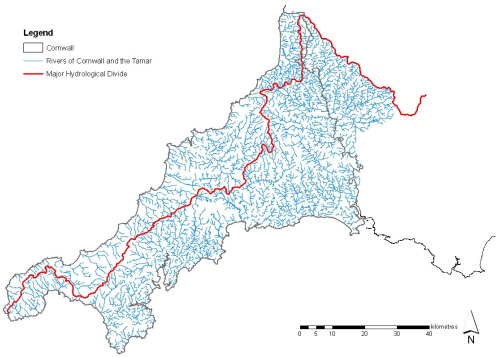
Cornwall Council

Preliminary Flood Risk Assessment Report

June 2011



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CORNWALL COUNCIL

REVISION SCHEDULE

Preliminary Flood Risk Assessment for Cornwall
June 2011

Revision	Date	Details	Prepared by	Reviewed by	Approved by
01	April 2011	Draft report (for internal and external consultation)	Dave Watkins (Cornwall Council)	Gregg Kerry (Environment Agency) and Peter May (JBA Consulting)	Dave Owens (Cornwall Council)
02	May 2011	Final draft report (including revisions from previous draft)	Dave Watkins (Cornwall Council)	Gregg Kerry (Environment Agency)	Dave Owens (Cornwall Council)
03	June 2011	Final report (for submission to Environment Agency and public dissemination)	Dave Watkins (Cornwall Council)	Gregg Kerry (Environment Agency)	Dave Owens (Cornwall Council)

EXECUTIVE SUMMARY

The Preliminary Flood Risk Assessment (PFRA) is a requirement of the Flood Risk Regulations (2009) and also embodies a number of principles under the Flood and Water Management Act (2010).

These new pieces of legislation establish new duties for the Council with respect to local flood risk management. Cornwall Council is designated as Lead Local Flood Authority (LLFA) within the administrative area of Cornwall. All LLFAs in England and Wales are required to submit a PFRA to the Environment Agency by 22 June 2011.

The PFRA is a high level screening exercise to locate areas in which the risk of local flooding is significant and warrants further examination. The scope of the PFRA is to consider past flooding and possible future flooding from local flood sources, most specifically from surface water and for flooding from Ordinary Watercourses. The PFRA does not address flooding from designated Main Rivers or from the sea unless there are interactions with local sources of risk. The PFRA identifies priority local flood risk communities within the LLFA's jurisdiction. This is done by considering both past flooding and potential future flooding. The preparation of the PFRA is also the first step toward the development of Cornwall's local flood risk strategy, providing an evidence base and identification and prioritisation of local flood risk areas.

The essence of the PFRA is fairly prescriptive, with guidance as to its content laid out by the Environment Agency, but the substance of the PFRA should reflect local issues and characteristics. The PFRA consists of a report and associated spreadsheets. The spreadsheets are designed by the Environment Agency so that the information submitted from all LLFAs can be readily assimilated and collated for submission by the Environment Agency to the European Commission. These spreadsheets are provided as Annexes 1, 2 and 3 of the PFRA Report.

The preparation of a PFRA is just one of several responsibilities of LLFAs under the new legislation. The PFRA Report provides a brief overview of other responsibilities Cornwall Council is obliged to fulfil under its role as a LLFA.

The PFRA sets out arrangements for partnership working and data sharing, particularly between the Council, the Environment Agency and South West Water.

The PFRA considers the types of local flooding that are prevalent within Cornwall. It reviews historic flooding and a chronology of major flood events in Cornwall is provided as Annex 5 of the PFRA.

Potential future flooding and its consequences are considered, mainly based on surface water flood risk using a methodology and flood risk indicators set out by the Environment Agency. A detailed analysis of potential surface water flood risk in Cornwall is provided as Annex 6 of the PFRA. This analysis indicates that there are no Indicative Flood Risk Areas in Cornwall, as defined by the national threshold of 30,000 people at risk of surface water flooding and no Proposed Flood Risk Areas as defined within the guidelines are recommended.

A review of communities associated with existing flood risks is carried out and reported within Annex 7 of the PFRA. These are used to identify locations where flooding is locally an issue but fall below the national Indicative Flood Risk Area thresholds. Further work will be undertaken to address local flood risk in these priority locations as part of the Local Flood Risk Management Strategy.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

Abbreviation	Definition
The Act	Flood and Water Management Act (2010)
AEP	Annual Exceedance Probability
AStSWF	Areas Susceptible to Surface Water Flooding
CDA	Critical Drainage Area
CFM-TWG	Cornwall Flood Management Technical Working Group
CFMP	Catchment Flood Management Plan
CFRP	Community Flood Risk Profile
CFP	Community Flood Plan
Defra	Department for Environment, Food and Rural Affairs
DEM	Digital Elevation Model
DSM	Digital Surface Model
DTM	Digital Terrain Model
EA	The Environment Agency
FMfSW	Flood Map for Surface Water
FRIS	Flood Reconnaissance Information System
FRMP	Flood Risk Management Plan
GHG	Greenhouse Gas
LLFA	Lead Local Flood Authority
MAFP	Multi-Agency Flood Plan
PFRA	Preliminary Flood Risk Assessment
PPS25	Planning and Policy Statement 25: Development and Flood Risk
The Regulations	Flood Risk Regulations, Statutory Instrument 3042 (2009)
RFCC	Regional Flood and Coastal Committee
RMA	Risk Management Authority
SuDS	Sustainable Drainage Systems
SAB	SuDS Approval Body
SMP2	Shoreline Management Plan (2nd edition)
SFRA1	Level 1 Strategic Flood Risk Assessment
SFRA2	Level 2 Strategic Flood Risk Assessment
SWMP	Surface Water Management Plan
SWW	South West Water
UKCP09	United Kingdom Climate Projections 2009

ACKNOWLEDGEMENTS

The author is grateful for the involvement of members of the Cornwall Flood Management Technical Working Group, providing input from the Environment Agency Cornwall Area and South West Water.

The South West Flood Risk Managers Group has provided a very useful forum for discussing and understanding the requirements of the PFRA.

The Communities of Practice web-based forum for flooding has also proved to be an extremely useful source of advice and discussion of the requirements of the PFRA and other issues related to the emerging requirements of the new legislation.

1 INTRODUCTION

1.1 Preliminary Flood Risk Assessment

This document reports the findings of research undertaken by Cornwall Council towards the preparation of a Preliminary Flood Risk Assessment (PFRA) for its administrative area.

The chief drivers behind this research and preparation of the PFRA report are two sets of new legislation: the Flood Risk Regulations (The Regulations), which came into force on the 10th December 2009 as Statutory Instrument 3042, and the Flood & Water Management Act (The Act) which gained Royal Assent on the 8th April 2010. Under these pieces of legislation, all Unitary Authorities, including Cornwall Council, and in two-tier systems, all County Councils, are designated as a Local Lead Flood Authority (LLFA) and have formally been allocated a number of key responsibilities with respect to local flood risk management. A brief overview of these responsibilities is provided in Section 2.

The purpose of the Regulations was to transpose the EC Floods Directive (Directive 2007/60/EC on the assessment and management of flood risk) into domestic law in England and Wales and to implement its provisions. In particular it places duties on the Environment Agency (EA) and LLFAs to prepare a number of documents including:

- Preliminary Flood Risk Assessments;
- Flood hazard and flood risk maps;
- Flood Risk Management Plans.

An excerpt from the Flood Risk Regulations 2009 regarding the duty to prepare PFRAs is shown in Figure 1. This states the respective duties of the EA to produce a preliminary assessment report for flooding from the sea, Main Rivers and reservoirs and Cornwall Council to report on flooding from all other sources.

Table 1 shows the elements of work required from Cornwall Council under the Flood Risk Regulations 2009, along with the timescales for their respective delivery. The first two elements of work, highlighted in blue, are covered by the preparation of this PFRA report. The further elements of work are not required to be undertaken during the present PFRA cycle as Cornwall Council has no Indicative Flood Risk Areas that meet the national criteria for England of 30,000 people at risk (5,000 in Wales) and does not intend to challenge this by proposing any such areas. However the data gathered and Local Flood Risk Communities identified will be used to support and inform the preparation of Cornwall's Local Flood Risk Management Strategy, which will be the next stage of legislation to progress.

PART 2

PRELIMINARY FLOOD RISK ASSESSMENTS

Duty to prepare preliminary assessment maps and reports: Environment Agency

9.—(1) The Environment Agency must prepare in relation to each river basin district—

(a) a preliminary assessment map, and

(b) a preliminary assessment report in relation to flooding from—

(i) the sea,

(ii) main rivers, and

(iii) reservoirs.

(2) This regulation is subject to regulations 31 and 32.

Duty to prepare preliminary assessment reports: lead local flood authorities

10.—(1) A lead local flood authority must prepare a preliminary assessment report in relation to flooding in its area.

(2) A lead local authority is not required to include in its report information about flooding from a source mentioned in regulation 9(1)(b) unless the authority thinks that it may affect flooding from another source.

(3) The Environment Agency—

(a) must review a preliminary assessment report prepared under this regulation, and

(b) may recommend modifications.

(4) Following a review, a lead local flood authority may revise its preliminary assessment report.

(5) The Agency's power to require information under regulation 36 includes power to require a lead local flood authority to provide a preliminary assessment report by a specified date.

(6) This regulation is subject to regulations 33 and 34.

Figure 1 Excerpt from the Flood Risk Regulations 2009 requiring the production of PFRAs by the Lead Local Flood Authority

Table 1 Elements of work required under the Flood Risk Regulations

22nd June 2011	**Prepare Preliminary Assessment Report.**	*The PFRA should focus on local flood risk from surface water, groundwater, ordinary watercourses and canals.*
22nd June 2011	**On the basis of the PFRA, identify and/or review Flood Risk Areas.**	*Flood Risk Areas are areas of significant risk identified on the basis of the findings of the PFRA, national criteria set by the UK Government Secretary of State and guidance provided by the Environment Agency.*
22nd June 2013	**Prepare Flood Hazard Maps and Flood Risk Maps for each Flood Risk Area.**	Used to identify the level of hazard and risk of flooding within each Flood Risk Area to inform Flood Risk Management Plans.
22nd June 2015	**Prepare Flood Risk Management Plans for each Flood Risk Area.**	Plans setting out risk management objectives and strategies for each Flood Risk Area.

1.2 Scope of PFRA Report

The PFRA is a high level screening exercise to locate areas in which the risk of local flooding is significant and warrants further examination through the production of maps and management plans.

It is noted that the scope of this PFRA is to consider past flooding and possible future flooding from the following local flood sources:

- Surface water;
- Groundwater;
- Ordinary Watercourses; and
- Canals.

It is noted that the PFRA report must consider floods which have significant harmful consequences for human health, economic activity, cultural heritage and the environment.

As described in Figure 1, flooding associated with the sea, Main Rivers and large raised reservoirs is the responsibility of the Environment Agency (EA) and does not need to be considered by the LLFA as part of the PFRA, unless it is considered that it may affect flooding from one of the sources listed above. It is also noted, however, that virtually all floods within Cornwall tend to comprise a combination of sources – Ordinary Watercourses and Main Rivers flood as one, surface water and fluvial flooding can occur together and coastal flooding creates river flooding through tide-locking, for example.

1.3 Aims and Objectives

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.

The key objectives can be summarised 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 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 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 Cornwall's Local Flood Risk Strategy;
- 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

The administrative area of Cornwall Council covers around 3600 km^2. It has a coastline of around 700 km in length.

