herrington CONSULTING LIMITED

In partnership with:

Canterbury City Council Engineering Services

Strategic Flood Risk Assessment

Canterbury City Council

August 2011

(Final Report)

Canterbury City Council
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CANTERBURY CITY COUNCIL

Environment Agency

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Strategic Flood Risk Assessment
Canterbury City Council

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Executive Summary

Canterbury is an historic city with a national and global reputation that far outweighs its size in both geography and population. The wider Canterbury District also boasts assets of great potential, including the coastal towns of Whitstable and Herne Bay, numerous villages that are often of outstanding historical quality, and a varied beautiful countryside. The District is located in the centre of the East Kent sub-region sharing boundaries with five other local authority areas and covers an area of 310 square kilometres. Parts of the District are low-lying with approximately 15%, including the town centres of the three main urban areas, lying within the Environment Agency's Zone 3a flood risk area.

Flooding can result not only in costly damage to property, but can also pose a risk to life and livelihood. It is essential therefore that future development is planned carefully, where possible away from areas that are most at risk from flooding, and ensuring that it does not exacerbate flooding elsewhere.

Herrington Consulting in partnership with Canterbury City Council Engineering Services have been commissioned by Canterbury City Council (CCC) in conjunction with the Environment Agency to prepare a Strategic Flood Risk Assessment (SFRA) for the District. This study provides an analysis of the main sources of flood risk to the District, together with a detailed means of appraising development allocations and existing planning policies against the risks posed by flooding over this coming century.

Planning Policy Statement 25: Development and Flood Risk (PPS25) published by the Department for Communities and Local Government in December 2006, requires Local Planning Authorities to apply a risk-based approach to the preparation of their development plans in respect of potential flooding. In simple terms, PPS25 requires local planning authorities to review the variation in flood risk across their District, and to steer vulnerable development (e.g. housing) towards areas of lowest risk. Where development is to be permitted in areas that may be subject to some degree of flood risk, PPS25 requires the Council to demonstrate that there are sustainable mitigation solutions available that will ensure that the risk to property and life is minimised (throughout the lifetime of the development) should flooding occur.

The SFRA is the first step in this process and provides the building blocks upon which the Council's forward planning and development control decisions are made. One of the most pressing issues for Canterbury City Council is the fact that a large percentage of brownfield sites that have the potential for redevelopment lie within Zone 3.

The primary objective of PPS25 is to steer vulnerable development towards areas of lowest flood risk. The Sequential Test provides clear guidance as to how this should be achieved. In simple terms, the Sequential Test requires that the District is delineated into areas of 'low', 'medium' and 'high' risk, i.e. Zones 1, 2 and 3. It then provides a list of suitable types of land use that should be permitted within each zone, depending upon the perceived vulnerability of the community that will be present day to day within that development.

However, all the coastal settlements within the District, lying within Zone 3, benefit from the protection provided by high quality flood defence infrastructure. Inland, Canterbury also benefits from various river defences and upstream flood storage. Before the completion of the SFRA the degree of risk across these areas was generally un-quantified and therefore it was not possible for the Council to implement the primary objectives of PPS25.

The key objectives of the SFRA are therefore to meet the following key requirements:

- To collate all known sources of flooding, including tidal, river, surface water (local drainage), sewers and groundwater, that may affect existing and/or future development within the District;
- To examine the impact of an extreme flooding event that exceeds the standard of protection provided by the existing coastal flood defences;
- To quantify the depth, velocity and other key parameters of flood events that result from the overtopping or failure of the existing defences;
- To map the outputs of this analysis in such a way so as to provide clear and precise information at a scale that is appropriate to inform the planning process at both a strategic and site-based level;

Graveney, Seasalter, Reculver and the Lower Stour area comprise the majority of the low-lying area of the District and are primarily devoted to agricultural use and large parts of these areas are protected for nature conservation purposes. However, there are still parts of a number of established towns and villages that are in the flood plain. The future sustainability of these communities relies heavily upon their ability to grow, prosper and where necessary redevelop. For this reason, PPS25 acknowledges that in some cases it is not possible to locate all new development outside of the flood risk area.

In this situation, where the local planning authority has identified that there is a strong planning based argument for a development to proceed, it will be necessary for the Council to demonstrate that the Exception Test can be satisfied.

The Exception Test requires that:

a) it can be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk.

b) the development is on developable (defined by PPS3 as a site that is in a suitable location for housing) or previously developed land (commonly known as brownfield land).

c) that a site-specific Flood Risk Assessment demonstrates that the development will be safe, without increasing flood risk elsewhere, and where possible, will reduce flood risk overall.

Effective development control policy is essential to assist the Council to manage flood risk, and to ensure a consistent approach at the planning application stage. This is essential to achieve future sustainability within the District with respect to flood risk management. To facilitate this, the SFRA provides detailed information on flood risk throughout the District.

In parallel with development control, emergency planning is imperative to minimise the risk to life posed by flooding within the District. The Council is therefore currently fully reviewing its adopted flood risk response plan in parallel with and taking account of the findings of the SFRA.

Furthermore, the SFRA has been developed building heavily upon existing knowledge with respect to flood risk within the District. The Environment Agency regularly reviews and updates its flood maps and a rolling programme of detailed flood risk mapping within the South East region is currently underway. In addition, much of the major flood defence infrastructure within the District has been upgraded and improved over the last twenty years, with plans for expenditure on further improvements in the near future.

These new defences and additional information will reduce risk and improve the current knowledge of flood risk within the District. Consequently this may influence future development control decisions and therefore the information within the SFRA will require updating.

In summary, it is imperative that the SFRA is adopted as a 'living' document and is reviewed regularly in light of emerging policy directives and an improving understanding of flood risk within the District.

1 Introduction

1.1 Overview

Herrington Consulting in partnership with Canterbury City Council Engineering Services have been commissioned by Canterbury City Council (CCC) in conjunction with the Environment Agency to prepare a Strategic Flood Risk Assessment (SFRA) for the District.

Planning Policy Statement 25: Development and Flood Risk (PPS25) published by the Department for Communities and Local Government (DCLG) in December 2006 requires Local Planning Authorities (LPAs) to apply a risk-based approach to the preparation of their development plans in respect of potential flooding. This District-wide appraisal of flood risk is to be delivered through the SFRA, the key requirements of which are described in paragraph D4 and Annex E of PPS25. Further guidance is contained in the Development and Flood Risk Practice Guide (June 2008).

1.2 Key SFRA Objectives

The key objectives of the SFRA are to:

- provide sufficient data and information to enable the Council to apply the Sequential Test to land use allocations and to identify whether the application of the Exception Test is likely to be necessary;
- provide a basis on which the Council can prepare appropriate policies for the management of flood risk within the Local Development Documents and to assist testing of site proposals;
- inform the sustainability appraisal so that flood risk is taken into account when considering strategic land use policies;
- give guidance on the level of detail required for site-specific Flood Risk Assessments (FRAs) in particular locations;
- enable the Council to determine the acceptability of flood risk in relation to its emergency planning capability.

1.3 SFRA Format

Under PPS25 there is a requirement that, where the Local Plan has been unable to allocate all proposed development in low flood risk areas, the scope of the SFRA shall be increased in order to provide fuller information in the application of the Sequential and Exception Tests. This Level 2 SFRA is a more detailed study of the individual major flood risk areas where development may be proposed under the Local Plan. To achieve the Council's housing targets in accordance with central government requirements and the target that all development is constructed on previously developed land, it is confirmed that development is required in areas of medium to high flood risk.

A number of more detailed studies have already been carried out to inform the Level 2 SFRA at urban centres where there is a flood risk and development has been proposed in the Local Plan. 2D hydraulic modelling has been carried out for the sea flood risk at Seasalter, Whitstable, Herne Bay, Swalecliffe, Hampton and Reculver and also for the fluvial flood risk from the River Stour through Canterbury. The information and outputs from these various models and studies has been used in this SFRA to provide the quantitative and thorough flood risk data required, which will enable the Council to apply a risk based approach to the preparation of its development plans backed up by very comprehensive information.

Therefore the structure of this SFRA is a combined report comprising both the Level 1 and Level 2 requirements in a single document.

It is important to recognise that the SFRA is a 'living' document. Consequently, as new information becomes available, updates will need to be made to the SFRA and its associated flood maps. This is especially important at a time where the Environment Agency's flood and coastal erosion risk management strategy is recommending significant expenditure on flood defence infrastructure in the District over the next 20 years.

This document has therefore been prepared in the knowledge that improvement works are planned to major sea defences in the District within the short term. Consequently, account has been taken of these improvement works to ensure that the best and most contemporary information is used to guide the site selection and appraisal process for future developments.

1.4 Impacts of New Climate Change and Revised Storm Surge Levels

Since the completion of the modelling stage of this SFRA, revised climate change predictions known as UKCP09 have been issued. This data suggests lower rates of predicted sea level rise than in the previous 2002 project on which Table B1 of PPS25 is based (Defra 2006). However, as at May 2011, both PPS25 and the most recent update of the PPS25 Practice Guide (paras 3.96 – 3.99) indicate that it is still appropriate to use the Table B1 figures. The flood depths and other outcomes from the modelling for this SFRA have therefore not been changed in response to the latest UKCP09 predictions on climate change. They are based on Table B1 of PPS25, which has not been amended, and this is in line with the general precautionary approach adopted in the SFRA.

