge and expertise that CWAC need to coordinate the management of local flood risk issues, resides with these partners.

The partnership arrangements that have been put in place by CWAC have allowed information and expertise to be shared during the production of this PFRA. The effectiveness of these arrangements is integral to the delivery and co-ordination of local flood risk management over the long-term.

This section of the PFRA details the partnership arrangements already in place, the internal governance structure that is proposed to be adopted by CWAC and how communication with the public and partners will continue in the future. It also contains information on the duties CWAC will have in the future under the FFRs and FWMA.

### 2.2 Governance Arrangements

Following the publication of the FRRs and FWMA, CWAC has reviewed its governance structure. The review has identified that whilst the existing structure would allow flood risk management decisions to be made, modifications are required to make these decisions in a more effective and timely manner.

Therefore, CWAC is proposing to adopt a new governance structure which gives clear responsibilities and also clear lines of communication between the various levels within the Council. Details of this structure are given in Figure 2-A.

### 2.3 Partnership Arrangements

#### 2.3.1 Sub-Regional LLFAs Task Group

This group was formed in 2010 and consists of 5 LLFAs and representatives of the Environment Agency. The purpose of the group is to share knowledge and resources to help meet the duties imposed by the FRRs and FWMA. It is also being used to explore ways in which efficiency savings can be made over the long-term.

At present the group meets monthly. These monthly meetings are planned to continue until significant progress has been made in the delivery of LLFA's duties. When this point is reached it is intended that the group will continue to meet once every two months.

The LLFAs included in the group are:

- Cheshire West and Chester Council
- Cheshire East Council
- Halton Borough Council
- St Helens Council
- Warrington Borough Council

### 2.3.2 CWAC Flood Task Group

The CWAC Flood Task Group has been set-up to develop effective communication routes between different departments within the Council and external organisations. It consists of the CWAC Lead Flood Officer, officers from other CWAC departments, and representatives from utilities companies and the Environment Agency.

The membership of the group has been defined so that CWAC specific issues can be discussed and decisions made on flood risk management policies and projects.

## 2.4 Public Engagement

It is recognised that members of the public may also have valuable information to contribute to local flood risk management more generally across the CWAC 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.

## 2.5 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 LLFAs from the FRRs and FWMA. These responsibilities include:

**Investigating flood incidents** – LLFAs have a duty to investigate and record details of significant flood events 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 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. The register must be available for inspection and the Secretary of State will be able to make regulations about the content of the register and records.