Being a peninsula, nowhere in Cornwall is very far from the sea[1]. This means that the rivers tend to be relatively short and the river catchments are relatively small compared to those in many other counties. Also due to the peninsular effect, all rivers in Cornwall, apart from western tributaries to the Tamar, discharge to the coast within the county and no rivers enter or leave the LLFA area to or from any other LLFA areas.

The River Tamar provides the majority of the county boundary between Cornwall and the LLFAs of Devon County Council and Plymouth City Council. In fact only about 10 km of the Cornwall-Devon boundary is not water. When considering the River Tamar, it needs to be noted that the left bank of the Tamar and its eastern tributaries are in Devon whilst the right bank and western tributaries are within Cornwall.

Figure 2 shows the river systems of Cornwall, with those designated as Main River highlighted in red. There are around 4,000 km of rivers in Cornwall (as measured as all river reaches greater than 500 m long and shown on the 1:25,000 Ordnance Survey map). Of these, 3,250 km are Ordinary Watercourses for which the Council are responsible and 750 km are designated as Main River, for which the EA hold responsibility.

Detailed information on the topography, geology, soils, climate and character of the county can be found in the Level 1 Strategic Flood Risk Assessment (SFRA1) and further information on flood risk within the relevant Catchment Flood Management Plans.

1.5 Flood Risk Areas

The term “Flood Risk Area” is used throughout the PFRA guidance (Defra 2010, EA 2010a, b, c, d). Table 2 below is provided to provide some clarity as to the different types of Flood Risk Area referred to within the various guidance documents.

Table 2 Definitions of Flood Risk Areas

Indicative Flood Risk Area	Areas defined by the EA analysis (see Annex 6) resulting in at least 30,000 people or 3,000 non-residential properties or 150 critical services at risk of flooding during an approximately 1 in 100 year event. Indicative Flood Risk Areas are provided by the EA (2010b).
Proposed Flood Risk Area	Areas that the LLFA can justify inclusion in the Indicative Flood Risk Area list.
Significant Flood Risk Area	Areas where flood risk is approximately one order of magnitude less than for Indicative Flood Risk Areas.
Equivalent Flood Risk Area	Areas susceptible to more frequent, less extensive flooding which can nevertheless over a period of time experience significant flood damages.
Local Flood Risk Communities	Locations where it is not presently required to prepare detailed flood risk hazard mapping or Flood Risk Management Plans. Approaches to Flood Risk Management to be set out and addressed through local flood risk management strategies.

[1] In fact the furthest you can get from the sea in Cornwall is 25 km, at Launceston. The average distance that land in Cornwall is located from the sea is only 7 km.

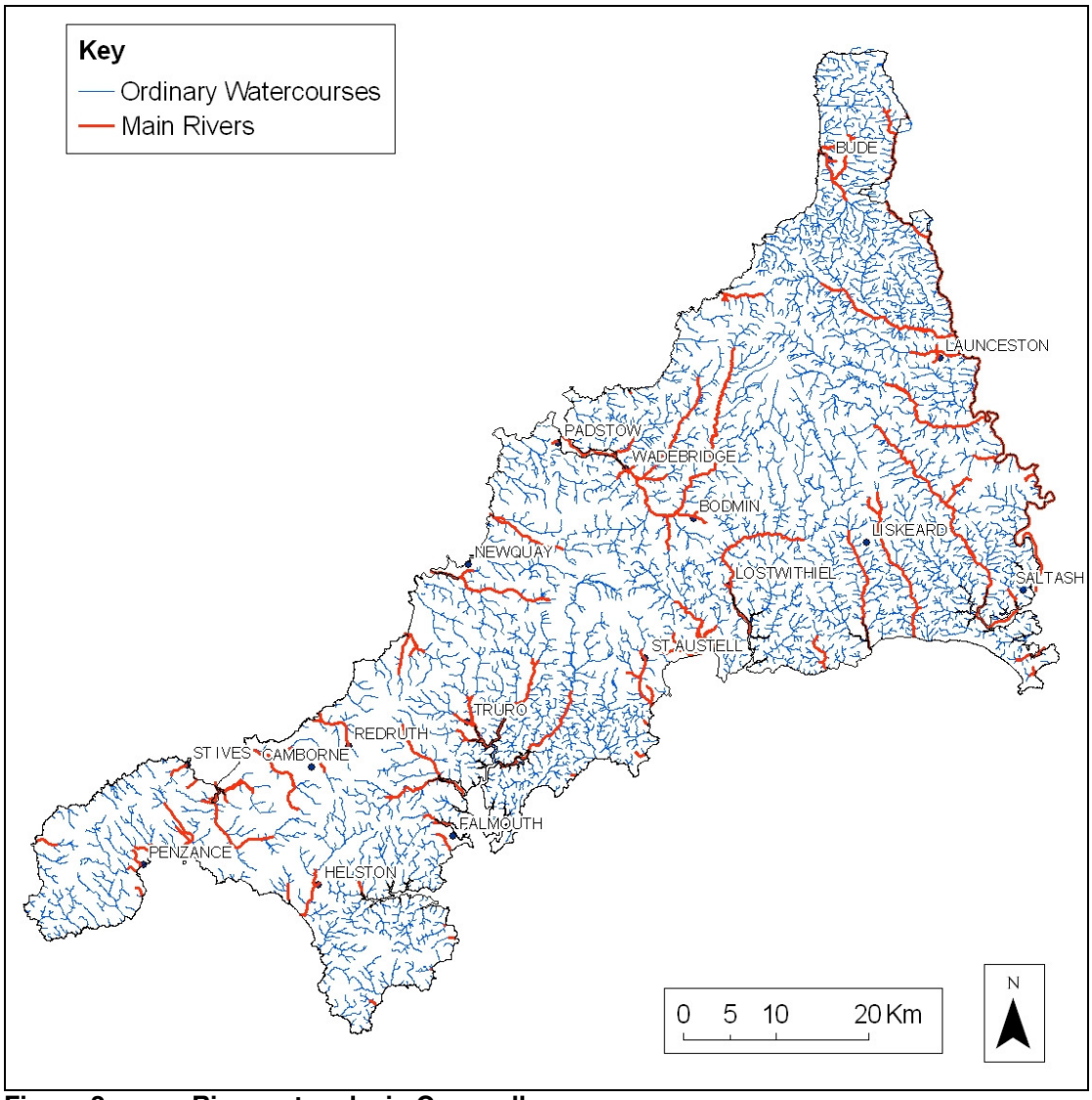

Figure 2 River networks in Cornwall

2 LLFA RESPONSIBILITIES

2.1 Introduction

The preparation of a PFRA is just one of several responsibilities of LLFAs under the new legislation. This section provides a brief overview of other responsibilities Cornwall Council is obliged to fulfil under its role as a LLFA.

Table 3 New Responsibilities for Managing Flood Risk (Environment Agency guidance, 2010c)

'The regulations define new responsibilities for flood risk management based on the recommendations of the Pitt review. These are consistent with the Flood and Water Management Act. Below summarises the key terminology and responsibilities:
***Environment Agency** – the competent authority for managing risk from main rivers, the sea and large raised reservoirs.*
***Lead Local Flood Authority** – responsible for managing local flood risk in particular from ordinary watercourses, surface runoff and groundwater. In relation to England, the LLFA is the unitary authority for the area, or if there is no unitary authority, the county council.'*

2.2 Coordination of Flood Risk Management

In his review of the summer 2007 flooding (Defra 2008), 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, Cornwall Council is therefore responsible for leading on local flood risk management across Cornwall.

Cornwall Council is the LLFA for Cornwall. Additionally, the Environment Agency and South West Water are the other designated Risk Management Authorities (RMA). Cornwall has no Internal Drainage Boards and British Waterways are not responsible for any canals within Cornwall.

A formal partnership between the RMAs exists in the form of the Cornwall Flood Management Technical Working Group (CFM-TWG). The aim of the CFM-TWG is to ensure delivery of the Council's duties under the Regulations and the Act and its objectives are:

- To plan and implement the new and emerging duties for Cornwall Council as Lead Local Flood Authority (LLFA).
- To ensure that the requirements and schedules of the Flood and Water Management Act and the Flood Risk Regulations are met.
- To provide partnership working between the three RMAs within Cornwall, namely Cornwall Council, the Environment Agency and South West Water.
- To provide a flow of information between the RMAs and to ensure consistency in data management.
- To coordinate responses to and provide means of comprehensively recording and acting upon future flood events.
- To prepare appropriate and coordinated flood risk management strategies for Cornwall.
- To monitor the Council's progress in meeting the obligations of The Regulations and The Act.

Within the CFM-TWP, Cornwall Council's internal partners are represented through the Floods & Drainage Team, Natural Resources, Spatial Policy and Highways. Additionally, the Group may call on other internal stakeholders such as Emergency Management, Planning & Regeneration, Localism, Green Infrastructure and Public Open Spaces.

In addition to the RMAs, external stakeholders may be consulted including The Highways Agency, Network Rail, Natural England, The National Trust, The Duchy of Cornwall, Police and Fire Services, Parish Councils, Council Members and the Public. It is envisaged that consultation with external stakeholders is more relevant to the later stages of work involving the formulation of Local Flood Risk Strategies and Local Flood Risk Management Plans.

2.3 Public Engagement

It is recognised that members of the public may also have valuable information to contribute to the PFRA process and to local flood risk management more generally across Cornwall. Stakeholder engagement can afford 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 strategies.

An interactive internet mapping site for flood risk was developed as part of the SFRA1 process. It is envisaged that this will continue to be used as a publicly accessible portal for accessing flood risk information. It is also often used for the public to provide feedback to the Council on flood risk management issues. The site can be accessed at:
http://mapping.cornwall.gov.uk/website/sfra/

2.4 Further Responsibilities

Aside from forging partnerships and coordinating and leading on local flood risk management, there are a number of other key responsibilities that have arisen for Lead Local Flood Authorities from the Act and the Regulations. 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 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. The register must be available for public 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 sustainable drainage system (SuDS), and therefore must approve, adopt and maintain any new 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.
- **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.
- **Consenting for Ordinary Watercourses** – LLFAs will take over this consenting role on ordinary watercourses from the Environment Agency. The Environment Agency will retain an overview role.

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 (updated March 2011). 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

The PFRA process and methodology has been set out in guidance published by the EA and Defra in December 2010. Additionally Defra have organised a series of Capacity Building workshops between January and April 2011 to allow further guidance, discussion and dissemination of information, which have been attended by Cornwall Council.

The PFRA methodology is a 10 step process:
Step 1 – Set up governance and develop partnerships.
Step 2 – Determine appropriate data systems
Step 3 – Collate information on past and future floods and their consequences
Step 4 – Determine locally agreed surface water information
Step 5 – Complete Preliminary Assessment Report Document
Step 6 – Record information on past and future floods with significant consequences in spreadsheet
Step 7 – Illustrate information on past and future floods
Step 8 – Review Indicative Flood Risk Areas
Step 9 – Identify Flood Risk Areas
Step 10 – Record information including rationale (only if an Indicative Flood Risk Area is present).

The available data relating to flood risk already held by Cornwall Council and its RMA partners was reviewed at a meeting of the CFM-TWG. This data is listed in the tables within Section 3.3.

The standard data system used by Cornwall Council is ArcGIS and all of the datasets are held in this format.

When formulating Local Flood Risk Management Strategies, following on from this PFRA Report, it will be necessary to drill down to flood data at a more local Parish or community level.