Also, since completion of the modelling stage of this SFRA, the Environment Agency has issued revised extreme sea levels for the UK coastline (Coastal flood boundary conditions for UK mainland and islands Project: SC060064/TR2: Design sea levels). These open sea levels are slightly lower than those currently adopted Canterbury City Council for use in the SFRA and its associated modelling.

The 200 year (plus climate change) extreme open sea level at Whitstable used throughout this SFRA is 5.80m AOD. Using the revised figures, this same extreme level would be 5.62m AOD. Given that the extreme sea level is one of the principle boundary conditions used in the breach and wave overtopping modelling, it is evident that this reduced value will affect the outcome of the model.

In order to quantify the magnitude of change, sensitivity testing has been carried out. However, when the change in extreme sea level is contrasted against other potential variables such as the level and condition of the beach, as well and wave overtopping rates, it is not shown to have a significant impact on the final outputs of the model. Whist using the revised extreme sea levels will result in a small reduction in the predicted flood level, this change is less than the variability in flood depths experienced when testing other variables such as beach level and wave overtopping rates.

Therefore taking account of the precautionary approach promoted by PPS25, the use of the predicted flood levels that are based on extreme sea level values currently adopted by the Council are considered to remain appropriate for the use in informing development in the coastal flood risk areas within the District.

2 The Study Area

2.1 Overview of the District

Canterbury is an historic city with a national and global reputation that outweighs its size both in geography and population. The wider Canterbury District also boasts assets of great potential, including the coastal towns of Whitstable and Herne Bay, numerous villages that are often of outstanding historic quality, and a varied and beautiful countryside. The District is located in the East Kent sub-region, sharing boundaries with five other local authorities: Ashford, Swale, Shepway, Dover and Thanet. Canterbury sits at the centre of this sub-region and covers an area of 31,000 hectares (310 square kilometres) with a population of 149,000. About 15% of the District is low-lying with approximately 46 square kilometres lying within the Environment Agency's Zone 3a flood risk area.

The District has a coastal frontage that extends for 21 kilometres between its western boundary at Graveney Marshes through to the Northern Seawall east of Reculver. The land at both the western and eastern boundaries of the District is low lying but between these the coastline is undulating with clay or sandstone cliffs between the valleys at Whitstable, Swalecliffe, Hampton and Herne Bay. A total of 10.1 km of the District's coast is low lying – all of which is defended by a seawall with a shingle beach in front. The River Stour virtually bisects the District and runs through the centre of the city of Canterbury. Other important watercourses are the coastal brooks – Sarre Penn, North Stream, River Wantsum, Gorrell Stream, Swalelcliffe Brook, Westbrook and Plenty Brook – and the Nailbourne/Little Stour chalk stream.

Canterbury has been identified in the South East Plan as a Regional Hub. This reflects its role as a Primary Regional Centre with a significant retail focus and an existing role as a population and service centre, as well as a focal point for higher and further education facilities. Herne Bay is a traditional Victorian seaside resort that has suffered some economic decline of its town centre and is currently the subject of significant regeneration efforts. Whitstable is an attractive coastal town with a lively independent retail sector and strong arts culture. The desirability of the town has led to significant numbers of second home owners. The rural area of the District contains a great diversity of settlements in terms of character, size and facilities. Figure 2.1 shows the geographical extents of the District along with the main towns and villages.

The high quality landscape in the District is a distinctive and variable feature of the area. This diverse landscape gives rise to a wide range of wildlife habitats and there are four internationally designated nature conservation sites as well as fifteen national sites and numerous local nature reserves. Much of the area of flood risk in the District, from both river and coastal flooding, coincides with the location of designated wildlife habitats where no development is proposed. These designated habitats include 'The Swale' (a complex of brackish and freshwater, with floodplain grazing marsh, saltmarshes and mud-flats), 'Thanet Coast and Sandwich Bay' (including tidal river, estuaries and mud flats) and 'Stodmarsh' (including inland water bodies, marshes and fens). These are all areas where inundation or saturation by surface or ground water (be that at different frequencies and duration) is essential to their quality and survival and must be protected at appropriate levels. However, the area of flood risk also affects large parts of the villages and urban areas due to the historical attraction of population to rivers and coastal areas. There was significant widespread inland flooding in 2000/2001. As a result of climate change, rising sea levels and increasing frequency of extreme weather patterns, flood risk will become an increasingly important issue for the District.

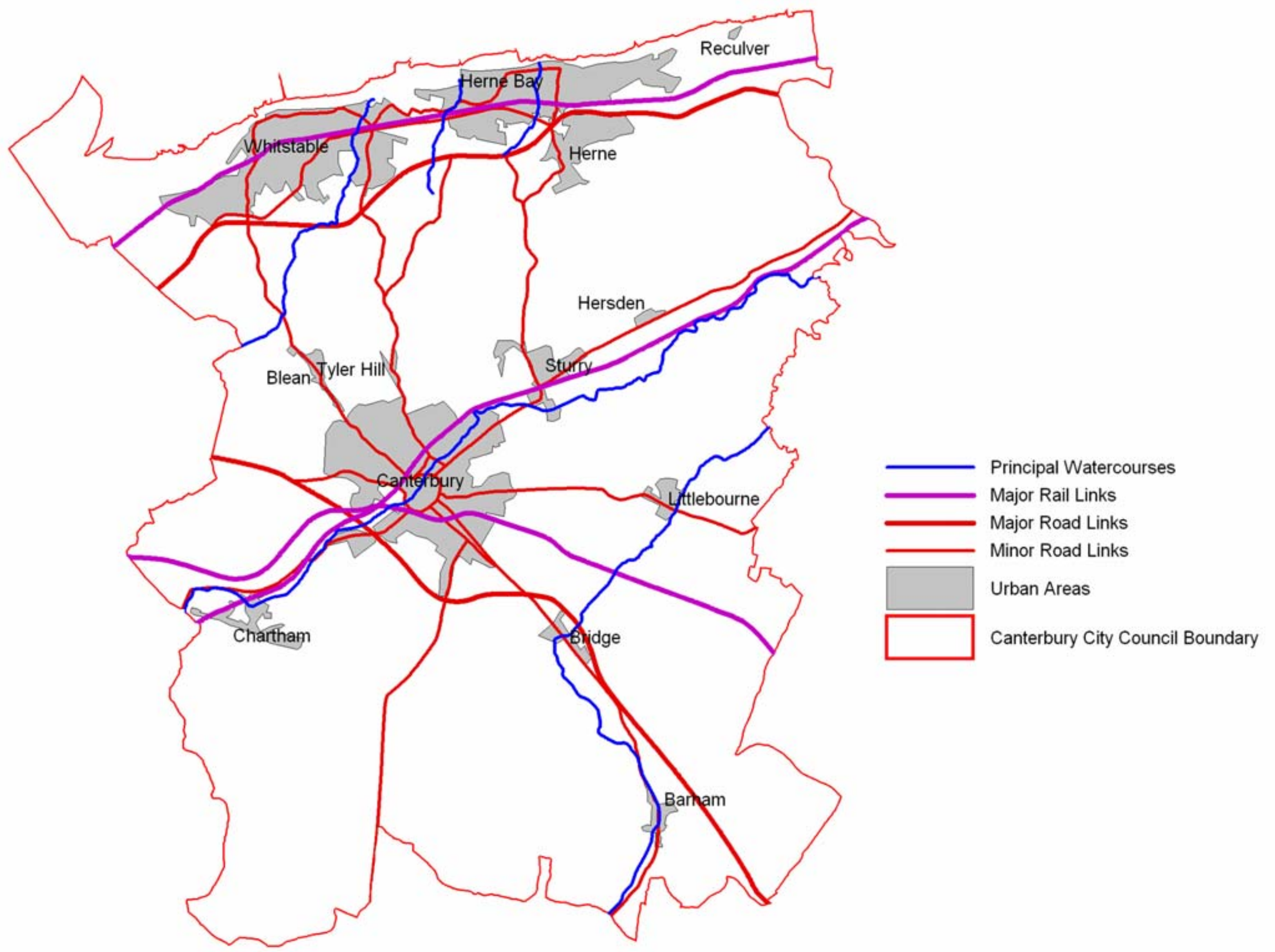

Figure 2.1 - Location plan showing the Canterbury District Boundary and the SFRA study area

2.2 Hydrogeology

The River Stour is the main hydrological feature running west to east through the District. There are no significant tributaries joining the Stour within the District although the Nailbourne does flow into the Stour, via the Little Stour, to the east of the District boundary. Flow into the Stour from north and south is via smaller streams and via groundwater base flow. To the east the Stour valley widens to form the low lying marshy land of the Westbere, Chislet and Stodmarsh Marshes.