**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.

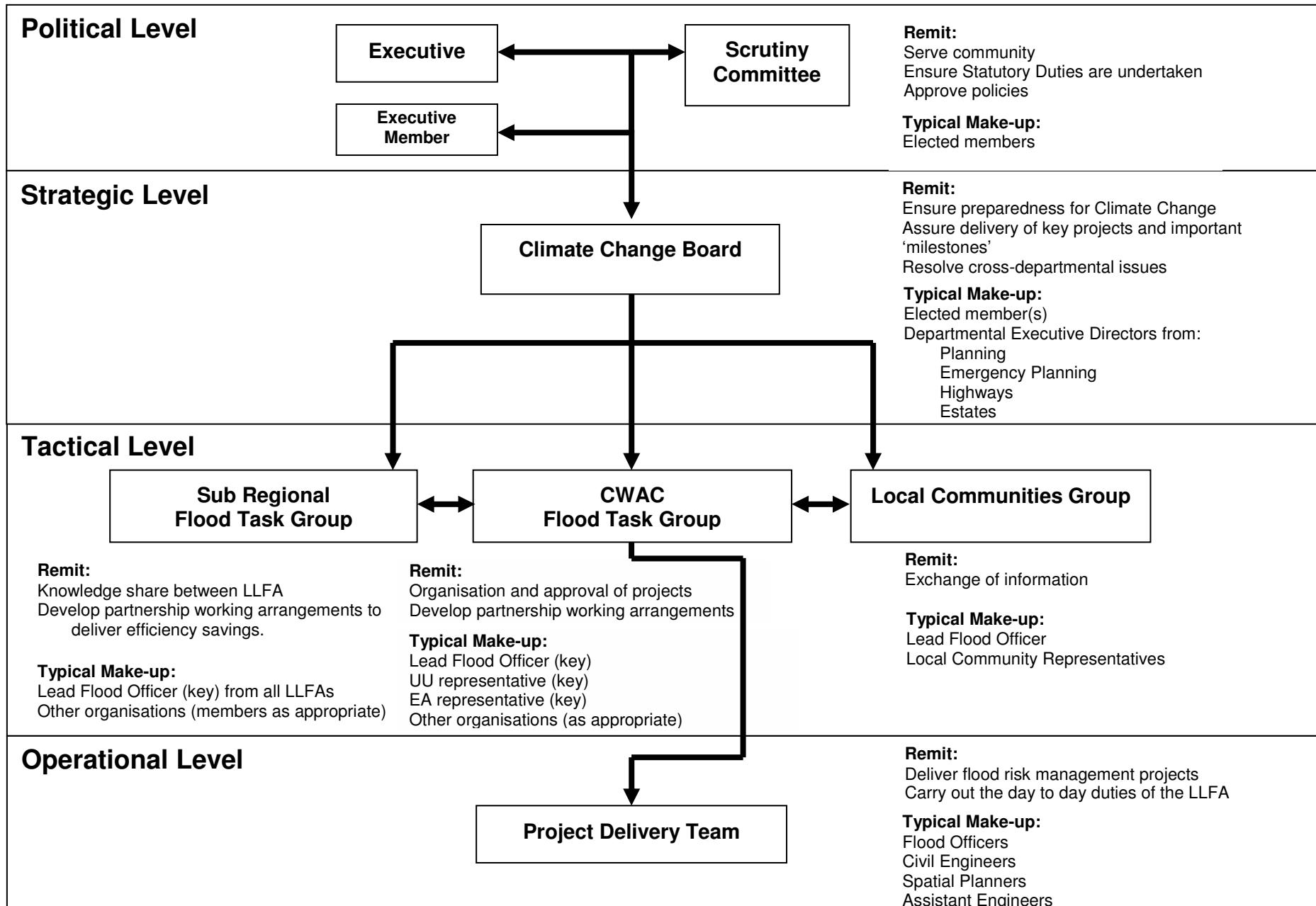
**Discharge Consents** – LLFAs will be required to administer Discharge Consents under the Water Act. They will provide consent to developments or works that have an impact on Ordinary watercourses, and take enforcement action against unconsented works.

**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.

Figure 2-A: Proposed CWAC Flood Risk Management Governance Structure



## 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 was 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 was used for the preparation of the PFRA:

- *Environment Agency;*
- *Utilities companies (United Utilities; Welsh Water);*
- *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.

Owner	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 <sup>2</sup> and from the sea.
	Areas Susceptible to Groundwater Flooding (AStGWF)	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	A merged unattributed flood extent for records of flooding from rivers, sea and groundwater only
	Flood Event Outlines	Attributed spatial flood extent data for flooding from all sources.
CWAC	Weaver Gowy CFMP, Dee 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.
	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) and Area Flood Risk Assessments (AFRA)	SFRAs and AFRA's may contain useful information on historic flooding, including local sources of flooding from surface water, groundwater and flooding from canals.
British Waterways	Multi-agency flood response plans	Regularly updated plans used by emergency responders, which hold details of historic flood locations and critical infrastructure
	Record of flood events and assets	British Waterways flooding records and assets in CWAC
University of Dundee	British Hydrological Society Flood Chronology	Records of flooding pre-1935 based upon reports in newspapers and other publications. Used to compliment existing knowledge
Water Companies	DG5 Register from United Utilities and Welsh Water	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 consistent flood data within the recording system across CWAC by the Council itself and external partners has led to inconsistencies in the recording of flood event data. For example, the reporting of sewer flooding incidents and the data collected is different between United Utilities and Welsh Water. This means that it is unlikely that the records between the two can be compared directly to each other.

#### (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 also hinder the identification of accurate flood risk areas. Further information on addressing this issue in the future is included in Chapter 7.

#### (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, LLFAs will have a duty to investigate and maintain a register of flooding incidents. At present CWAC are working with the neighbouring authorities of Warrington, Cheshire East, St Helens and Halton 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 data providers were able to provide comprehensive details of the consequences of specific past flood events, which made accurately 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 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 River/sewer flow data Rain gauge data
2	Data with known deficiencies	Best replaced as soon as new data are available	Typical sewer on river model that is a few years old.
3	Gross assumptions	Not invented but based on experience and judgment.	Location, extent and depth of much surface water flooding Operation of un-modelled highway drainage. '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. CWAC 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 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. For the purposes of this PFRA, the definition of “significant harmful consequences” has been defined by CWAC (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.*

However, all flood events affecting property or people are of importance to CWAC, and justify being evaluated. The Local Flood Risk Management Strategy, which will be produced following this PFRA will identify and seek to address these.