In addition to GIS-based data, there are various published flood risk management reports available. These include those prepared for specific flood defence schemes, the county-wide SFRA1, Community Flood Risk Profiles (CFRP) providing community-wide SFRA Level 2 (SFRA2) reports for supporting the emerging Core Strategy, site specific SFRA Level 2 reports, the Multi-Agency Flood Plan, Community Flood Plans, the South West River Basin Management Plan, Catchment Flood Management Plans (CFMP) and the Shoreline Management Plan (SMP2).

Section 4 of this PFRA reviews past flood events in Cornwall and Section 5 considers future risks. The findings of these assessments are used in Annex 7 and summarised in Section 6 to identify Local Flood Risk Communities for prioritising within the Local Flood Risk Management Strategy for Cornwall.

3.3 Data Sources and Restrictions

Tables 4 to 7 list the data obtained from the EA national, EA local, South West Water and internally within Cornwall Council.

The EA National data is obtained from the EA's web-based Data Share facility[2] and is regularly updated. This is supplemented by data obtained from the EA Cornwall Office, which provides more detail at a local scale. The use of some EA and SWW data is restricted to Cornwall Council and their consultants for the investigation of flood risks and for flood risk management purposes. Further restrictions and limitations are recorded with the individual dataset's metadata.

Data has also been obtained from the Council's Highways, Emergency Management (Multi-Agency Flood Plan (MAFP)) and Fire Service. Data transfer processes within the Council are being reviewed and formalised as part of the new requirement to investigate and log local flooding incidents.

3.4 Data Management

All datasets listed in Tables 4 to 7 are held within Cornwall Council's own GeoStore GIS data repository. This ensures that old versions are replaced on updating, that GIS projects link to the current and definitive data and that metadata is managed and stored with the datasets.

Table 4 Data obtained from EA National (DataShare)

Dataset	Description
Flood Zones 2 & 3, Fluvial and Tidal	GIS polygons layer providing outlines of flood zones as defined within PPS25 combined for both rivers with catchments greater than 3 km^2 and coastal flooding, assuming no artificial flood defences.
Flood Defences (no detail)	GIS lines layer showing locations of flood defences for Main Rivers and the Sea, without any attribute data.
Areas benefitting from defences	GIS polygons of areas that would flood were it not for the presence of artificial flood defences (incomplete dataset).
Flood storage areas	GIS polygons of areas designed to hold water as a flood protection measure.
Historic flood map	GIS polygons providing a merged, unattributed flood extent for records of flooding from rivers, sea and groundwater only and derived from the Flood Event outlines map (Table 5 below).
Main Rivers	GIS lines of watercourses designated as Main Rivers.
Detailed River Network (DRN)	GIS lines and points showing all watercourses and confluences, derived from OS MasterMap.
National Receptors database (NRD)	A collection of GIS datasets of potential receptors to flooding. These include a properties database, transport links and sites and structures with environmental or heritage designations
Surface Water: AStSWF	GIS polygons. The first generation national mapping, outlining areas of risk from surface water flooding across the country with three susceptibility bandings (less, intermediate and more).
Surface Water: FMfSW	GIS polygons. 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) and two depth bandings (greater than 0.1m and greater than 0.3m).
Groundwater: AStGWF	Coarse scale national mapping showing areas which are susceptible to groundwater flooding.

[2] http://www.geostore.com/environment-agency/

Table 5 Data obtained from EA local office

Dataset	Description
Flood Zones 2 & 3, Fluvial	GIS polygons layer providing outlines of flood zones as defined within PPS25 all rivers with catchments greater than 3 km^2, assuming no artificial flood defences.
Flood Zones 2 & 3, Tidal	GIS polygons layer providing outlines of flood zones as defined within PPS25 for coastal flooding, assuming no artificial flood defences.
Flood defences (with some detail)	GIS lines layer showing locations of flood defences for Main Rivers and the Sea, including some attribute data.
Flooded properties	GIS points identifying 2062 properties within Cornwall that are recorded to have been flooded.
Flood event outlines	GIS polygons showing the extents of flooding for 414 areas within Cornwall including descriptions and dates of flooding.
Flood levels	GIS points recording the depth of flooding at 284 properties that have flooded within Cornwall.
Critical drainage areas	GIS polygons showing the extents of 29 sub-catchments in Cornwall designated as Critical Drainage Areas where there are particular drainage concerns along with development pressures.
CFMP policy units	GIS polygons showing the 24 policy units and their respective policy options derived from the Catchment Flood Management Plans.
SMP policy units	GIS lines showing 1020 policy units and their respective policy options derived from the Shoreline Management Plans (2nd edition).
FRIS	GIS points for the Flood Reconnaissance Information System detailing information held on around 2,500 flood events within Cornwall. See Figure 3.

Table 6 Data obtained from SWW

Dataset	Description
Sewerage network for high risk communities	GIS points and lines for foul, combined and surface water sewer systems. Lines of sewers, junctions, manholes, outfalls, pumping stations, etc. Coverage for networks of 26 waste water treatment works serving the main communities in Cornwall where flood risk is considered to be an issue.
CSOs	GIS points locating 358 combined sewer overflows across Cornwall.
Hydraulic overload (DG5) by 4 digit postcode	GIS polygons of 23 sewer catchments with known hydraulic overload problems. Areas are defined by 4-figure post code. See Figure 9.
Pollution Incidents	*Data requested, but still awaited at the time of writing*
Flooding Incidents	*Data requested, but still awaited at the time of writing*
Equipment Register	*Data requested, but still awaited at the time of writing*

Table 7 Data held by Cornwall Council

Dataset	Description
Highways Flooding Enquiries Database	GIS points recording incidents of highway flooding logged through the Council's Call Centre. Records cover the period from 2003. See Figure 4.
Fire service callout records	Excel spreadsheet summarising locations and numbers of callouts to flooding related incidents since 2005. Records have been transferred to GIS points. See Figure 8.
Fluvial Flood Zone 3b	GIS polygons showing functional floodplain, see Cornwall SFRA1 for definitions.
Flood vulnerable A & B roads	GIS points identifying locations of known flood risks to highways, determined for the MAFP for flooding. See Figure 6.
Gulley Hotspots	GIS points locating problematic highway drainage systems. This allows these locations to be checked and cleared if necessary when rainfall alerts are received. See Figure 5.
Rivers	GIS lines showing 3094 rivers and streams in Cornwall greater than about 500 m in length digitised at a scale of 1:25,000 with approximately 50 m vertex spacing.

4 HISTORIC FLOOD RISK

The main source of information on past floods is the EA's Flood Reconnaissance Information System (FRIS) database. Thanks to existing data sharing agreements arising from the SFRA partnership group, information from the Council's own Highways Flood Record database had previously been integrated with FRIS. The version of FRIS supplied by the EA is current to 2010 but has been updated with local knowledge where applicable as more recent events, such as those of November 2010, have yet to be fully entered into FRIS.

This PFRA is required to address issues of local flood risk: those associated with surface water, Ordinary Watercourses, groundwater and canals, whilst issues related to flooding by Main Rivers and the sea are the remit of the EA, Figure 1. However, most significant floods tend to involve a combination of sources of flooding and virtually all flood events contain elements of flooding from local sources.

4.1 Types of Flood Risk

Surface Water Flooding

Surface water refers to rainfall that has been intercepted by the ground or roofs but has not yet entered a natural watercourse system. Surface water flooding occurs when heavy rainfall exceeds the capacity of the local drainage network and water flows across the ground. This occurs either due to blockages in the drainage system or during very high intensity storms when water builds up before it can reach the surface water drainage system.

The Pitt Review highlighted the impact of surface water during flood events and the recommendations have led to the LLFAs being given greater responsibility for surface water management within the Act.

Due to the geographical nature of Cornwall, with steep valleys and small catchments, surface water is the largest source of flood risk in Cornwall; compare Tables 10 and 12.

Groundwater flooding

Groundwater flooding occurs as a result of water rising up from the underlying aquifer or from water flowing from ephemeral springs. This tends to occur after long periods of sustained high rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by major aquifers, although it is also being associated with more localised floodplain alluvial deposits.

Cornwall's geology is essentially that of hard fractured rocks – granite moors, mudstone/slate (killas) lowlands and the Lizard Complex, that are classified as minor aquifers. Superficial deposits occupy areas of flat marshy land in the valley bottoms. These deposits grade into "head", highly weathered granular material, in the upper parts of the valleys. As many valleys in Cornwall are steep and narrow, alluvial floodplains also tend to be fairly narrow strips.

The soils in Cornwall are mainly free draining or relatively free draining with moderate to high permeability, but with low to moderate storage.

Groundwater flooding is generally not a major issue in Cornwall. Though occasional isolated problems are known in respect of some springs, these would usually relate to a single property. However, low-lying areas and those within floodplains can be affected by high groundwater levels, irrespective of physical flooding. Groundwater flooding problems may be experienced through seepage into underground spaces or lead to ingress into the sewerage system and a corresponding reduced sewer capacity.

PFRA guidance does not address the issue of minewater flooding, which could, in some circumstances, be considered to be a specific form of groundwater flooding.

Mining related features

Mining has affected the river systems within Cornwall, through early tin streaming from the Bronze Age to the deep mines of the 18th, 19th and 20th centuries. Tin streaming has resulted in reworking of the alluvium within river floodplains and realignment of natural channels. Use of water for power and mineral processing has resulted in the construction of leat systems and stream diversions. Drainage of deep mines involved the construction of adits (horizontal tunnels worked to allow mine water to drain by gravity to the lowest nearby points of river valleys). These can even divert water from one river catchment to another.

Whilst mine drainage can result in lower groundwater levels in an area, it can react in a similar way to a pipe or sewer, short-circuiting the natural flow paths and releasing pulses of water quickly into the river systems.

The locations of over 1500 individual mines and 935 known adits are recorded on the Council's GIS database.

Apart from unexpected adit breakout, the risk of flooding related to adits and leats is low but there may be a need for minewater management or considerations to be included within local flood management strategies in Cornwall.

Flooding from reservoirs

The EA are responsible for regulating large raised reservoirs under the Reservoirs Act 1975. They currently regulate reservoirs over 25,000 m^3 in capacity. This will reduce to10,000 m^3 through provisions of the Act. Reservoirs below this size are unlikely to present significant flood risks in the context of the Regulations. On this basis there is no need for LLFAs to include information on reservoirs in their PFRAs (EA 2010c).

Sewer Flooding

Sewer flooding is often caused by excess surface water entering the drainage network. The sewerage system comprises foul sewers, which do not accept surface water runoff, surface water sewers that do and combined sewers, which accept a combination of surface water and foul sewage. Flood risk management strategies need to take account of both surface water and combined sewer capacity as these impact on surface water drainage and should seek to reduce the number of Combined Sewer Overflow (CSO) spills if at all possible.

LLFAs do not need to assess flooding from sewers, unless wholly or partly caused by rainwater or other precipitation entering or otherwise affecting the system (EA, 2010c). Floods of raw sewage caused solely, for example, by a sewer blockage do not fall under the Regulations. The Regulations also do not apply to floods from water supply systems, e.g. burst water mains.

Canals

Flooding problems related to canals tend to be with respect to breaches rather than overtopping.

The only major canal within Cornwall is the Bude Canal, which is managed by Cornwall Council. Other canals were constructed as part of the minerals industry, such as the Trefry Canal at Par, which is now designated as Main River, and many watercourses in Cornwall have been heavily modified in relation to the mining and minerals industries. Many leats constructed in relation to mining and mineral processing are more akin to canals than to natural watercourses.

Ordinary Watercourses

An Ordinary Watercourse is defined as any river, stream, ditch, cut, sluice, dyke or non-public sewer which is not a Main River.

The Act devolved consenting powers for works on Ordinary Watercourses from the EA to the LLFA.