The chalk south of Canterbury forms a principle bedrock aquifer. Streams run northwards from this area towards the River Stour. Many of the valleys in the chalk are dry valleys whilst some have ephemeral streams that flow intermittently. There are several water extraction points along the Stour and within the chalk aquifer. A secondary aquifer is formed by the Thanet Sand Formation to the east and north east of Canterbury.

To the north of Canterbury, London Clay dominates. This stiff clay leads to low permeability with runoff flowing across the land surface through a network of ditches and streams to several more major watercourses running south to north and discharging to the North Sea.

2.3 Geology and Hydrogeology

In terms of the strategic appraisal of flood risk, it is important to understand the geology and hydrogeology of the District. This provides a background both for an evaluation of the potential for groundwater flooding and for an understanding of the role of infiltration drainage, either as part of sustainable drainage system, or within the overall natural water cycle.

The bedrock across the District is broadly split into three elements. To the south of Canterbury the geology is dominated by chalk which forms the high ground of the North Downs.

The central and eastern part of the District is formed by the Thanet Sand Formation characterised by pale yellow-brown, fine-grained sand that can be clayey and glauconitic and consisting of the Oldhaven, Blackheath, Woolwich and Reading and Thanet Beds. The Thanet Sand Formation lies unconformably on the Chalk.

To the north and west between Canterbury and Whitstable and Herne Bay the bedrock geology is London Clay, part of the Thames Group. The London Clay lies unconformably on the Woolwich and Reading Beds.

The majority of the District has no recorded drift deposits. This includes large areas to the south of the District over the higher chalk bedrock and large areas to the north over the London Clay. Where there are drift deposits, these are concentrated in the valleys and lower lying areas of the District.

Within the chalk valleys superficial geology consists of clay with flints. This is a residual deposit formed by the reworking of the chalk and is typically orange brown sandy clay with nodules and pebbles of flint. Along the Stour and lower Nailbourne valleys, plus to the north east and north west of the District are superficial deposits of alluvium, characterised by soft to firm consolidated, compressible silty clay, that can contain layers of silt, sand, peat and basal gravel.

To the centre and in areas of the northern part of the District are deposits of Brickearth, which varies from silt to clay and is usually yellow-brown and massive.

To the east of Canterbury are river terrace deposits of sand and gravel. Further sand and gravel deposits are found in isolated areas east of Herne. Finally along the northern coastline between Herne Bay and Reculver is an area of landslip deposits.

Figures 2.2 and 2.3 below show a simplification of the solid and drift geology of the Canterbury District.

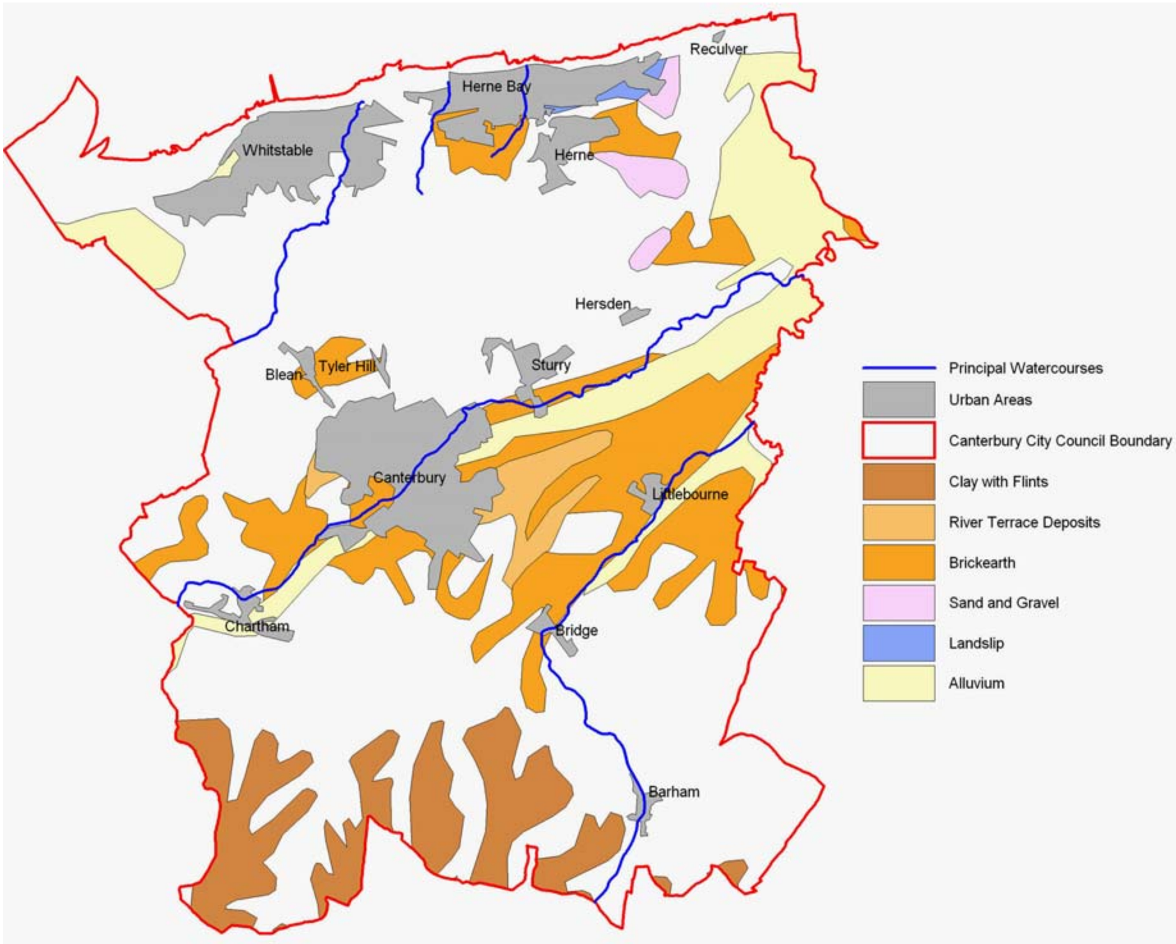

Figure 2.2 - Drift geology of the Canterbury District

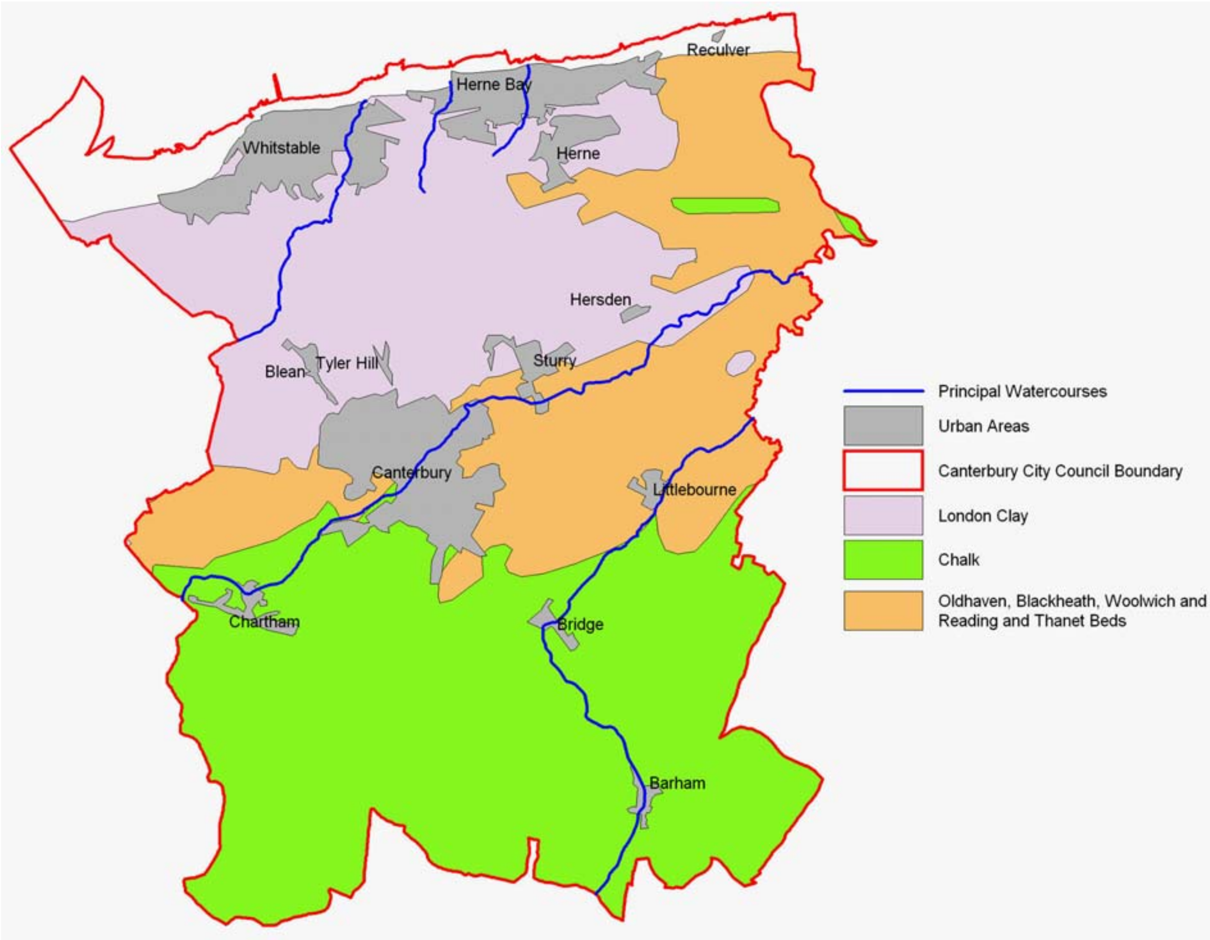

Figure 2.3 - Solid geology of the Canterbury District

2.4 Soils

Soil type provides a generic description of the drainage characteristics of soils. This will dictate, for example, the susceptibility of soils to water logging or the capacity of a soil to freely drain to allow infiltration to groundwater. Generally, soil types can only be fully determined after suitable ground investigations, however, it is possible to use the mapped soil types (Soil Association) within the study area as an indicator of permeability and infiltration potential. The soil characteristic map in Figure 2.4 has been based on the soil types within the Canterbury District as mapped by the National Soil Resources Institute.