Past floods that meet the “significant harmful consequences” criteria above, 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 events with “significant harmful consequences”, and other events that are known to have occurred from the various sources of local flooding.

#### 4.1.1 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.

As part of the PFRA process, historical flooding incidents were collected from a number of key flood risk stakeholders and from internal sources. Data collected from



CWAC identified 97 recorded historic surface water flooding incidents in its administrative area.

Figure 3 in Appendix A provides a spatial overview of collected historic surface water flooding data. The map shows a spread of surface water flooding incidents across the CWAC administrative area.

The map shows clusters of incidents in the industrial town of Ellesmere Port and small residential town of Neston. To a lesser extent there are smaller clusters of surface water flooding incidents in the urban areas of Chester and Northwich.

However, none of the events recorded are considered to have had “significant harmful consequences”.

#### **4.1.2 Fluvial Flooding**

“Ordinary Watercourses” are any watercourse that is not designated a ‘Main River’ by the Environment Agency, and therefore responsibility for flood risk management of them is under CWAC.

These watercourses can vary considerably in size, and can include drains and open ditches, streams, brooks and small rivers. Ordinary Watercourses in Cheshire West and Chester have been identified using the Environment Agency’s Detailed River Network (DRN).

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.

Since enmainment, 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 CWAC.

The historic data received from the Environment Agency relates to fluvial flooding is associated with main river flooding only. However, data collected from CWAC records 29 instances of flooding relating to Ordinary Watercourses, these are shown on Figure 3 of Appendix A, along with 4 recorded instances of flooding relating to main rivers.

None of these instances of fluvial flooding are considered to have had “significant harmful consequences” that warrant inclusion within Annex 1.

The University of Dundee ‘Chronology of British Hydrological Events’ has been obtained to identify historical flood events within the CWAC administrative area<sup>4</sup>. Available fluvial flooding records date back to 1574 and 27 flooding incidents are recorded. Details of these events are contained in Appendix B. However, the records are often vague and it is not clear if the information relates to Ordinary Watercourses. As a result, this information has not been used to determine if these floods had “significant harmful consequences”, and has been included only for information purposes.

<sup>4</sup> Chronology of British Hydrological Events. <http://www.dundee.ac.uk/geography/cbhe>



#### 4.1.3 Flooding from Sewers and Artificial Drainage Systems

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 flood waters within properties, or discharging through manholes.

Some of the sewers across CWAC date back to 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 leading to longer, heavier periods of rain. These two factors result in the existing sewers and drains not being able to cope at certain times.

The CWAC administrative area has 2 sewerage undertakers:

1. United Utilities Plc;
2. Dŵr Cymru Welsh Water Limited (DCWW).

Both organisations have provided data on historic instances of sewer flooding across CWAC, collected over a number of years. Table 4-A shows the towns located in the CWAC administrative area that have the highest recorded incidents of sewer flooding.

As noted in Section 3.2, it is unlikely that the same methodology has been used by both of the utilities companies; therefore, the results are not directly comparable.

Town/City	Welsh Water	United Utilities
Chester	546	
Ellesmere Port		20
Malpas	18	
Northwich		12
Frodsham		3
Winsford		2

Table 4-A: Number of Historic Sewer Flooding Incidents

Figure 4 in Appendix A provides an overview of recorded sewer flooding incidents across the CWAC administrative area. The recorded incidents of sewer flooding are mainly clustered around the large urban area of Chester. There are smaller clusters of incidents in the towns of Ellesmere Port, Malpas, Northwich, Frodsham and Winsford.

The records indicate that there are no instances of sewer flooding that are considered as having “significant harmful consequences” to warrant inclusion within Annex 1.

#### 4.1.4 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 state that groundwater flooding has occurred in some areas. These are localised issues and the risk of groundwater flooding is considered to be low at a catchment scale<sup>5</sup>.

There are no records of historic groundwater flooding that are considered as having "significant harmful consequences" to warrant inclusion within Annex 1.

#### 4.1.5 Canal Flooding

British Waterways is the public body responsible for the care and enhancement of the nation's 2,200-mile network of canals, much of which dates back to the 1800s. Some canals and navigable waterways are also managed by private companies.