Interaction with the Main Rivers

Main Rivers are watercourses legally defined and marked as such on the Main River map. Generally they are larger streams or rivers, but can be smaller watercourses or even individual culverts. The Environment Agency has legal responsibility for Main Rivers.

Though Main Rivers make up a relatively small proportion of the lengths of watercourses in Cornwall (<20%, by length, Figure 2), they do tend to be those with the more severe potential flooding problems.

Interaction with the sea

Coastal flooding can occur as a result of a combination of high tides and stormy conditions. If low atmospheric pressure coincides with a high tide, a tidal surge may cause serious flooding. The EA are responsible for managing risk from sea flooding. However, tide-locking can cause fluvial flooding from both Main Rivers and Ordinary Watercourses and wave-overtopping can result in significant surface water problems.

Other sources of flooding

Other rare sources of flooding are mentioned in the Floods Directive and include snowmelt and tsunamis. Snowmelt could lead to surface runoff. Tsunamis are a form of flooding from the sea. The EA (2010c) anticipates that that the main focus of LLFAs in their PFRAs will be ordinary watercourses, surface runoff and groundwater.

4.2 Chronology of Major Flood Events

Annex 5 lists the more significant and notable of the 2500 events recorded within Cornwall in the FRIS database, including appropriate records from the Council's highways flooding database and supplemented or updated by local information.

The British Hydrological Society's Hydrochronology database[3] was also consulted, but did not add any further information.

Of those events listed in Annex 5, only the 15 most significant, recent, relevant and applicable to local flooding have been entered into the Annex 1 spreadsheet. These have been selected through consultation with local EA personnel and cross-referenced with the FRIS database. The 15 events identified for submission in Annex 1 are listed in Table 8, below. Note that most events are fairly widespread, affecting more than one location. Exact determination of the numbers of properties affected can be difficult as records often refer to the number of flooded properties within a particular location, but note that an unspecified number of others also occurred elsewhere.

All of the events listed in Table 8 are considered to be of national significance as they were widely reported within the national press. Each event involved a combination of both surface water and fluvial flooding. No events related to solely flooding from the sea are reported in Table 8, though these are included in Annex 5. Many significant events occurred prior to the 1970s, such as the Great Floods of 1847 and 1894, but these have not been included in Table 8 as changes in flood defence and general infrastructure and development make these less relevant.

More information on each of the events listed in Table 8 can be found in Annex 5.

Figure 3 shows the geographical distribution of all events recorded within FRIS.

In addition to the fact that much local flooding is widespread, affecting numerous locations during a single flooding episode, the catchments in Cornwall tend to respond rapidly and the critical durations of flood events are short, typically around one hour. Extreme localised rainfall events therefore lead to fast flowing waters with high hazard, such as the well known Boscastle event of 2004.

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

Table 8 Significant flood events submitted in Annex 1

Date	Location	Consequences
17/11/2010	Mid-Cornwall and St Austell Bay	c. 400 properties
24/04/2009	St Ives/Zennor	3 fatalities, 7 footbridges
16/08/2004	Boscastle area	c. 80 properties
01/01/2003	West Cornwall	50+ properties
13/11/2002	St Ives and West Cornwall	70+ properties
18/12/1999	Cornwall widespread	100+ properties
26/11/1997	St Austell area	55+ properties
28/02/1995	St Austell area	40+ properties
30/12/1993	Mid-Cornwall	200+ properties
12/06/1993	Cornwall widespread	250+ properties
29/05/1992	St Ives & Carbis Bay	60 properties
11/10/1988	Truro	100+ properties
29/01/1988	Truro area	100+ properties
27/12/1979	Cornwall widespread	200+ properties
24/09/1976	Cornwall widespread	1 fatality and 100+ properties

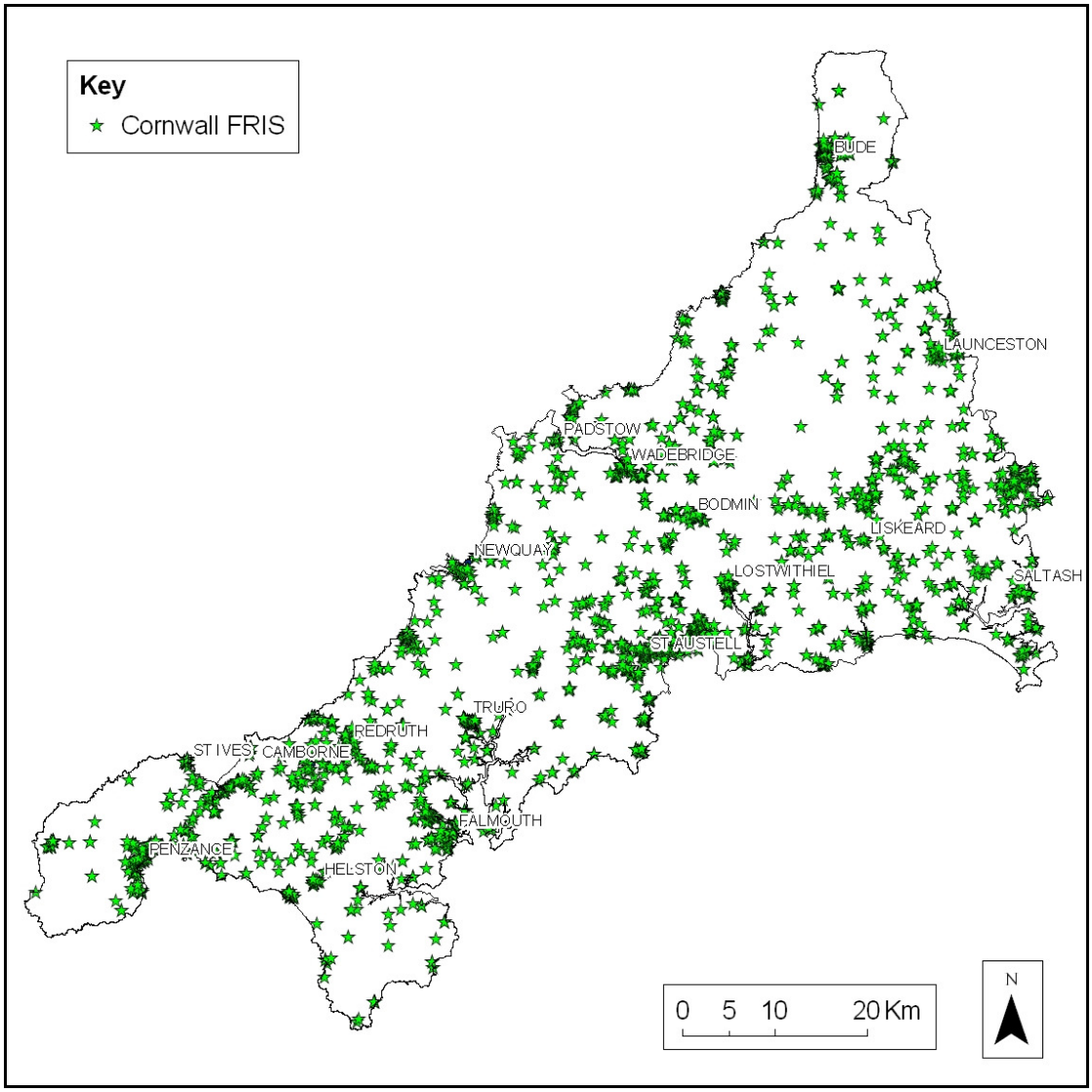

Figure 3 Distribution of all flood events recorded in FRIS

4.3 Highway Records

The Highways flooding database lists all reports of flooding and drainage incidents received through the Call Centre from 2003. Up to the end of March 2011, over 14,000 records have been logged, though many of these are relatively trivial such as individual blocked gullies, burst water mains, etc. The main flooding events from the Council's Highways database have previously been incorporated into FRIS.

Figure 4 shows the geographical distribution of these records.

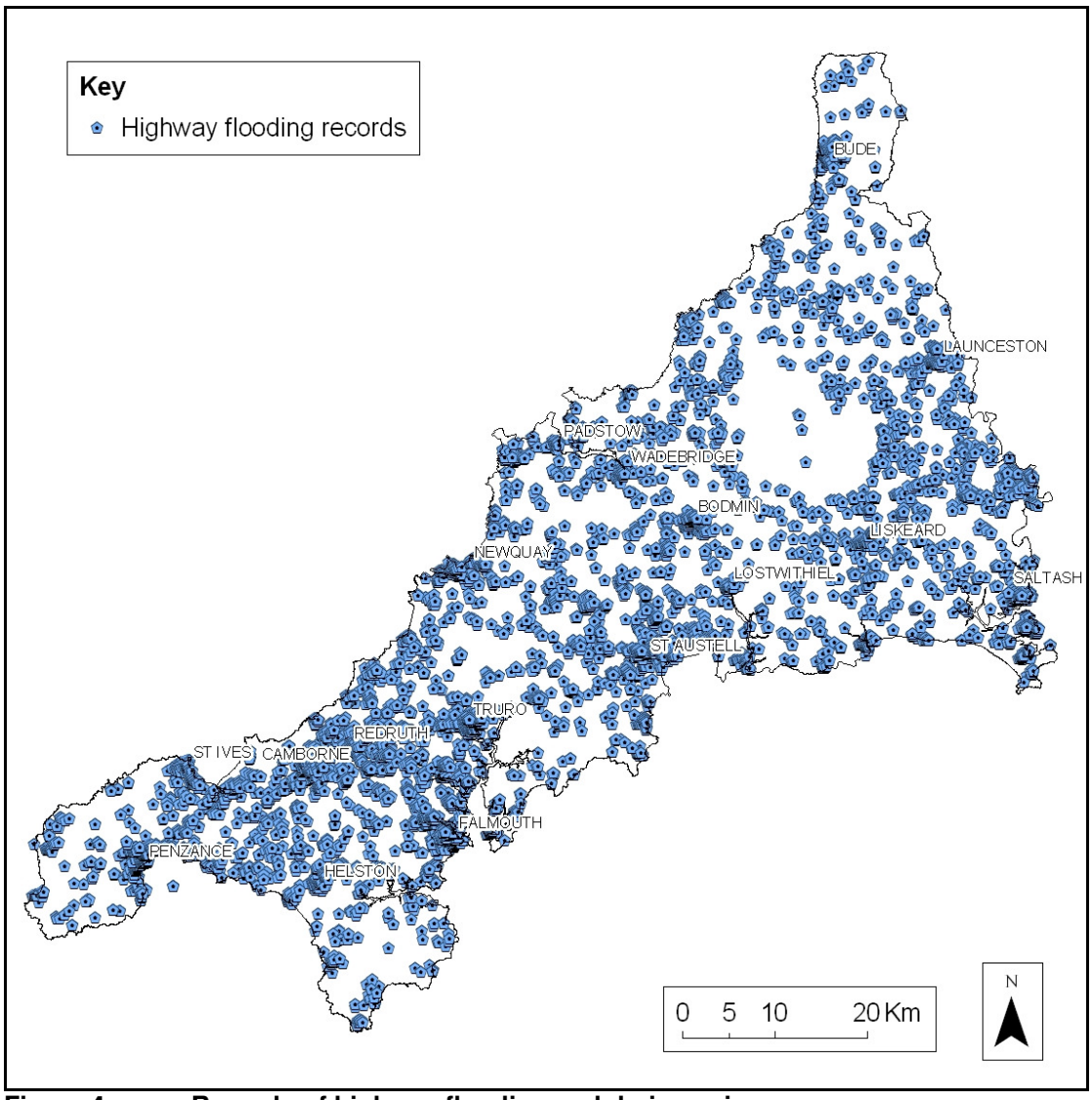

Figure 4 Records of highway flooding and drainage issues

Cornwall Council Highways also maintain a database of 205 locations where there are known problems with highway drainage such as where regular maintenance and clearance of gullies is required. This allows maintenance teams to be mobilised when severe rainfall alerts are received to ensure that these are flowing freely.