The soil types within the Canterbury District closely follow the bedrock and superficial geology. To the south of the District there are shallow lime-rich soils over the higher chalk areas. In the dry valleys where superficial deposits have been deposited the soils are clayey with impeded drainage. The soils across the central section are generally freely draining whilst to the north, overlying the London Clay the soils are seasonally wet or have naturally high groundwater levels.

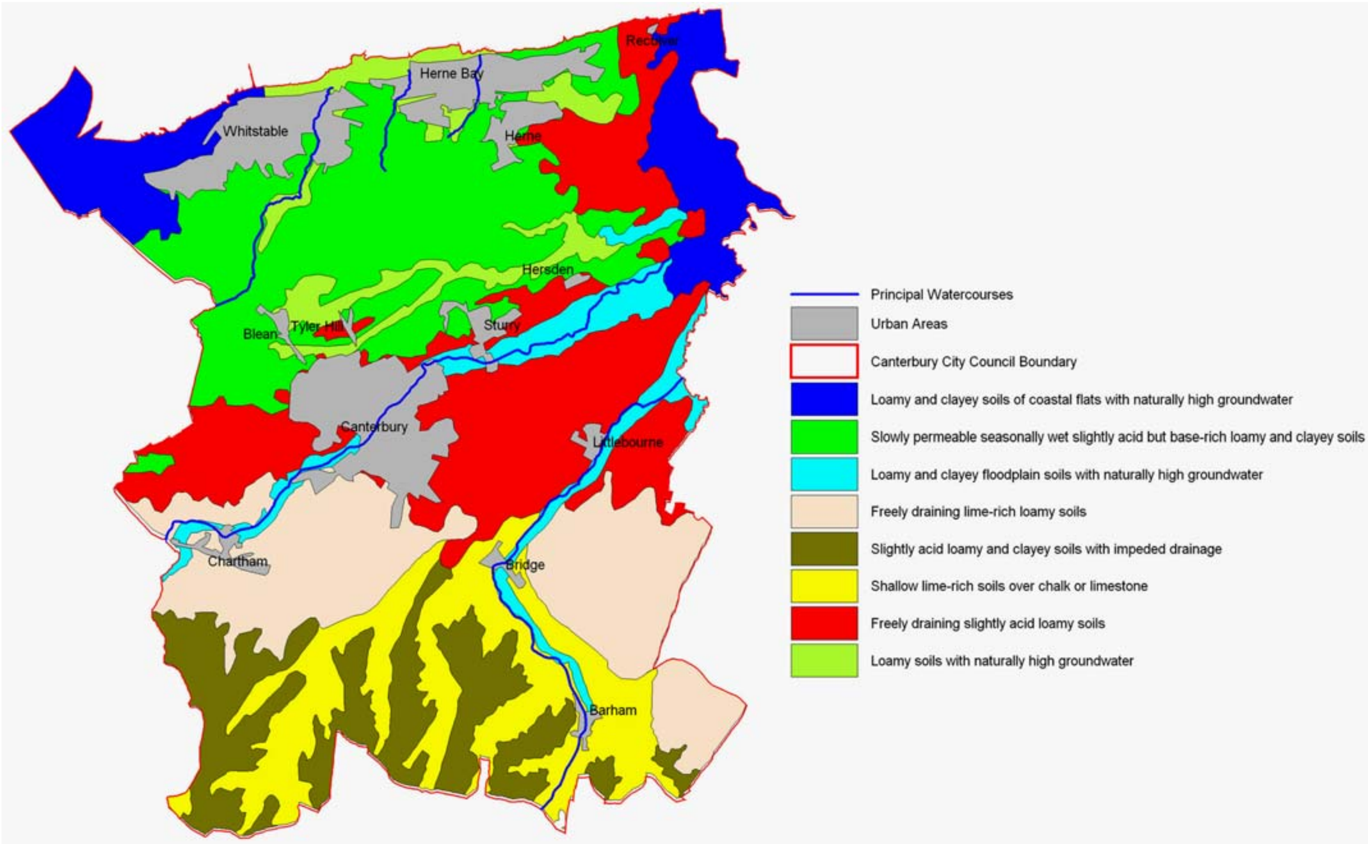

Figure 2.4 - Map showing the range of soil characteristics across the Canterbury District

2.5 Topography

Canterbury's topography varies significantly across the District with areas along the north Kent coast being below mean high water level and the North Downs to the south of the District rising to 155m Above Ordnance Datum (AOD). The topography south of Canterbury is characterised by chalk downland falling fairly steeply from 155mAOD in the south to between 30-40mAOD around Canterbury, Littlebourne and Chartham. This area is bisected by several dry valleys or in the case of the Nailbourne valley an ephemeral stream that runs intermittently. Groundwater flow through the chalk is the predominant mechanism by which water flows in this area and it is characterised by springs and intermittently running streams.

A further area of high ground lies to the north of the Stour valley with levels reaching 75-85mAOD around Blean and Tyler Hill. This ridge of high ground forms a watershed with several streams running north towards Whitstable and Herne Bay. To the south flow is towards the River Stour but via small streams and groundwater flow.

The north west and north east of the District is characterised by very low lying marshland at Seasalter and Chislet Marshes respectively. Land here is lower than 5mAOD and defended from inundation by sea defences along the coast. Between these two low lying areas the topography along the coastline varies with sand cliffs to the east and clay slopes interspersed with low lying areas in Herne Bay, Swalecliffe and Whitstable. The low lying areas are below 5mAOD whilst the slopes and cliffs rise to 20-35mAOD.

As well as the importance of the elevation of the land above sea level, topography is also important in assessing the risk of flooding from other sources such as overland flow and groundwater flooding. This data, in combination with the geology and soils maps can be used to gain an understanding of the potential for these mechanisms of flooding and is also useful in the determination of the appropriateness of Sustainable Urban Drainage Systems (SuDS).

Height data from the Ordnance Survey Landform Panorama digital terrain model has been used to create Figure 2.5 below, which illustrates graphically the topographic variation across the study area. For the more detailed breach modelling and flood mapping work, which forms the basis of the flood risk and hazard analysis used in this SFRA, much higher resolution land level data derived by use of LiDAR (Light Detection and Ranging) has been used and is discussed further in Section 9 of this report.