There are three British Waterways' canals in the study area:

- *The Trent and Mersey Canal*
- *The Shropshire Union Canal*
- *The Weaver Navigation*

The Manchester Ship Canal, a private canal owned and managed by the Manchester Ship Canal Company (a subsidiary of The Peel Group), also runs through the CWAC study area.

The risk of flooding along each canal is dependent on a number of factors. As they are artificial 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.

Data collected from British Waterways regarding historical canal overtopping and breach incidents is summarised in Table 4-B. Figure 5 in Appendix A shows the locations of these historic flooding incidents.

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<sup>5</sup> River Dee CFMP Summary Report January 2010, Weaver/Gowy CFMP Summary Report, December 2009, and Mersey Estuary CFMP, December 2009

No information is available in Environment Agency's CFMPs regarding canal flooding in the study area.

Canal	Location	Incident Type	Year
Trent and Mersey	Breach near Dutton Hall	Unknown	1770
Trent and Mersey	Marbury Breach	Piping / Leak failure	1907
Trent and Mersey	Little Leigh Embankment Breach	Piping / Leak failure	1989
Shropshire Union	Stanthorne/ Middlewich Breach	Unknown	1991

Table 4-B: Historic Canal Flooding

#### 4.1.6 Interaction with Main Rivers and the Sea

The Mersey Estuary lies to the north and the Dee Estuary to the west of the study area. These estuaries are both tidal and interact with the watercourses and drainage infrastructure flowing out into them. The following locations represent the tidal limits within the study area;

- Bridge Trafford, a hamlet north east of Chester on the River Gowy;
- Frodsham on the River Weaver;
- Chester weir on the River Dee and during high astronomical tides as far as Shocklach Green.

There is evidence from CWAC SFRA suggesting that in the low-lying parts of the study area that there could be an interaction between high water levels on main rivers and the sea. However, due to the incomplete nature of the information available at present, the degree of influence on local flood risks cannot be determined.

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## 5 Future Flood Risk

### 5.1 Overview of Future Flood Risk

Whilst analysis of past flooding provides the area within CWAC's current boundary, with valuable information on the nature and extent of past flooding that has occurred, it does not necessarily inform us about how and where flooding may occur in the near 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:

- Surface water;
- Fluvial (ordinary watercourses);
- Groundwater;
- Canals.

The responsibility for dealing with sewer flooding is the responsibility of the water companies: however, the possibility of providing a link to the information contained in their strategic plans for the 2010 to 2015 Asset Management Period is discussed later in this chapter.

### 5.2 Surface Water Flooding

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

- 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.

The 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.

CWAC are required by the Environment Agency to agree an appropriate dataset that represents the risk from surface water in their area.

The overall administrative area of CWAC is 91,664 hectares, which includes a vast range of land uses, topography, flooding causes/mechanisms, flooding probabilities and flood consequences. Artificial drainage systems within the county 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.

Given the above, it is considered that either of the two national datasets could be applicable, depending on the physical characteristics of a specific location.

However, for the purposes of this PFRA, it has been decided that the AStSWF dataset will be used for the following reasons:

The information collected from local highways engineers highlighted that there is a significant number of localised surface water flooding issues in low-lying and potentially tidally influenced areas. Information from Welsh Water also shows numerous sewer flooding incidents in these areas. This suggests that there could be tide-locking of drainage outfalls. The FMfSW assumes that there is a loss of surface water through the drainage system. This assumption would be incorrect if tide-locking occurred. Therefore, the FMfSW may be an underestimate of the risk in the urbanised areas of Ellesmere Port, Neston and possibly some parts of Chester.

It is considered that the AStSWF dataset will best represent the risk in those areas of highest consequence (urban centres). However, further work is planned as part of the development of the Local Flood Risk Management Strategy to investigate surface water issues in greater detail.

Figures 6 and 7 show the FMfSW and AStSWF datasets and Table 5-A indicates the number of properties at risk from surface water flooding in the future, according to the AStSW dataset.

Properties	Less Risk	Intermediate Risk	More Risk
All	28,900	10,000	520
Residential	22,000	7,400	475
Non-residential	6,900	2,600	45

Table 5-A: Number of properties at risk in the AStSWF

### 5.3 Fluvial Flooding

The Environment Agency's National Flood Zone Map represents the probability of flooding from Main Rivers, and Ordinary Watercourses with a catchment area greater than 3km<sup>2</sup>. Figure 8 in Appendix A shows the Flood Zone Map with Main Rivers and Ordinary Watercourses highlighted.