The distribution of these 'Highway Floodspots' are shown in Figure 5.

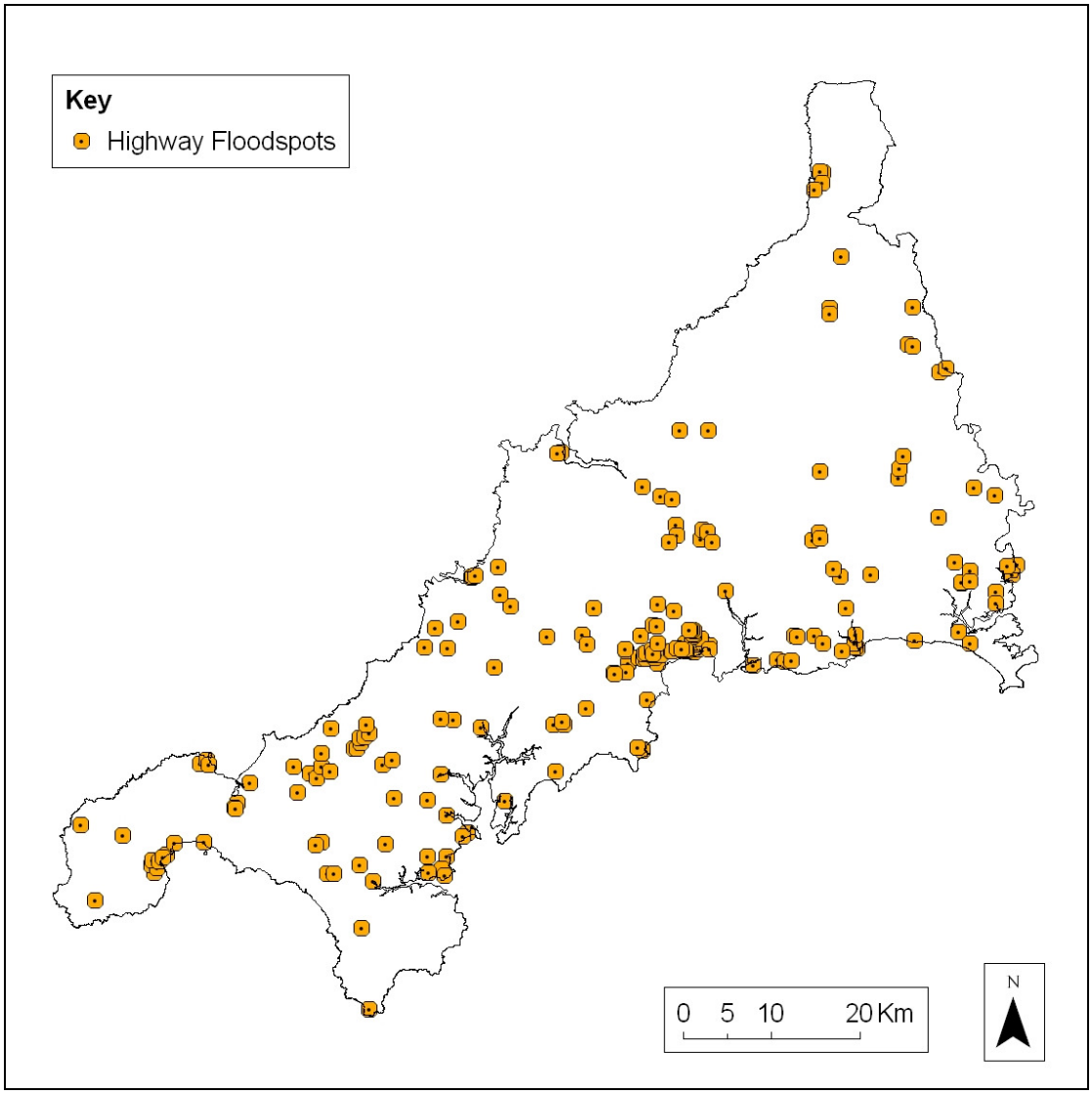

Figure 5 Distribution of problematic highway drainage locations

The Multi-Agency Flood Plan (MAFP) produced by the Local Resilience Forum lists 125 locations considered to be hotspots for highway flooding. These are shown in Figure 6, below.

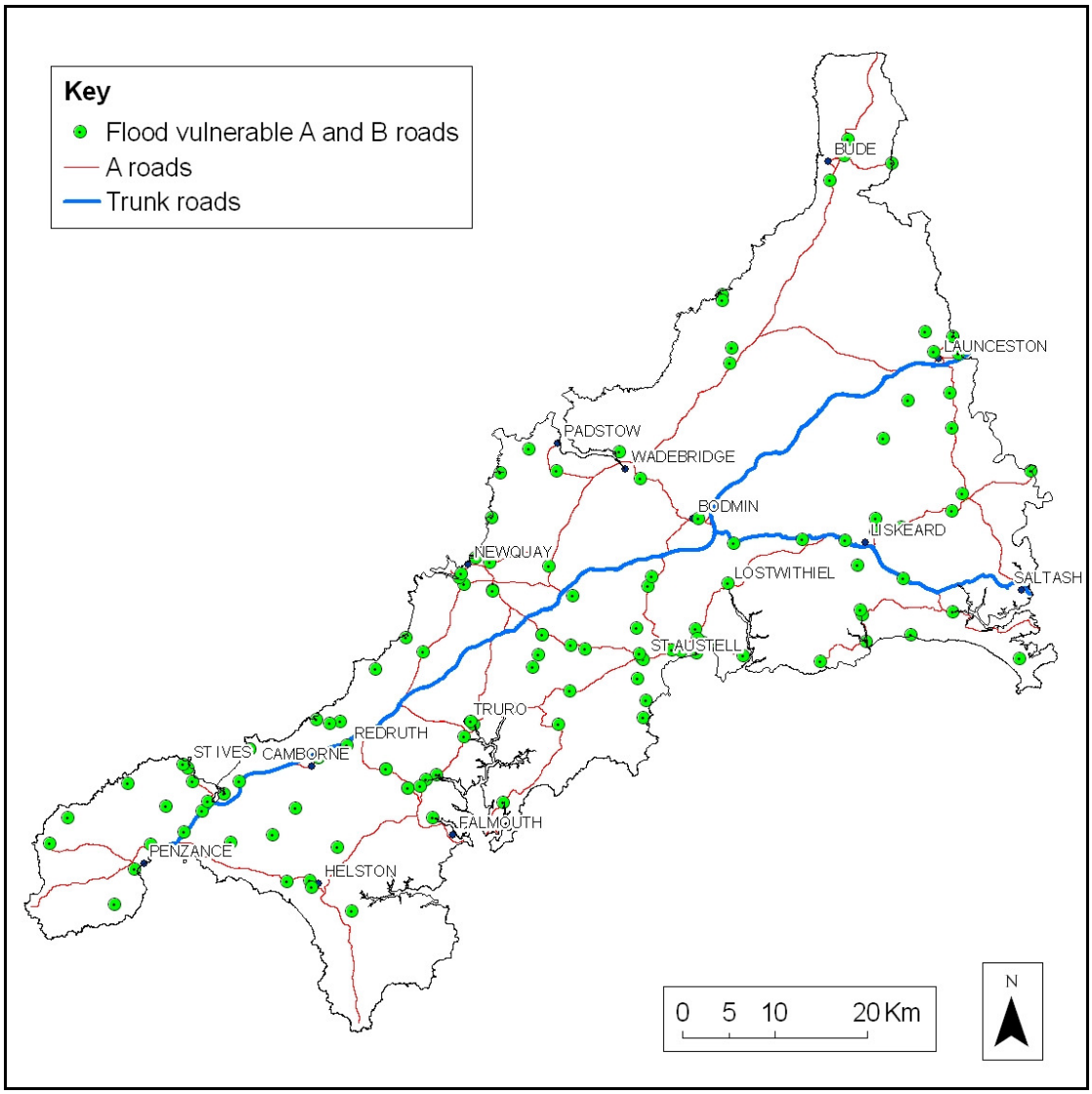

Figure 6 Flood vulnerable A and B roads identified within the MAFP

4.4 Fire Service Records

The Fire Service in Cornwall has logged 463 incidents related to flooding that were attended between April 2005 and March 2011, an average of around 7 per month. Figure 7 shows the number of flood incidents attended per month over the past 5 years and Figure 8 shows the geographical distribution of all flood events attended from April 2005.

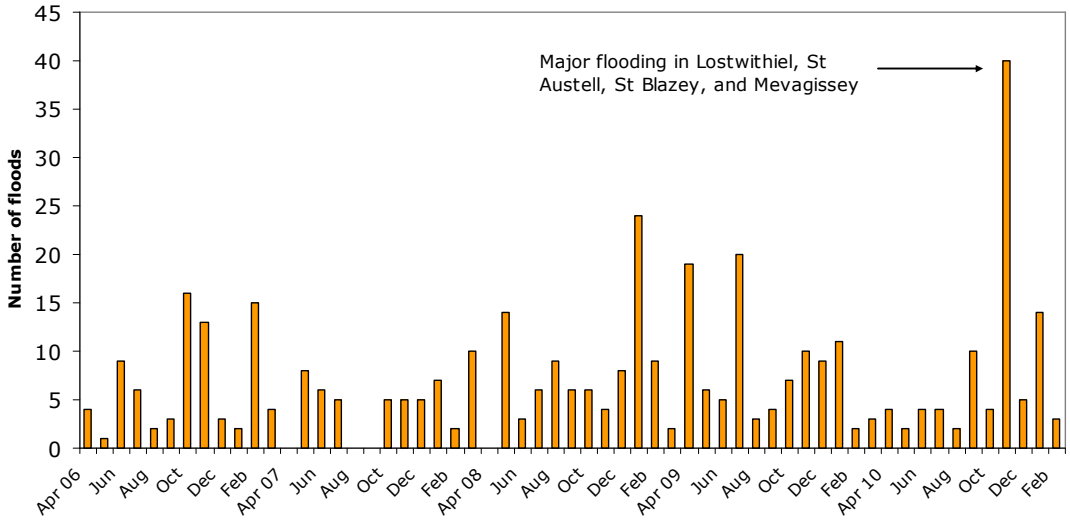

Figure 7 **Flood incidents attended by the Cornwall Fire Service within the past 5 years**