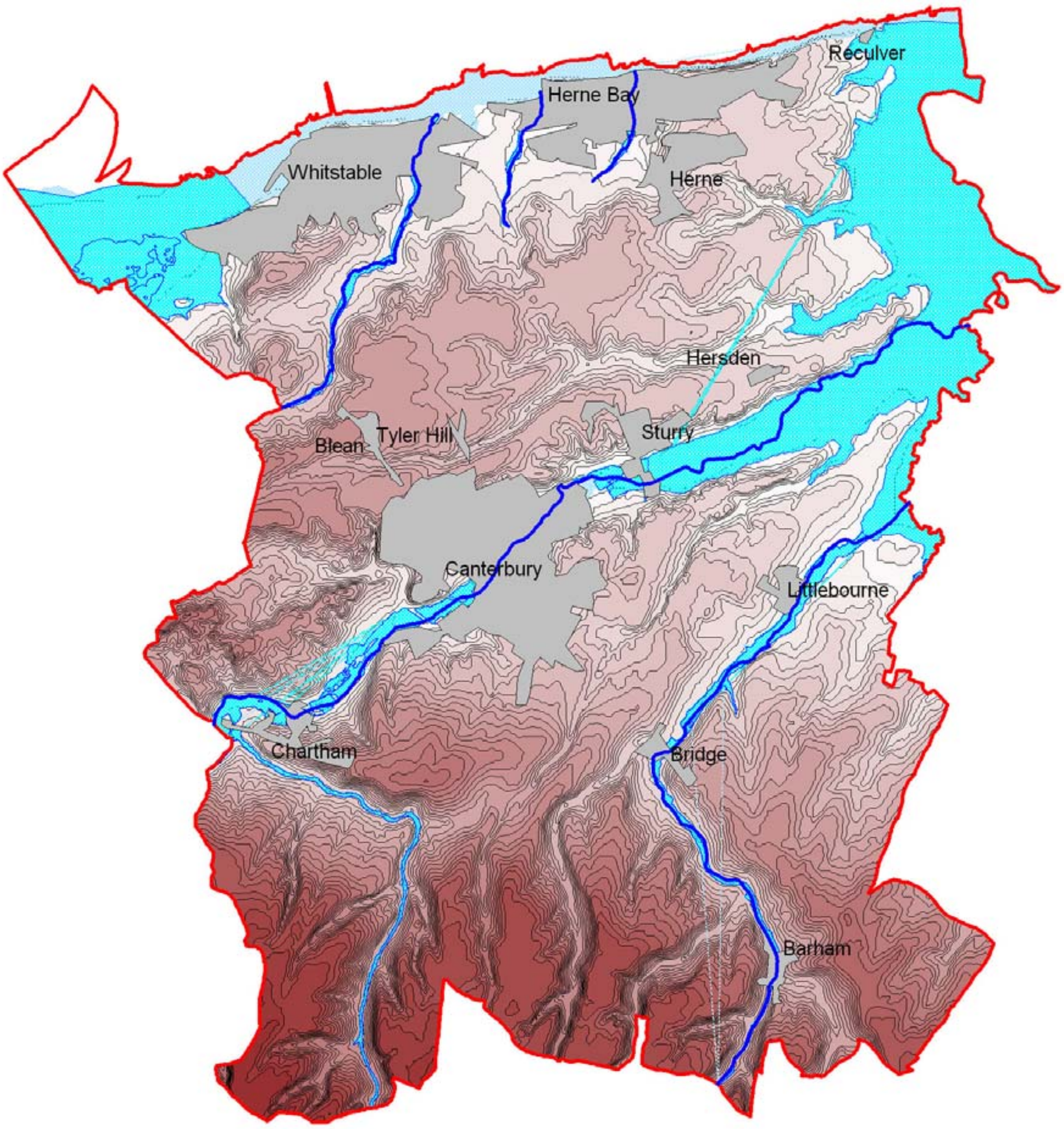

Figure 2.5 - Topography of the Canterbury District

3 SFRA Approach and Methodology

3.1 Overall Approach

The SFRA is at the core of the PPS25 approach. It provides the essential information on flood risk, taking climate change into account, thereby allowing the LPA to understand risk across its District so that the Sequential Test can be properly applied. The need for LPAs to consider flood risk when preparing Local Development Documents (LDD) and to produce SFRAs is highlighted in paragraphs 12 and 25 of PPS25. PPS25 paragraphs E5-E7 give some preliminary guidance and this is developed below.

The Practice Guide to PPS25 promotes a two stage approach to undertaking a SFRA. The first stage (Level 1) involves discussing the scope of the SFRA with key stakeholders, in particular the Environment Agency, Internal Drainage Boards (IDBs) and sewerage undertakers. This scoping stage is recommended so that an understanding of the strategic flood risk issues that need to be assessed can be gained.

Where the Level 1 SFRA demonstrates that land in Flood Zone 1 (taking climate change into account) cannot accommodate the necessary development, then the Exception Test needs to be applied. This will involve a more detailed Level 2 SFRA that includes further data collection and analysis.

However, the town centres of the three main urban areas of the District - Canterbury, Whitstable and Herne Bay – where the majority of the District's population live and work, lie fully or partially within Flood Zone 3. Also close to 50% of all the Local Plan development housing units to be allocated are within Flood Zones 2 or 3. The Council had considered these issues in detail before commencing the SFRA and had therefore already commissioned Level 2 type studies to gain a better knowledge of flood risk and its consequences at the three town centres. As a result of the findings of these initial Level 2 type studies, the Council engaged with the Environment Agency to discuss the scope of the SFRA study and any detailed analysis requirements. As a consequence of these discussions, it was clear that the Level 2 information already held should be included and form an essential part of the SFRA document.

3.2 SFRA Aims

As well as achieving the objectives set out in Section 1, at the project inception stage an overarching aspiration of the SFRA was identified. This was for the study to provide the end user of the SFRA with as much quantitative risk-based information as possible. This will not only assist the Council in preparing its development plans and undertaking the Sequential Test, but will also allow other users to gain an understanding of the complex and wide-ranging flooding issues that exist within the District.

3.3 SFRA Outputs

The aim of the SFRA is to provide sufficient data and information to enable the LPA to apply the Sequential Test to land use allocations and, where necessary, the Exception Test. PPS25 also indicates that Sustainability Appraisals should be informed by the SFRA for their area. Under the Town and Country Planning (Local Development - England) Regulations 2004, a Sustainability Appraisal (SA) is required for all Local Development Frameworks (LDF). The purpose is to promote sustainable development through better integration of sustainability considerations in the preparation and adoption of plans. The Regulations stipulate that SAs for LDFs should meet the requirements of the Strategic Environmental Assessment (SEA) Directive.

A SFRA is used as a tool by a LPA for the production of development briefs, setting constraints, identifying locations of emergency planning measures and requirements for site-specific FRAs. It is important to reiterate that PPS25 is not applied in isolation as part of the planning process. The formulation of Council policy and the allocation of land for future development must also meet the requirements of other planning policy.

Clearly a careful balance must be sought in these instances, and the SFRA aims to assist in this process through the provision of a clear and robust evidence base, upon which informed decisions can be made.

3.4 The Sequential Test

LPAs are encouraged to take a risk-based approach to proposals for development in or affecting flood risk areas through the application of the Sequential Test. The objectives of this test are to steer new development away from high risk areas towards those at lower risk of flooding. However, in some areas where developable land is in short supply there can be an overriding need to build in areas that are at risk of flooding. In such circumstances, the application of the Sequential Test is used to ensure that the lower risk sites are developed before the higher risk ones.

PPS25 states that the Sequential Test should be applied at all stages of the planning process and that generally the starting point is the Environment Agency's flood zone maps. These maps and the associated information are intended for guidance, and do not provide details for individual properties. They do not take into account other considerations such as existing flood defences, alternative flooding mechanisms and detailed site based surveys. They do, however, provide high level information on the type and likelihood of flood risk in any particular area of the country. The flood zones are classified as follows:

> Zone 1 – Low probability of flooding – This zone is assessed as having less than a 1 in 1000 (0.1%) annual probability of river or sea flooding in any one year.
>
> Zone 2 – Medium probability of flooding – This zone comprises land assessed as having between a 1 in 100 (1%) and 1 in 1000 (0.1%) annual probability of river flooding or between 1 in 200 and 1 in 1000 annual probability of sea flooding in any one year.
>
> Zone 3a – High probability of flooding - This zone comprises land assessed as having a 1 in 100 (1%) or greater annual probability of river flooding or 1 in 200 (0.5%) or greater annual probability of sea flooding in any one year.

> Zone 3b – The Functional Floodplain – This zone comprises land where water has to flow or be stored in times of flood and can be defined as land which would flood during an event having an annual probability of 1 in 20 (5%) or greater. This zone can also represent areas that are designed to flood in an extreme event as part of a flood alleviation or flood storage scheme.

PPS25 states that only where there are no reasonably available sites in Flood Zones 1 or 2 should decision makers consider the suitability of Flood Zone 3, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required. PPS25 adds that the Exception Test is only appropriate where there are large areas in Flood Zones 2 & 3, where the Sequential Test cannot alone deliver acceptable sites, but where some continuing development is necessary for wider sustainable development reasons, taking into account the need to avoid social or economic blight – as is the case for the town centres within the Canterbury District.

The Canterbury District Local Plan (2006) applies the regional (RPG9-2001 and draft South East Plan-March 2006) and county (Kent & Medway Structure Plan-2006) theme of regeneration of the coastal towns at the local level. Paragraphs 3.27 and 3.28 of the Local Plan set out the Priority Area Economic Regeneration Strategy, which seeks to co-ordinate projects and policies to address economic regeneration. The Local Plan responds to this by identifying sites for employment and projects for enhancement within the towns. The Council's objectives for the city and the coastal towns is to sustain and enhance their vitality and viability by providing a focus for investment to enable urban renaissance; and to ensure a wide range and choice of homes, shops, businesses, services, leisure activities, tourism, cultural and heritage initiatives and other facilities to which people have easy access by a range of transport.

Paragraph 4.2 states that the key to urban renaissance is to improve the overall quality of life. This is underpinned by the quality of the physical environment, social well-being and economic and environmental improvements. Paragraph 4.11 sets out that a strong town centre provides an opportunity for a full range of uses and development to be implemented thereby ensuring vitality and viability. Policy TC1 seeks to grant permission for developments that add to the vitality and viability of the town centre.

The proposed development allocations in the adopted local plan, together with sites yet to be allocated in a review of the Local Plan, will help to regenerate the town centres and will deliver the objectives of policy EKA4 of the South East Plan. Together these sites will encourage a new economic impetus that will in turn help deliver a stronger local service function and a mix of employment uses. These previously developed sites are the most sustainable locations for town centre development/regeneration.