Figure 8 shows that few ordinary watercourses within the study area have been included within the Flood Zone Map. However, the majority of Ordinary Watercourses are not within high consequence locations, such as urban areas. Therefore, although future climate change is likely to increase fluvial flood risk, the majority of risk will come from Environment Agency Main Rivers.

### 5.4 Canal Flooding

The main risks from canals within the CWAC administrative area are likely to be associated with the following:

- **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 has 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.

The Environment Agency's Flood Zone Map includes flood risk from the Weaver Navigation and Manchester Ship Canal and is shown in Figure 8 in Appendix A. Because these are such large bodies of water, which are fed directly by Main Rivers, they are not considered to be 'local' flood issues and the Environment Agency provides a major role in management of the flood risks from these bodies of water. Note that the Flood Zone Map for the Manchester Ship Canal is currently under review.

## 5.5 Groundwater Flooding

The British Geological Survey (BGS) Groundwater Flooding Susceptibility Map has been used to show the potential future groundwater flood risk. This data does not necessarily imply flooding of properties, only that groundwater would emerge at the surface first within the indicated areas.

Figure 9 in Appendix A indicates that areas of the study area to the south west of Chester, in Ellesmere Port, Northwich and various villages across the CWAC administrative area are highly susceptible to groundwater emergence.

As discussed previously, the CFMPs do not consider groundwater to be a catchment-scale issue, based on historical instances of groundwater flooding. It could be deduced that the BGS Groundwater Flooding Susceptibility Map represents a conservative (high) estimate of the level of risk.

## 5.6 Sewer Flooding

As discussed previously, records of sewer flooding have been obtained from the water and sewerage companies. Based on information readily available on their websites in their "Strategic Direction Statements" they are proposing to address a significant number of 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

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 20% (1 in 5) annual probability or rarer, could increase locally by 40%.

### 5.7.2 Key Projections for CWAC

CWAC administrative area falls with 2 River Basin Districts, The River Dee and the North West Basin District. Key projections for climate change for the North West Basin District are presented in this report as a worst case because more of the CWAC administrative area falls within the North West Basin District. The key projections for 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 rain are projected to be greater near the coast than inland.

\* Note: Reference made to Morecambe as the town lies with the North West River Basin District, however the town lies outside the CWAC administrative area.

### 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 and sewers, and negatively effect water quality. Storm intensity in summer could increase even in drier summers, so we need to be prepared for the unexpected. Rising sea or river levels could also increase local flood risk inland or away from major rivers because of interactions with drains, sewers and smaller watercourses.

In the past, drainage systems in the district have been modified to help manage local water levels. These drainage systems could also be used to help manage the

impacts of climate change on flood risk, but to do this, they may need to be managed differently.

Where appropriate, CWAC 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 future flood damage.

#### **5.7.4 Adapting to Change**

Some climate change as a result of past GHG emissions 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 with 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 flood risk increasing as a result of new development.

In England, Planning Policy Statement 25<sup>6</sup> 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).

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<sup>6</sup> Planning Policy Statement 25: Development and Flood Risk, Communities and Local Government March 2010

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## 6 Review of Indicative Flood Risk Areas

### 6.1 Overview

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 10 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 CWAC boundary.

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## 7 Next Steps

### 7.1 Future Data Management Arrangements

In order to continue to fulfil their role as LLFA, CWAC 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 CWAC, 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 & 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: Local Authority Review; and Environment Agency Review.

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.

#### (a) 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.

Within CWAC, the PFRA will be reviewed by the CWAC Lead Flood Officer. It will then be taken for approval to the Executive Member for Community and Environment

#### (b) 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 Office review and National Office review) of the PFRA, which will focus on instances where Flood Risk Areas have been amended and ensure the format of these areas meets the required standard. 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 PFRAAs are collated, published and submitted to the European Commission.

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.