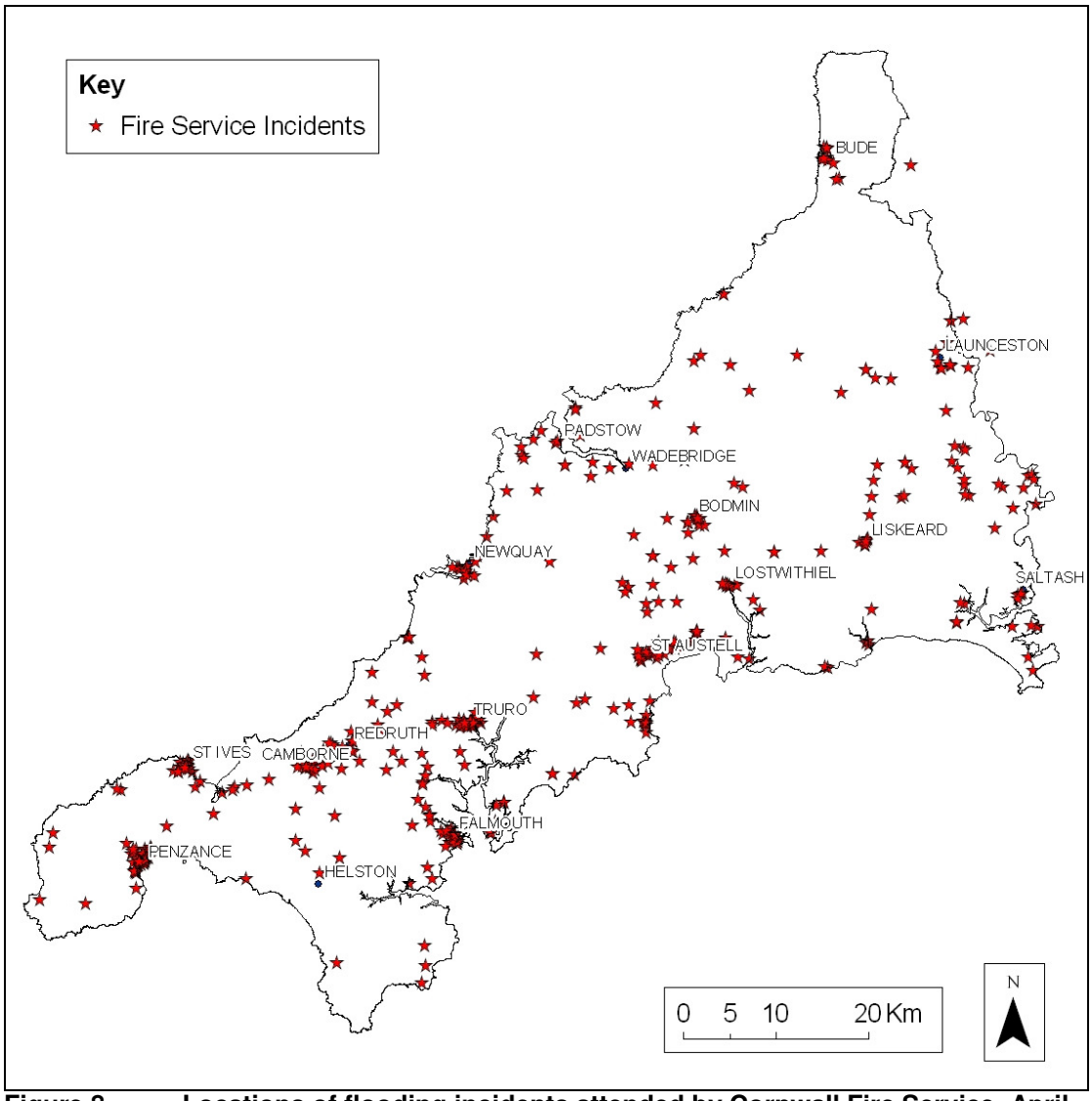

Figure 8 **Locations of flooding incidents attended by Cornwall Fire Service, April 2005 – March 2011**

4.5 Sewer Flooding Records

SWW has provided details of sewer catchments with known hydraulic overload problems, from their DG5 register. This register documents those properties at risk of flooding internally more frequently than 1 in 10 years. Areas are defined by 4-figure post code. These areas are shown on Figure 8, below. Whilst it is known that some metropolitan LLFAs have found this data useful for identifying problem locations at 4-figure post code level, Figure 9 illustrates than in a rural area such as Cornwall the data is not specific enough to indicate where surface water sewer problems lie.

Discussions with SWW are ongoing to identify the methodologies required to identify where surface water sewerage issues exist that should be taken into account when determining the local flood risk strategy.

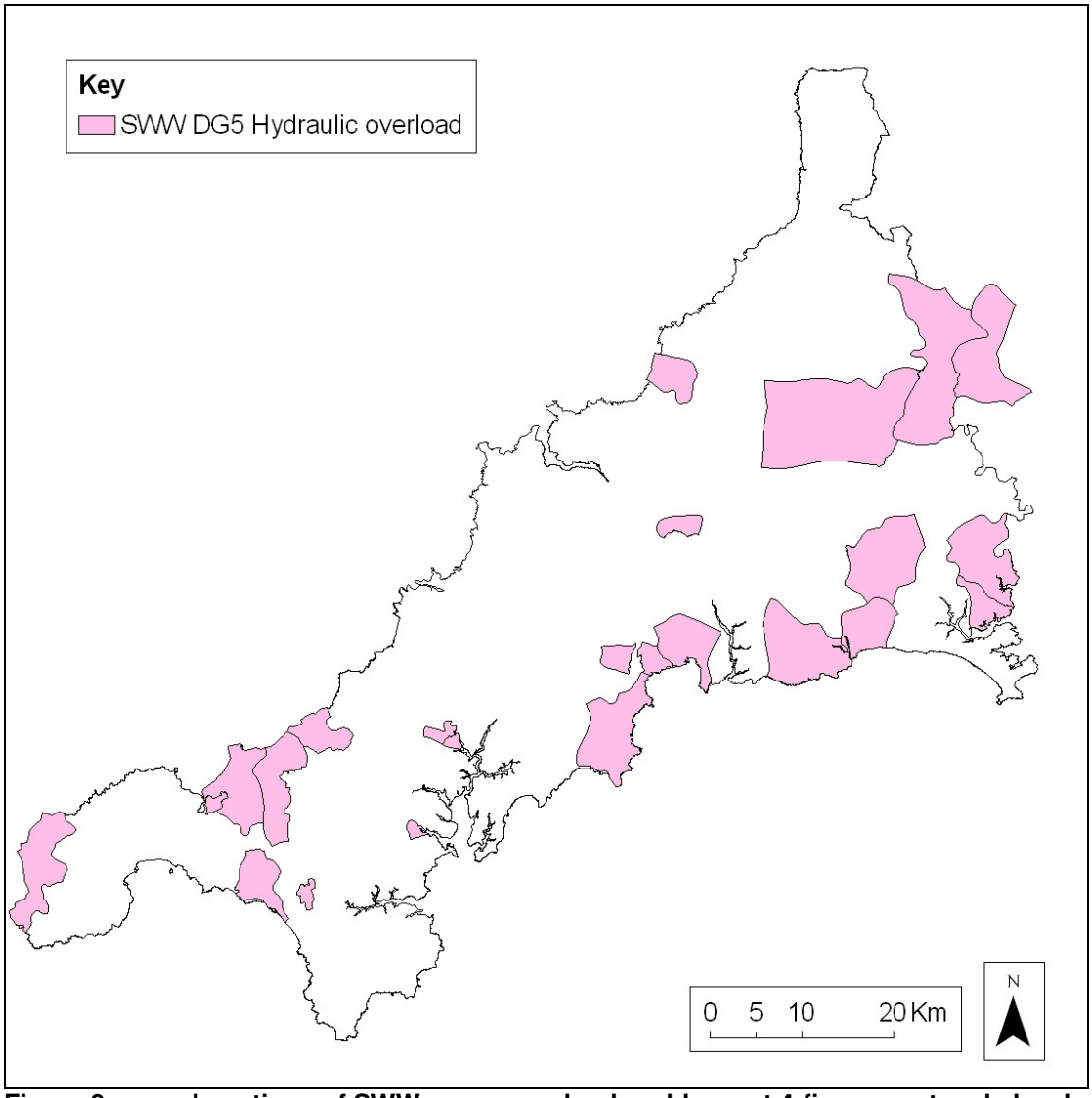

Figure 9 Locations of SWW sewer overload problems at 4-figure post code level

5 FUTURE FLOOD RISK

5.1 Local Flood Risk

The remit of the PFRA is to consider local flood risk, based on existing information. Local flood risk pertains to surface water, fluvial flooding from Ordinary Watercourses, groundwater flooding and flooding from canals and small reservoirs. For the purposes of this report, groundwater flooding and flooding from canals and small scale reservoirs are not considered to constitute major flood risks in Cornwall. Surface water and Ordinary Watercourses are therefore the focus of attention in identifying any Proposed Flood Risk Areas and Local Flood Risk Communities.

Flooding from the sea, from Main Rivers and from large raised reservoirs is addressed by the EA, Figure 1. However, it is not possible to completely separate these sources of flooding from the local flood risks due to their interactions. The small and rapidly responding catchments in Cornwall result in close interactions and shared floodplains between Main Rivers and Ordinary Watercourses. Both Main River and Ordinary Watercourses are affected by tide-locking and it is notable that fluvial floods in coastal communities commonly occur coincidently with high tides.

The National Flood Zone maps, Table 4, aggregate both tidal and fluvial flood risk zones. The versions provided by the EA Cornwall Area Office, Table 5, provide Tidal and Fluvial flood risk zones separately, enabling a distinction between the flood risks to be made. The fluvial map identifies flood risk zones for all watercourses with catchment areas greater than 3 km^2. However, there is no readily available flood risk map that separates fluvial flood risks by Ordinary Watercourses from those by Main Rivers.

Once priority flood risk areas are identified (Section 6.3), local strategies will require more detailed analyses of flood risks in specific locations and it is at this stage that fluvial flooding from Ordinary Watercourses can be identified separately to those from Main Rivers.

5.2 Flooding Receptors

Identifying Flood Risk Areas

Information regarding historic and future flood risk is used to formally identify Flood Risk Areas. To achieve this, flood risk indicators are used to determine the impacts of flooding on human health, economic activity, cultural heritage and the environment. The use of flood risk indicators helps to develop understanding of the impacts and consequences of flooding. Key flood risk indicators are summarised in Table 9, taken from the EA Guidance (2010c).

Table 9 Key flood risk indicators

Impacts of flooding on:	Flood Risk Indicators
Human Health	Number of residential properties. Critical services (Hospitals, Police/Fire/Ambulance Stations, Schools, Nursing Homes, etc).
Economic Activity	Number of non-residential properties. Length of road or rail. Area of agricultural land.
Cultural Heritage	Cultural heritage sites (World Heritage Sites). Listed buildings.
Environment	Designated sites (SSSIs, SACs, SPAs, etc) and BAP habitat.

The above information is available within the EA's National Receptors Database (NRD), Table 4.

Whilst Cornwall Council holds much of this information, through its own properties database, Natural England datasets, etc., the NRD data (Version 1.1, October 2010) has been used for all analyses reported here, in order to provide repeatability, transparency and national consistency in the analyses.

5.3 Flooding From All Sources

Notwithstanding flooding from groundwater, sewers, canals and small reservoirs, the main sources of flooding affecting Cornwall are Fluvial, Tidal and Surface Water.

Fluvial Flood Risk Zones

The EA fluvial flood risk map, Table 5, provides the extents of fluvial flood zones 2 and 3 as defined within Planning Policy Statement 25 (PPS25) on Development and Flood Risk.

- Flood Zone 3 is land within the extent of the 1% Annual Exceedance Probability (AEP) event (a 1% chance of occurring in any one year).

- Flood Zone 2 is land within the extent of the 0.1% AEP event (a 0.1% chance of occurring in any one year).

Fluvial Flood Zones 2 and 3 are defined assuming that no existing flood defences are in place, representing a worst case, or breach, scenario and are only available for catchments greater than 3 km^2 in area, unless more detailed modelling is available[4].

Tidal Flood Risk Zones

The EA tidal flood risk map, Table 5, provides the extents of tidal flood zones 2 and 3 as defined within PPS25.

- Flood Zone 3 is land within extent of the 0.5% AEP event (a 0.5% chance of occurring in any one year).