From the above it is shown that there are overriding sustainability reasons for development to be carried out in the town centres within Flood Zones 2 & 3. The Sequential Test has therefore been applied to the town centre areas and considered to be satisfied in accordance with the requirements of PPS25. Development in these town centres should be considered against the

Exception Test to determine whether development can proceed safely with the flood risk managed.

To date the Sequential Test has presented the Council with a significant challenge because, as discussed above, nearly half of the housing units allocated for development within the approved Local Plan lie within Zones 2 & 3a. Also there is a need for sustainability reasons to develop/redevelop parts of the three town centres - all within Zone 3a.

The Environment Agency has a statutory responsibility and must be consulted on all development applications located within Zones 2 and 3, including areas with critical drainage problems. For all of these cases the Agency will require the Council to demonstrate that there are no reasonable alternatives in lower flood risk categories available for development.

3.5 The Exception Test

If following the application of the Sequential Test it is not possible, consistent with wider sustainability objectives, for the development to be located in zones of lower probability of flooding, the Exception Test can be applied.

As part of this process it is, however, necessary to consider the type and nature of the development as not all situations require the test to be applied. Table D.2 in PPS25 defines the type and nature of different development classifications in the context of their flood risk vulnerability. This has been summarised in Table 3.1 below, which highlights the combinations of vulnerability and flood zone compatibility that require the Exception Test to be applied.

For the Exception Test to be passed there are three criteria that must be satisfied and these are listed below:

a) that it can be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk.

b) that the development is on developable (defined by PPS3 as a site that is in a suitable location for housing) or previously developed land (commonly known as brownfield land). This includes land and buildings that are vacant or derelict as well as land that is currently in use but which has potential for re-development.

c) that a FRA demonstrates that the development will be safe, without increasing flood risk elsewhere, and where possible, will reduce flood risk overall.

Flood Risk Vulnerability Classification	Zone 1	Zone 2	Zone 3a	Zone 3b
Essential infrastructure – Essential transport infrastructure, strategic utility infrastructure, including electricity generating power stations	✓	✓	e	e
High vulnerability – Emergency services, basement dwellings caravans and mobile homes intended for permanent residential use	✓	e	×	×
More vulnerable – Hospitals, residential care homes, buildings used for dwelling houses, halls of residence, pubs, hotels, non residential uses for health services, nurseries and education	✓	✓	e	×
Less vulnerable – Shops, offices, restaurants, general industry, agriculture, sewerage treatment plants	✓	✓	✓	×
Water compatible development – Flood control infrastructure, sewerage infrastructure, docks, marinas, ship building, water-based recreation etc.	✓	✓	✓	✓

Key :

✓ Development is appropriate
× Development should not be permitted
e Exception test required

Table 3.1 - Flood risk vulnerability and flood zone compatibility

4 Policy Framework

4.1 National Policy

Planning policy for the area is set out in the Canterbury District Local Plan 2006.

Positive planning has an important role in helping to deliver sustainable development and applying the Government's policy on flood risk management. It avoids, reduces and manages flood risk by taking full account in decisions on plans and applications of present and future flood risk, involving both the statistical probability of a flood occurring and the scale of its potential consequences, whether inland or on the coast. It also has a role in considering the wider implications for flood risk of development located outside flood risk areas.

PPS25 also promotes early consideration of flood risk in the formulation of Regional Spatial Strategies, Local Development Documents and proposals for development by regional planning bodies, LPAs, the Environment Agency, other stakeholders and developers. This process should identify opportunities for development of infrastructure that offers wider sustainability benefits. These include dual use i.e. flood storage and recreation and realising cost effective solutions for the reduction and management of flood risk.

4.2 Regional Policy

South East Plan

It is the Government's intention to abolish regional strategies and replace them with a National Planning Framework. However, as at July 2011 the South East Plan is still relevant and is summarised below for the Canterbury District.

The South East Plan was adopted in 2009 and provides a framework for the region for the next 20 years to 2026. It brings together policies for development with other policies and programmes that influence the nature of places and how they function, including those governing health, social issues, the economy, culture, skills and the environment.

The Plan sets out the direction and scale of change needed to sustain a high quality of life across the region. The Plan's core objectives are to balance continuing economic and housing growth with rising standards of environmental management and reduced levels of social exclusion and natural resource consumption. The Plan's vision for 2026 is for a healthier region, a more sustainable pattern of development and a dynamic and robust economy, the benefits of which are more widely shared. The Plan also highlights that the single most critical issue in the region is the inadequacy of infrastructure provision to keep pace with new development.

The delivery of the agreed housing allocations is essential to the achievement of the overall spatial strategy in the South East Plan. The South East Plan identifies the City of Canterbury as a Regional Hub. It states (Spatial Planning Principles) that new development should be focussed on these Regional Hubs and indicates that they should be a focus for new housing, new major retail and employment development, new investment in economic activity and other new infrastructure. The City of Canterbury is also identified as part of the strategic network of town centres (Policy TC1).

Policy H1 of the South East Plan sets out provisions for housing in each local authority and for Canterbury. This is 10,200 dwellings over the 20 year period of the Plan and equates to an average of 510 in each year. Approximately 6700 of these dwelling have been allocated or permitted (March 2010), leaving a remaining requirement of 4000 dwelling units.

Policy TSR7 identifies priority areas for tourism, including the south east "coastal strip" – seeking complementary approaches to the development and management of tourism so as to upgrade facilities, promote diversity, reduce seasonality and improve access, whilst retaining and enhancing the natural character of the area and having regard to issues of capacity and environmental sensitivity. This includes making use of the attraction of Canterbury to encourage longer stays through linked trips to surrounding areas.

The South East Plan also includes sub-regional strategies, which set out some of the key issues facing each of the sub-regions and indicates the scale and general location of development envisaged. The Canterbury District is located centrally within the East Kent and Ashford sub-region, which includes the Districts of Thanet, Dover, Canterbury and Shepway, and parts of Swale and Ashford. The sub-region therefore includes the Growth Area of Ashford, coastal towns and the former Kent coalfield.

East Kent Sub Regional Strategy

The East Kent Sub Regional Strategy (2009) seeks to provide a coordinated strategy for the Districts of East Kent. However, it is vital that the East Kent Core Strategies complement each other in terms of spatial strategy.

Despite the role of the area as the gateway to Europe, many of its former economic strengths (including seaside tourism, fishing and coal mining) have declined and as a result this sub-region now includes some of the least economically buoyant areas in the South East. The area does, however, have a great many strengths, including its position relative to Europe, its attractive coastline, important and extensive wildlife habitats, rich culture and heritage, the educational strength of Canterbury, beautiful landscapes and improving transport connections.

The South East Plan identifies that the key challenges faced by this sub-region are how to:

- concentrate development and successfully spread the benefits of Ashford's growth across the wider sub-region;
- ensure that each area makes a positive and distinctive contribution to the future success of the sub-region;
- promote further growth at Dover;
- develop Canterbury's role as an historic centre of learning and commerce with strong links between university research and business, and promote housing growth to provide balanced and sustainable mixed communities;

- regenerate other urban areas and coastal towns whilst respecting important environmental constraints;
- deliver a sufficient supply of housing to meet the needs of the future population and support its economic regeneration and growth;
- maximise the benefits of international and domestic links provided by Channel Tunnel Rail Link (CTRL);
- protect and enhance the environment, heritage and quality of life across the sub-region.

Policy EKA1 indicates that Canterbury should develop links between university research and business, and continue as a commercial and cultural centre of international historic importance. Policy EK4 supports the urban renaissance of coastal towns and indicates that Whitstable and Herne Bay should develop stronger local service functions and mixed employment uses of a scale and character suitable to their size. It supports the regeneration efforts in Herne Bay. The Herne Bay Area Action Plan was adopted in Spring 2010.

In addition to cross-cutting policies, the Plan also sets out policies for effective flood management, including the use of SuDS and other measures to reduce the risk of flooding.

Regional Flood Risk Appraisal (RFRA) for South East Plan

The South East Plan does not include a detailed assessment of flood risk; however, it does identify areas where locations of planned high levels of growth coincide with Zone 2 and 3 flood risk areas. The planned housing provision for Canterbury is below the threshold for it to be classified as having a high level of growth and is therefore not highlighted in this report. It states, however, that local SFRAs will give a '*greater indication of the local capacity to accommodate growth and also to ensure that development takes place in areas with the lowest flood risk*'.

Section 5 of the report summarises key findings and policy implications of the study, including the implications of climate change and surface water flood risk. Section 6.3 of the report makes recommendations for future SFRA Reports.

Isle of Grain to South Foreland Shoreline Management Plan (SMP)

Whilst the SMP is not a statutory planning document, it does set policy for the management of the shoreline over the next 100 years. Consequently, the SMP is an important document when appraising the risk of coastal flooding on a regional and local scale.

The Isle of Grain to South Foreland SMP Review has been completed and was approved by the Environment Agency's Regional Director in August 2010. The SMP was adopted by the Council on 7 February 2008. The SMP has been examined as part of the SFRA process and the relevant policies are listed in Table 4.1.