## Appendix A Figures

Figure 1	PFRA Study Area
Figure 2	Historic Surface Water Flooding Incidents
Figure 3	Historic Fluvial & Tidal Flooding Incidents
Figure 4	Historic Sewer Flooding Incidents
Figure 5	Historic Canal Flooding Incidents
Figure 6	Future Flooding – Flood Map for Surface Water (FMfSW)
Figure 7	Locally Agreed Surface Water Flooding Information (Environment Agency AStSWF)
Figure 8	Future Flooding - Fluvial Flood Map for Ordinary Watercourses
Figure 9	Future Flooding –Groundwater Flood Risk Map
Figure 10	High Surface Water Flood Risk Areas

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## Appendix B Historical Flood Records

### Flood Chronology from University of Dundee

Year	Month	Quotation
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 brydge" according to one eye-witness " [R. Weaver]
1584		Chester: 1584 ....Dreadful hailstorm: much damage done to the Dee Mills by floods; many cattle killed by lightning. "
1767	10	"They write from Birmingham that there fell so great a quantity of snow on the hills in Derbyshire and Cheshire, that on its melting it caused great floods in those parts, particularly last Thursday at Northwich the waters were so high, that the inhabitants went about the streets in boats." [River Weaver]
1851		Approx. 212m <sup>3</sup> /s on Weaver at Ashbrook (ga. stn 68001). "The highest flood recorded at Ashbrook on 8.2.1946 with an estimated discharge of 212m <sup>3</sup> /s is reported to be much higher than any other flood since 1851 when a similar flood occurred"
1852	11	1852 November 17 River Weaver flood
1863	1	1863 January 2 River Weaver flood
1872	6	1872 June 19 River Weaver flood
1872	10	1872 October 21 River Weaver flood
1875	11	1875 November Observer at Chester (Pulford) noted, p110, "In July, rain commenced, and we had a very wet month. August was also wet, and September, October, and November still more so. Floods prevailed in the low-lying lands. "[Welsh Dee]
1877	7	1877 July 14 Rainfall observer at Northwich noted (p[20]) "The rainfall during the night of this date was greater than has ever been registered here at any previous time, the fall from 5 p.m. to 8.30 a.m. amounting to 2.10 in., followed by a fall of 1.80 in. up to 5 p.m."
1877	7	1877 July 15 River Weaver flood
1877	12	1877 December 30 River Weaver flood
1879	8	1879 August 18 River Weaver flood
1879	8	1879 August 16/17 Rainfall observer at Neston (Hinderton) noted, p[18], "Rain commenced August 16th about 1.30 pm, amount measured on 17th, 8 am, 1.36 in; from 8.30 am to 6.30 pm, 17th, 1.98; from 6.30 pm, 17th, to 8 am, 18th, .12; total in 42½ hours, 3.46 [inches]. I have never in my life seen so much water lying about, and the actual amount measured exceeds anything recorded in the last 10 years, at least during any one storm, in this part of the country.
1880	12	1880 December 29 River Irwell and River Weaver flood "Estimated flow of 14,500 cusec for the Irwell"
1880	8	1880 August 8 River Weaver flood
1880	10	1880 October 28 River Weaver flood
1886	5	1886 May 14 River Weaver flood
1886	5	1886 May "The following is a list of the principal rivers and their tributaries which were flooded and overflowed their banks: ... DEE, Alyn ..." [ha 067]
1890	1	1890 January 23 P[5] "Considerable floods in Cheshire, especially in the valley of the Dee"

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."
1900	2	1900 February 19 Rainfall observer at Chelford (Astle Hall) noted (p[11]) "Heavy rain and floods everywhere." [Wincham Brook]
1903	5	1903 May 4 Rainfall observer at Chelford (Astle Hall ) noted " Floods out" [Wincham Brook]
1903	10	1903 October 27 Rainfall observer at Chelford (Astle Hall) noted "Rain 1.46 in., causing floods" [Wincham Brook]
1903	11	1903 November 28 Rainfall observer at Chelford (Astle Hall) noted "On the 28th every stream and ditch was over its banks and the country was more under water than ever seen before."
1906	1	1906 January 2 "In a Return supplied by Mr J.A.Saner, the Engineer of the Weaver Navigation, it is stated that the minimum daily flow so far recorded at Dutton Locks occurred on January 2nd, 1906, and amounted to 24,448 cubic yards per 24 hours, or 660,096 cubic feet per day, but it would appear that this was an exceptionally low Figure..."
1924	5	1924 May 31 Rainday mapped totals exceeding 75 mm over a belt from Gloucester to the Wirral. Editor noted "Severe floods were produced in many places along the belts of high rainfall. At Worcester the Three Counties' Agricultural Show had to be abandoned on account of the flood". [Severn, Dee, Weaver]

## Annexes

Annexe 1	Past Floods
Annexe 2	Future Floods
Annexe 3	Flood Risk Areas



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