- Flood Zone 2 is land within the extent of the 0.1% AEP event (a 0.1% chance of occurring in any one year).

Tidal Flood Zones 2 and 3 are defined assuming that no existing flood defences are in place, representing a worst case, or breach, scenario unless more detailed modelling is available[4].

Surface Water Flood Risk Zones

Two sets of surface water risk maps are available from the EA, Table 4.

The Areas Susceptible to Surface Water Flooding (AStSWF) map was the first generation map (2009) and is based on a Digital Elevation Model (DEM) with surface features removed, the Digital Terrain Model (DTM) or "bare earth model". The rainstorm event modelled to create the map is the 0.5% AEP storm with 6.5 hours duration. The map is divided into three zones: More Susceptible (rapid onset, deep water), Intermediate Susceptibility and Less Susceptible (slow onset, shallow depth) to surface water flooding.

The Flood Map for Surface Water (FMfSW) is the second generation map (2010) and is based on a more refined DEM and with surface features included, the Digital Surface Model (DSM). Two rainstorm events are modelled to create the map; a 1 in 30 year (3.3% AEP) storm with 1.1 hours duration and a 0.5% AEP storm with 1 hour duration. Each map is divided into two zones: shallow flooding (to 0.1 m depth) and deep flooding (to 0.3 m depth).

[4] Refer to Environment Agency metadata for more details on the accuracy and applicability of the data.

It is generally considered that the AStSWF map better represents flat catchments with broad floodplains and that the FMfSW better represents steep catchments, narrow floodplains and urban areas. Section 5.4 explains the reasoning for the agreed surface water map used to conduct more detailed analyses of surface water flood risk applied in Annex 6 and used to prioritise Local Flood Risk Communities in Annex 7.

Summary of Flood Risks

Tables 10 to 13 summarise the results of applying GIS analyses to identify the numbers and types of properties within each of the flood risk zones described above. In accordance with the EA guidance (2010c), the number of people is calculated as the number of residential properties × 2.34. A more detailed analysis of surface water flood risk is provided in Annex 6.

The approach taken was the detailed methodology as described in the EA guidance (EA 2010d): The properties (points) were overlaid with the Ordnance Survey (OS) MasterMap layer to identify individual buildings (polygons) that are associated with individual properties. These buildings were then overlaid by each of the flood zones (polygons) to identify which buildings encroach onto flood zones. These selected buildings were then re-associated with the point properties database to identify the types and uses of each building within a flood risk zone.

Table 10 Property receptors within tidal and fluvial flood zones across Cornwall

Receptor	Tidal flood zone		Fluvial flood zone	
	Flood zone 3 (0.5% AEP)	Flood zone 2 (0.1% AEP)	Flood zone 3 (1% AEP)	Flood zone 2 (0.1% AEP)
Residential properties	1990	3050	8020	9310
No of people	4657	7137	18767	21785
Non-Residential properties	1605	2220	4718	5416
Critical Services	28	39	103	111
Listed buildings	257	326	707	816
Scheduled ancient monuments[5]	17	46	55	56
Total properties (residential + non-residential)	3595	5270	12738	14726

Table 11 Breakdown of critical services receptors within tidal and fluvial flood zones across Cornwall

Receptor	Tidal flood zone		Fluvial flood zone	
	Flood zone 3 (0.5% AEP)	Flood zone 2 (0.1% AEP)	Flood zone 3 (1% AEP)	Flood zone 2 (0.1% AEP)
Schools	5	5	18	18
Hospitals	0	0	3	3
Care Homes & Prisons	0	0	8	8
Police Stations	4	5	2	2
Fire & Ambulance Stations	2	2	0	0
Sewage treatment works	9	14	45	48
Electricity installations	8	13	27	32
Total	28	39	103	111

[5] As the Scheduled Ancient Monuments file is a polygon GIS layer, the step linking property points to building polygons is omitted from this analysis.

Table 12 Property receptors within surface water flood zones across Cornwall

Receptor	AStSWF			FMfSW			
	1 in 200 year			1 in 30 year		1 in 200 year	
	less	int.	more	shallow	deep	shallow	deep
Residential properties	21838	10715	3568	23526	9207	43975	18005
No of people	51101	25073	8279	55051	21544	102902	42132
Non-Residential	14650	7553	2823	14732	5956	25034	10660
Critical Services	263	152	62	258	113	431	207
Listed buildings	259	726	1302	1409	729	2234	1205
Scheduled ancient monuments[4]	61	126	213	143	78	204	113
Total properties (residential + non-residential)	36488	18268	6391	38258	15163	69009	28665

Table 13 Breakdown of critical services receptors within surface water flood zones across Cornwall

Receptor	AStSWF			FMfSW			
	1 in 200 year			1 in 30 year		1 in 200 year	
	less	int.	more	shallow	deep	shallow	deep
Schools	57	19	9	90	40	152	71
Hospitals	5	2	1	6	4	9	7
Care Homes & Prisons	12	4	2	12	4	21	9
Police Stations	10	6	1	5	1	14	4
Fire & Ambulance Stations	13	10	2	10	2	16	6
Sewage treatment works	95	71	32	75	42	95	67
Electricity installations	71	40	15	60	20	124	43
Total	263	152	62	258	113	431	207

The risks of flooding to areas with environmental designations, SSSI, SPA, BAP Habitats, etc. need to be considered on a case by case basis. This is because often these designations are only made due to the fact that the area is susceptible to flooding, i.e. salt marshes, fens and wet woodlands.

5.4 Locally Agreed Surface Water Information

It has been agreed with the EA, through the CFM-TWG, that the dataset and scenario to be used for further surface water risk analysis would be the FMfSW 0.5% AEP rainstorm event with deep (>0.3 m) water flooding.

It is understood that this was the scenario used by the EA itself when conducting the national scale risk analyses for determining indicative flood risk areas (EA 2010b).

Both the AStSWF and FMfSW were reviewed for Cornwall. It was noted that the FMfSW tends to have more accurate topography than AStSWF, for which some river valleys appear to be slightly offset from true topography. The critical duration used in the FMfSW, of 1.1 hours, is considered to be more representative of the rapid response catchments found in Cornwall.

The FMfSW correlates better with localised modelling of surface water flows, where this is available. Furthermore a review of FMfSW against the November 2010 event reconnaissance has verified this as the correct approach.

5.5 Effect of Climate Change and Long Term Developments

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 cannot 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% probability annual chance, or rarer) could increase locally by 40%.

Key Projections for South 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 17% (very likely to be between 4 and 38%)
- Precipitation on the wettest day in winter up by around 12% (very unlikely to be more than 24%)
- Relative sea level at Plymouth very likely to be up between 12 and 42cm 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 21%

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

Implications for Flood Risk

Climate changes can affect local flood risk in several ways. Impacts will depend on local conditions and vulnerability. Wetter winters and more of this rain falling in wet spells may increase river flooding. More intense rainfall causes more surface runoff, increasing localised flooding and erosion. In turn, this may increase pressure on drains, sewers and water quality. Storm intensity in summer could increase even in drier summers, so we need to be prepared for the unexpected.

Rising sea or river levels may increase local flood risk inland or away from major rivers because of interactions with drains, sewers and smaller watercourses.

There may be an increased risk of flooding from groundwater in the area. Recharge may increase in wetter winters, or decrease in drier summers.

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.

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 against deeper uncertainty. We will therefore consider a range of measures and retain flexibility to adapt. This approach, embodied within flood risk appraisal guidance, will help to ensure that we do not increase our vulnerability to flooding.

Long Term Developments

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

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

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

Key Projections for Cornwall

A review of the Meteorological Office standard climate datasets has shown that, due to the peninsular effect, key findings for the South West are not particularly accurate for Cornwall (Cornwall Council 2010a). Furthermore, long-term climate statistics for Cornwall reflect local geographic differences as three distinct climatic regimes: upland, inland lowland and coastal lowland.

Projections from UKCIP09 specifically for Cornwall, rather than for the SW River Basin District, are shown in Table 14.

The High, Medium and Low scenarios are based on UKCP09 modelling from 25km grid cells using the maximum and minimum values of each grid cell that coincides with the boundary of Cornwall, carried out by UKCIP and provided by Climate SW. Nine 25km grid cells are used, which, due to the large grid size, cover all grid cells that are geographically within Cornwall.

The upper range is the 90% confidence level which represents “very unlikely to be greater than” and the lower range is the 10% confidence level representing “very unlikely to be less than”.

Table 14 UKCP09 analysis of precipitation for Cornwall (mm/day)

Scenario	Autumn		Spring		Summer		Winter	
	Not less	Not more	Not less	Not more	Not less	Not more	Not less	Not more
High emissions								
2025	3.112	5.291	2.167	3.707	1.509	3.584	3.637	6.733
2055	3.251	5.288	2.161	3.686	1.014	3.317	3.836	7.676
2085	3.215	5.317	2.145	3.778	0.605	3.199	3.866	8.951
Medium emissions								
2025	3.234	5.177	2.147	3.689	1.464	3.472	3.632	6.705
2055	3.281	5.253	2.16	3.677	1.043	3.268	3.875	7.53
2085	3.295	5.232	2.148	3.765	0.821	3.259	3.939	8.314
Low emissions								
2025	3.252	5.325	2.187	3.729	1.508	3.446	3.604	6.631
2055	3.232	5.15	2.181	3.736	1.146	3.539	3.723	7.188
2085	3.251	5.282	2.107	3.825	1.045	3.447	3.921	7.659
Baseline (1961 -1990 long term average)								
1975	3.649		2.501		2.320		4.167	

6 FLOOD RISK AREAS

Indicative flood risk areas have been identified by the EA, (EA, 2010b). The PFRA provides an opportunity for each LLFA to suggest any further indicative flood risk areas (proposed flood risk areas, Table 2), if the evidence base used in the PFRA warrants such a move.

The PFRA also provides the opportunity for the LLFA to identify areas of significant flood risk which, whilst not meeting the national criteria of an Indicative Flood Risk Area, may still warrant designation as a Local Flood Risk Community for inclusion and prioritisation within its local flood risk strategy.

Also, for this round of the Regulations cycle, Defra has set the criteria for indicative flood risk areas in England at a very high level. This may be considerably lowered during the next cycle and so there are advantages in identifying areas likely to be included next time around and making progress on their Local Flood Risk Management Strategies during the intervening period.

6.1 Indicative Flood Risk Areas

The Environment Agency has used the Flood Map for Surface Water (FMfSW) mapping and the National Receptors Database (NRD) to identify a number of areas across the country that exceed a given threshold, described in Table 15.

Table 15 Flood risk thresholds used to identify future consequences of flooding

'Significant harmful consequences' defined as greater than…[6]	Scenario
200 people	Flooded to a depth of 0.3m during a rainfall event with a 0.5% AEP
20 businesses	
1 critical service	

This assessment was carried out by the EA (2010b) based on 1km^2 national grid squares, and the grid squares that exceed these criteria were identified.

The EA then used the 1 km^2 grid squares to identify clusters of grid squares whereby if 5 or more grid squares meeting the criteria listed in Table 15 are present within a 3 × 3 km square of 9 grid squares (a "5/9" approach) then this represents a cluster. This is illustrated in Annex 6. Any moving 3 × 3 km square meeting the "5/9" criterion creates an aggregated cluster. A sensitivity analysis on this approach for Cornwall is provided in Annex 6.

If an aggregated cluster using the "5/9" approach results in a total of ≥30,000 people at risk, then this identifies an indicative flood risk area. Any LLFA that has all or part of an indicative flood risk area within its administrative boundary will need to produce hazard and risk maps and FRMPs for that area according to the timetable set out in Table 1.