Location	Policy Unit Reference	SMP Policy		
		2008 to 2028	2028 to 2058	2058 to 2108
Faversham Creek to Seasalter (Blue Anchor) *Flood frontage*	4a07	Hold the line	Hold the line for Seasalter (Sportsman to Blue Anchor) Managed realignment for the rest of the policy unit	Managed realignment
Seasalter to Whitstable Town (Golf Course) *Erosion frontage*	4a08	Hold the line	Hold the line	Hold the line
Whitstable Town to Whitstable Harbour *Flood frontage*	4a09	Hold the line	Hold the line	Hold the line
Whitstable Harbour to Swalecliffe *Erosion frontage*	4a10	Hold the line	Hold the line	Hold the line
Swaleciffe to Herne Bay Breakwater *Flood & erosion frontage*	4a11	Hold the line	Hold the line	Hold the line
Herne Bay Breakwater to Reculver Country Park *Erosion frontage*	4a12	Hold the line	Hold the line	Hold the line
Reculver Country Park *Erosion frontage*	4a13	No Active Intervention	No Active Intervention	No Active Intervention
Reculver Towers to Minnis Bay *Flood & erosion frontage*	4a14	Hold the line	Hold the line for Reculver Towers Managed realignment for the majority of the rest of the policy unit	Hold the line for Reculver Towers Managed realignment for the majority of the rest of the policy unit

Table 4.1 – Summary of SMP policies for frontages within the Canterbury District

In the text of the SMP for both Whitstable and Herne Bay the importance of the current defences at those locations is highlighted in the policy statements which state to “maintain the existing defences to protect the significant assets, which are important to the region’s economy” and in the second epoch to “upgrade the defence structures, this will maintain the character of the frontage and protect the significant built assets from sea level rise”.

The SMP also contains an Action Plan, which sets out the recommended works and improvements to the coastal defences in order to meet the policy objectives. This Action Plan, which is summarised below for those frontages containing a flooding element, is important in that it gives a clear indication as to the future maintenance and improvement where necessary of sea defences that have an impact on the SFRA and should be taken into consideration when defining future flood risk.

For all the policy units between and including Whitstable and Herne Bay the Action Plan states to "*undertake engineering works and maintenance activities to hold the defence line, to maintain the sea wall and to maintain beach and groynes".* For the two frontages at Seasalter and Reculver, where managed realignment is proposed commencing in the second epoch, the Action Plan states to "*engage with affected parties to enable adaptation to the change in coastline"* but to "*continue maintenance to hold the defence line and maintain the sea wall"* prior to managed realignment.

Stour Catchment Flood Management Plan (CFMP)

A CFMP is a high-level strategic planning tool through which the Environment Agency seeks to work with other decision-makers within a river catchment to identify and agree policies for sustainable flood risk management. The primary objectives of the CFMP are to:

- Develop complementary policies for long-term (50-100 years) management of flood risk within the catchment that take into account the likely impacts of changes in climate, land use and land management.

- To undertake a strategic assessment of current and future flood risk from all sources within the catchment and quantify the risk in economic, social and environmental terms.

- Identify opportunities and constraints within the catchment for reducing flood risk through strategic changes and identify how these benefits could be delivered.

- Identify opportunities to maintain, restore or enhance the total stock of natural and historic assets from flooding.

- Identify the relative priorities for the catchment and assign responsibility to the Environment Agency and other operating authorities, local authorities, water companies and other key stakeholders for further investigations or actions to be taken to manage and reduce flood risk within the catchment.

The Stour CFMP, relevant to Canterbury District, was completed and published by the Environment Agency in March 2007. The CFMP has been examined as part of the SFRA process and the relevant policies and Action Plans are listed in Table 4.2.

Policy Unit	Preferred Policy	CFMP Outputs	
		Policy	**Action Plan Summary**
Middle Stour *Through to Shalmsford Street*	6	Take action to increase the frequency of flooding to bring benefits locally or elsewhere	High priority action to carry out Flood Risk Management (FRM) study to explore range of options and identify areas of floodplain for additional flood storage
Stour Canterbury *From Shalmsford Street through Canterbury and Fordwich*	5	Take further action to reduce flood risk (now and/or in the future)	High priority action to carry out FRM study to explore range of flood risk management options. High priority action to produce a System Asset Management Plan to determine how the assets can best be managed
Nailbourne & Little Stour *Nailbourne and Little Stour streams*	4	Take further action to sustain the current scale of flood risk into the future (responding to potential increases in flood risk)	Low priority action to carry out FRM study to explore range of flood risk management options including investigating sewer flooding and possible areas for additional flood storage
Lower Stour *From past Fordwich*	6	Take action to increase the frequency of flooding to bring benefits locally or elsewhere	Medium priority action to carry out FRM study to explore range of options and identify areas of floodplain for additional flood storage
Oyster Coast Brooks *Gorrell Stream, Swalecliffe Brook, Kite Farm Ditch, Westbrook & Plenty Brook coastal streams*	5	Take further action to reduce flood risk (now and/or in the future)	Low priority action to carry out FRM study to explore range of flood risk management options. High priority action to produce a System Asset Management Plan to determine how the assets can best be managed

Table 4.2 – Summary of CFMP policies and Action Plans for Canterbury District

It should be noted that for those policy units where the preferred policy is Policy 6, this means that it is the intention to increase flood risk at specific locations only and not across the whole policy unit.

4.3 District policy

Canterbury District Local Planning Policies

Canterbury City Council's planning policy is set out in the District Local Plan (2006) which was published in July 2006, together with the LDF and core strategy, Reculver Master Plan and Herne Bay Area Action Plan as described beow. The Local Plan was produced before PPS25, however it does recognise and support the principle that inappropriate development in areas at known risk from flooding and coastal erosion should be discouraged. It recognises that flood risk will have a strong influence on development within the District and indicates Flood Zones 2 and 3 on the proposals map.

Policy C32 sets out the Council's policy relating to development on 'previously developed' or 'not previously developed' land within Zones 2 and 3 and in the overtopping zone. Policy C31 sets out the requirements for Flood Risk Assessment and Drainage Impact Assessment to be submitted with planning applications. Where PPS25 supersedes Council policy on planning and flood risk, it is recognised that PSS25 will take precedent. Policies C35 and C36 set out the Council's policy regarding its coastal protection zone and with respect to the undeveloped coast. Although not relevant to flooding these are important policies to be taken into consideration for any development along the Council's coastline.

Canterbury District Local Development Framework

The Canterbury District Local Development Framework to date includes the Herne Bay Area Action Plan, and numerous Supplementary Planning Documents including the Reculver Masterplan. The preparation of the Core Strategy is currently (as at July 2011) underway. This may evolve into a more traditional Local Plan style document in the light of emerging Government policy in the Localism Bill and National Planning Policy Framework. Amongst other things, this document will seek to allocate appropriate locations for development, and this SFRA will assist with this process. The Herne Bay Area Action Plan, designed to focus the delivery of regeneration initiatives in the town, was adopted in April 2010 and recommends that developments within the town centre should be allowed to proceed, subject to individual site Flood Risk Assessments being produced at planning consent stage that fully incorporate the conclusions and recommendations of the FRA. The Reculver Masterplan has an overarching objective to develop Reculver as a high quality strategic regional hub for green tourism and education in East Kent.' This includes future aspirations for a large scale development of a saltwater marshland habitat, enabled by a strategic change in the location of sea defences.

Faversham Creek to Whitstable Harbour Coastal Defence Strategy

This Strategy Plan was completed and approved by Defra in 2004 and makes recommendations for implementing flood and coastal erosion risk management schemes along this length of coast. For the Whitstable flood frontage a number of phased capital construction schemes were proposed. The initial scheme, which comprised a major beach recharge and the construction of new groynes, was implemented in 2006 and raised the standard of protection along the full defended length to 1 in 200 years. Further beach recharges and groyne maintenance/reconstruction works are programmed for appropriate intervals throughout the century in order to continually maintain this standard.

In about 20 to 30 years time, depending on more accurate predictions of climate change, it is proposed to raise the rear seawall by 0.6m to allow for rising sea levels. For the whole 100 year capital and maintenance costs for the works proposed in the strategy there is a benefit cost ratio of 21:1 – clearly demonstrating the very high economic viability of the future sea defence improvement works.

Swalecliffe Coastal Defence Strategy

The Strategy Plan includes the Swalecliffe and Hampton flood frontages. It was recently completed and submitted to the Environment Agency in March 2010 for approval. The strategy recommends continued maintenance and, where necessary, upgrading of the defences at both locations to maintain the 1 in 200 year defence standard over the next 100 years. Beach recharge and new groyne works are proposed for part of the Hampton frontage in 2014 and funding for this work is in the Environment Agency's Medium Term Plan. The Hampton seawall and parts of the seawall at Swalecliffe, not already at an appropriate level, are proposed to be raised in 20 to 30 years time to keep pace with the predicted rise in sea levels. The benefit cost ratio for the flood defence improvements recommended in the strategy is 8:1 – indicating significant economic justification to continue maintaining and improving defences to a high standard.