There are no indicative flood risk areas with in Cornwall identified under the national guidance, according to the definition described above. Cornwall Council does not propose any additions or changes to this. Only 10 such areas are identified within England; the only one in the South West being Bristol.

However, it is prudent to use a similar approach but with a lower threshold than 30,000 people at risk to identify Local Flood Risk Communities for the purposes of informing local flood risk strategies and commencing the production of these strategies. This analysis is reported in Annexes 6 and 7 and the results are summarised below. In identifying such communities, however, it is sensible to also consider areas where flood risks have already been identified rather than just relying on a surface water potential flood risk approach.

[6] i.e ≥201 people (≥85 residential properties), ≥21 non-residential properties or ≥2 critical services.

6.2 Identifying Local Flood Risk Communities

The analysis conducted and reported in Annex 6 is required as it provides a quantitative assessment using a similar approach to that taken by the EA in identifying Indicative Flood Risk Areas.

However, the analysis should not ignore areas with previously identified flood risk issues. Annex 7 lists a number of communities in Cornwall where Critical Drainage Areas (CDA) have been defined, Community Flood Plans (CFP) are proposed, a need for Surface Water Management Plans (SWMP) is recognised and Level 2 Strategic Flood Risk Assessments (SFRA2) are required to aid planning and regeneration.

The grid-based and community-based assessments of surface water flood risk reported in Annex 6 have been incorporated with the other indicators listed in Annex 7 to provide a semi-quantitative assessment and prioritisation of potential flood risk areas.

This has identified 28 communities as listed in Table 16 below. These include all of those identified from the grid-based surface water risk analysis and the top 32 from the community-based surface water risk analysis described in Annex 6.

These Local Flood Risk Communities are broadly listed in priority order in Table 16, with the highest risk communities at the top of the table. It should be borne in mind, however, that the risk analysis element (derived from Annex 6) is based only on surface water risk. Local Flood Risk Strategies will require consideration of all sources of flood risk. A similar risk analysis, not reported within this PFRA, has also been applied to flooding from both fluvial and tidal sources in order to inform the Local Flood Risk Management Strategy.

Table 16 Proposed Priority Flood Risk Areas based on all considerations

Community	Surface water analysis		SFRA2 / CFRP required	CFP required	SWMP required	CDA
	Grid approach ranking	Community approach ranking				
Truro	Level 6	1	✓	✓	✓	✓
Bodmin	Level 3	2	✓	✓	✓	✓
Redruth	Level 5	3	✓	✓	✓	✓
St Austell	Level 2	4	✓	✓	✓	✓
Camborne & Pool	Level 1 / -	5 & 30	✓	✓	✓	✓
Penzance	Level 1	6	✓	✓	✓	✓
Liskeard	Level 6	7	✓	✓	×	✓
St Ives	-	8	✓	✓	✓	✓
Hayle	Level 7	9	✓	✓	✓	✓
Newquay	Level 7	10	✓	×	×	×
Bude	Level 4	18	✓	✓	×	✓
Par & St Blazey	Level 2	19 & 20	✓	✓	✓	✓
Helston	Level 8	14	✓	✓	✓	✓
Wadebridge	Level 8	11	✓	✓	✓	✓
Callington	-	12	✓	×	×	×
Launceston	-	13	✓	✓	×	✓
Penryn & Falmouth	Level 7 / -	15 & 23	✓	✓	✓	✓
Perranporth	-	16	✓	✓	×	×
Polperro	-	17	×	✓	×	×
Lostwithiel	-	21	✓	✓	×	✓
Looe (East & West)	-	22 & 25	✓	✓	×	×
Mevagissey	-	24	×	✓	✓	×
Camelford	-	26	✓	×	×	×
Portreath	-	27	×	✓	×	×
Porthleven	-	28	✓	×	✓	×
St Agnes	-	29	×	×	×	×
Padstow	-	32	✓	✓	✓	✓
Mousehole	-	31	×	×	✓	×

7 SCRUTINY AND REVIEW PROCEDURES

The scrutiny and review procedures that must be adopted when producing a PFRA are set out by the European Commission (EC). 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 three key steps, as discussed below.

7.1 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 and that the LLFA is satisfied that its products are fit for purpose in meeting the requirements of the regulations (EA 2010c).

The draft report was circulated to relevant officers within Cornwall Council in April 2011 for internal review.

Within Cornwall Council, the PFRA was taken for consideration by the Environment and Economy Overview and Scrutiny Committee on 4 May 2011. It was agreed that (a) the Cornwall Preliminary Flood Risk Assessment be noted and recommended for approval by the Cabinet Member for Waste Management, Climate Change and Historic Environment, in consultation with the Chairman and Vice-Chairman of the E&EOSC; and (b) a further report be submitted to E&EOSC in 6 months' time regarding any changes made by the EA to the Cornwall Preliminary Flood Risk Assessment together with an update on progress in respect of the Local Flood Risk Management Strategies.

7.2 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, which will focus on instances where Flood Risk Areas have been amended and ensure the format of these areas meets the provided standard. If satisfied, they will recommend submission to the relevant Regional Flood and Coastal Committees (RFCC) for endorsement. RFCCs will make effective use of their local expertise and ensure consistency at a regional scale. Once the RFCDC 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.

The first review cycle of the PFRA will be led by Cornwall Council and must be submitted to the Environment Agency by the 22 June 2017. They will then submit it to the European Commission by the 22 December 2017 using the same review procedure described above.

7.3 External Review

The draft PFRA was sent to members of the CFM-TWG, including the EA and SWW for review and comment, in April 2011. Jeremy Benn Associates Ltd were also commissioned to provide an independent review of the first draft of the PFRA. Comments received were incorporated in the final draft in May 2011.

8 NEXT STEPS

8.1 Local Strategy for Flood Risk Management

Having identified the highest priority flood risk areas within Cornwall, the next step is to use this information to deliver Cornwall's local flood risk strategy. This is a tool that should make a difference to the communities at risk of flooding and to direct resources to help to manage flood risks.

The PFRA process forms part of a continuous 6 year cycle for LLFAs under The Regulations. However, as Cornwall has no indicative flood risk areas within the present cycle, there is no immediate statutory requirement to produce flood hazard and risk maps or FRMPs. Cornwall Council will however, be required to review and prepare a revised PFRA report, to be completed before June 2017. This review process must then subsequently be carried out at intervals of no more than 6 years.

In the meantime the Council are required to produce a Local Flood Risk Strategy. This strategy should involve all 28 communities listed in Table 16. Initially, efforts may concentrate on the highest priority communities, but all identified Local Flood Risk Communities should be subject to further evaluation. The list in Table 16 should not be considered as exhaustive or prescriptive as other flood risk issues are liable to come to light.

It is envisaged that the local strategy should be achieved by further developing the Community Flood Risk Profiles (CFRP) for all communities listed in Table 16. These will identify the most important flood risk issues within each community and allow actions to be identified. The CFRPs provide the evidence base from which local strategies may be developed and result in definitive flood risk assessment documents. These strategies and plans will evolve as more information becomes available and will provide a good basis for further work that is likely to arise when the next PFRA cycle begins in 2017.

8.2 Reviewing and Updating Flood Data and Modelling

Cornwall Council's function as LLFA and the other new burdens listed in Section 2 mean that the Council will be taking a more proactive role in local flood risk management, including the collection and collation of flooding related information, flood defence asset management database and flood risk studies.

Numerical hydraulic models may have an important function, not just in predicting and assessing flood risks, but also in compiling and updating information that affects flood risks, such as river structures, flood defence assets, channel capacities, flood flow exccedance routes, etc.

Cornwall Council holds some model information, such as in the Camborne and Redruth areas. SWW holds a number of models, mainly related to foul sewer flows but increasingly for surface water sewer flows (for example the Truro integrated urban drainage project). The EA hold, or are developing, a number of models for fluvial and surface water flows, such as for Truro, St Austell, Penzance, Perranporth and Helston. It is envisaged that partnership working with Cornwall Council, the EA and SWW will see modelling becoming a more shared resource for integrated flood risk management and a tool for developing local flood risk management strategies.

8.3 Post Flood Event Data Collection

As set out within The Act the implementation of the duty of LLFAs to investigate following flood events will lead to a database similar to FRIS, along with actions agreed in response to the investigation. There is a need to ensure that this is done in partnership with the other

RMAs in Cornwall – EA and SWW and to ensure that effort is not duplicated but that results are fully shared.

More formal arrangements will be agreed within the Council over the recording and follow up of flood incidents. These protocols are currently being developed.

8.4 Maintaining an Asset Register

Also set out within the Act is a duty to maintain an asset register for recording information on all features that can affect flooding.

At the time of writing a great deal of debate is underway amongst LLFAs over the level of detail required under this duty and advice from Defra is emerging concurrently with the PFRA process.

Initially, the asset register will focus on high priority areas, as identified in Table 16. Starting points for this asset register are the EA's National Flood and Coastal Defence Database (NFCDD), records of Highways Section 38 adopted SuDS features and the existing Highways Asset Management System.

The Council is keen to liaise with the EA during the development of the EA's Creating Asset Management Capacity (CAMC) system, expected to be available in summer 2012, in order to ensure consistency of information and avoid duplication of efforts.

8.5 Development and Planning

Surface water runoff from hard surfaced areas increases peak flow and therefore the incorporation of SuDS in a development should ensure impact is minimised to greenfield runoff rates. This needs consideration early in the planning process to ensure that the SuDS principles can be applied on development sites without contributing to problems in the surrounding areas. Therefore planning applications should clearly include these drainage strategies.

With the emerging responsibility as a LLFA under The Act, Cornwall Council will be required to create a SuDS Approval Body (SAB). It not envisaged that this part of the Act will be fully implemented until April 2012 or later, though a number of opportunities for the Council to become involved in SuDS approval and adoption are already coming forward.

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

Please refer to Annex 1 of the Preliminary Assessment Report Spreadsheet attached to this report, detailing the past significant flood events identified for Cornwall Council, also discussed in Chapter 4.2.

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

Please refer to Annex 2 of the Preliminary Assessment Report Spreadsheet attached to this report. This includes a complete record of future flood risk within Cornwall, including details of the potential consequences of flooding to key risk receptors within the county listed for a range of predictive tidal and fluvial, surface water, and groundwater models. The details of this are discussed in Chapter 5.

Annex 3: Records of Flood Risk Areas and their rationale (Preliminary Assessment Report Spreadsheet)

Please refer to Annex 3 of the Preliminary Assessment Report Spreadsheet attached to this report. However there have been no Indicative Flood Risk Areas identified for Cornwall Council and therefore none have been recorded in this section.

Annex 4: Preliminary Flood Risk Assessment Checklist

Please refer to Annex 4, attached to this report, which contains the Preliminary Flood Risk Assessment Checklist that has been provided by the Environment Agency to act as a checklist for reviewing PFRA submissions.

Annex 5: Chronology of Major Flood Events in Cornwall

Please refer to Annex 5, attached to this report, which provides a compilation of past flood events and episodes that have happened in Cornwall.

Annex 6: Analysis of Surface Water Flood Risk

Please refer to Annex 6, attached to this report, which details the analysis of surface water flood risk used to identify any Indicative or Proposed Flood Risk Areas and assesses the risks to local communities associated with surface water flooding.

Annex 7: Prioritisation of communities for assessment within the Local Flood Risk Management Strategy

Please refer to Annex 7, attached to this report, which assesses communities in Cornwall that require inclusion within the Local Flood Risk Management Strategy.