Herne Bay Flood and Erosion Risk Management Strategy Plan

Approval to carry out this strategy plan has been received from the Environment Agency and the study is under way with completion programmed for autumn 2011. Preliminary work carried out for the study application and to inform the Environment Agency's Medium Term Plan indicates that some improvement works will be necessary in the short to medium term to maintain the 1 in 200 standard of the flood defences at Herne Bay over the next 100 years. This will include raising the rear seawall by about 0.6m in about 20-30 years time depending upon sea level rise. The benefit cost ratio of those works is over 10:1, which confirms the economic practicability of the likely strategy recommendations.

Reculver to Minnis Bay Coastal Defence Strategy Plan

The strategy was completed and approved by Defra in 1997. It demonstrates that it is economically beneficial for the entire defence length, including the Northern Seawall, to be maintained and improved where necessary to provide between a 1 in 50 and 1 in 100 standard of protection over the next 100 years. As a result of these recommendations, capital works were carried out around the Reculver Towers area in 1998 to reconstruct various parts of the defences. The SMP currently recommends managed realignment in the medium term for the Northern Seawall and a revised strategy plan is scheduled for 2012 to examine this conflict in policy.

Stour CFMP Flood Risk Management Studies

Although of high priority for the River Stour through Canterbury, these studies scheduled for 2008 have not yet been commenced by the Environment Agency. It is assumed that their objectives will be similar to those for the coastal studies and will better define actual works and improvements to flood risk.

Council Policy Statement on Flood & Coastal Defence

In March 2001 the Council formally adopted its policy with respect to flood and coastal defence. This states that the "Council will provide an adequate, economically, technically and environmentally sound approach to providing the flood and coastal defence service and will ensure that appropriate maintenance regimes are in place for flood and coastal defence for which the Council takes responsibility". This policy was reinforced by the Council's Flooding Scrutiny Panel report (adopted by Council in September 2001), which contained 50 Actions to reduce flood risk in the District. This report concentrated on the reduction of inland flooding from whatever source, but under Action 3 specifically stated that "this Council should continue with its proactive approach to coastal defence, both maintenance and improvement works, to ensure that the risk of flooding and erosion is kept to the very minimum".

The Flooding Scrutiny Panel report has been regularly updated. The latest update, November 2007 see Appendix 8, was adopted by Council in December 2007 and contains a summary of all improvements carried out to reduce flood risk in the District and further improvements to be made.

Council Policy on Drainage Impact Assessment Requirements for New Development

In March 2003 the Council formally adopted its policy with respect to the requirement for a drainage impact assessment to be submitted and approved for all new development proposals. The guidance note for the impact assessment (see Appendix 9) sets out all the necessary requirements to ensure that the development does not flood nor result in increased flood risk elsewhere and, depending upon the size of the development, developers may be required to carry out or fund works to reduce flood risk.

5 Data Sources

5.1 Consultation and Data Collection

The following organisations have been consulted either during the development of the SFRA or for comment on the final draft.

- Canterbury City Council
- Environment Agency
- River Stour (Kent) Internal Drainage Board
- Lower Medway Internal Drainage Board
- Kent County Council - Highways
- Kent County Council – Emergency Planning
- Southern Water

The data supplied for use within the SFRA has been summarised in the following table.

Organisation	Data supplied	Use within SFRA
Canterbury City Council	OS 10k National Grid mapping	Flood risk mapping
	Historic flood database and mapping	Historic flooding
	Proposed development site locations (GIS layer) and details	Flood risk mapping
	Isle of Grain to South Foreland SMP Review 2010 (Halcrow)	Information on shoreline management policy
	Coastal defence asset database	Information on existing defences and their standard of service
	Coastal defence strategy plans (Whitstable, Tankerton, Swalelcliffe, Herne Bay, Reculver)	Information on coastal processes and proposed defence improvements
	Flood Scrutiny Review Report and Appendices, various site specific flood reports and analyses	Information on flooding history, flood policy and post flood improvements
Environment Agency	Flood Zone 2 & 3 extents (GIS layer)	Mapping of flood zones
	Historic flooding extents (GIS layer)	Mapping of historic flooding
	National Flood and Coastal Defence Database (NFCDD)	Information on existing defences
	Lidar data – supplied at a resolution of 2m for the whole District.	Flood risk mapping
	Extreme sea levels – taken from the JBA Extremes Sea Levels Report (Version 10)	Flood risk mapping
	River Stour Catchment Flood Management Plan 2007	Information on fluvial processes and proposed improvement
Southeast Strategic Regional Coastal Monitoring Programme	Beach and structure profile data	Flood risk analysis and mapping

Table 5.1 – Summary of data supplied

5.2 Existing Hydraulic Modelling

There have been a number of hydraulic studies carried out for watercourses within the Canterbury District. These focussed on the Swalecliffe Brook, Westbrook and the Plenty Brook, although none of these included any flood mapping or accurately quantified the extent of flooding likely to occur as a result of an extreme flood event. The majority of these studies also pre-date current guidance on climate change and consequently their role as part of this SFRA in informing flood risk is limited. Notwithstanding this, for site-specific Flood Risk Assessments within the flood risk zones of these watercourses it may be beneficial to examine this data.

In addition to this, in 2009 Herrington Consulting was commissioned to undertake a series of detailed flood modelling studies of the key development areas within the District. The outputs from these hydraulic modelling studies have been used to inform this SFRA and are included in Appendix 5 and 6. A more detailed description of the scope and methodologies employed is given in Section 9 of this report.

5.3 Flood Zone Mapping

The Environment Agency Flood Zone maps show the areas at risk of flooding from rivers and the sea and are produced initially from a national generalised and large scale computer model (JFlow). This mapping process ignores the presence of existing defences, although those defences constructed during the last 5 years are highlighted on the maps. The Environment Agency's Flood Zone mapping for the Canterbury District has been reproduced and included in Appendix 1 of this report.

Whilst the Flood Zone maps divide up land areas into Zones 1, 2 or 3, this delineation is far too course for the application of the Sequential Test within the densely urbanised town centre areas of the District. Consequently, as part of this SFRA, the flood zone mapping has been refined by the use of more detailed flood risk mapping. However, this analysis has only been undertaken for the coastal floodplains and therefore the flood risks associated with the many streams and man made watercourses within the District are mapped solely with the existing Environment Agency Flood Zone mapping information.

In addition to the Flood Zone maps, which are based on current climatic conditions, the change in risk from coastal flooding has also been mapped for a future climatic scenario. Based on the predicted rates of sea level rise discussed in Section 7 of this report, Flood Zone maps have been produced for the year 2115. Whilst it is readily understood that the risk of flooding will increase as sea levels increase over time, the climate change flood maps provide an indication of the change in extents of the areas that are affected.

These maps have been produced by re-mapping the current day flood zone extents using the 2115 predicted extreme sea levels, and as with the current day Flood Zone maps, no account has been taken of existing flood defence infrastructure. Using this approach for areas that are at risk from coastal flooding is relatively straight forward, however, without undertaking detailed hydraulic analysis of all of the watercourses within the District, it is not possible to predict the increase in flood extents that may occur as a result of climatic changes. Consequently, climate change flood zone maps have only been produced for the coastal floodplains and the Canterbury city centre area of the River Great Stour floodplain.

5.4 Historic and Localised Flooding

There is a detailed history of flooding within Canterbury District that has been well documented by the Council's Engineering Team and the Environment Agency. Information on actual and potential sea flood events since World War II and inland flooding over the past thirty years is held. There are particularly good records of the flooding that took place over the winter of 2000/2001 and events since that date. The relevant details have been reproduced in a table format in Appendix 2 which accompanies the Historic Flood Map.

The most significant flood events that have affected the District are discussed in more detail below.

1953 North Sea Surge – During the January 1953 storm, the sea defences along most of the North Kent coast were overtopped or breached and severely damaged. Both Whitstable and Herne Bay town centres were badly flooded and at Seasalter and Reculver the sea breached the railway line hundreds of metres inland of the primary sea defences. The storm is estimated to have a return period of about 1 in 150 years (Canterbury City Council – Coastal Management Study 1993) and a still water level of 4.7AOD was recorded at Whitstable.

The worst flooding was at Whitstable where the sea defences failed mainly due to a breach in the golf course seawall at the western end of the flood plain. There was also significant overflow and overtopping at Whitstable Harbour, at the eastern end, which quickly filled the low lying land behind it. Failure of the golf course seawall resulted in floodwater also breaching the golf course bund (secondary defence) and flooding much of the town by the "back door". Water coming through the harbour flooded the eastern part of the town, which is particularly low lying in the Gorrell area. Flooding to a depth of nearly two metres was recorded at the lowest part of the town at Cromwell Road.

The floodwater extended to the railway and passed through the bridge at Canterbury Road to flood some of the land and properties south of the railway. Seafront properties all along the Whitstable frontage were badly flooded due to a combination of overtopping and isolated pockets of overflow. Over 2,000 people became temporarily homeless as a result of the flooding but there were no fatalities or serious injuries.

At Herne Bay during the same 1953 storm event, there was no major failure of the main seawall. The flooding resulted from significant overtopping and even some overflow of the low seawall. Flooding to a depth of about 1.2 metres was recorded at the lowest part of the town at the Beach Street car park.

Figure 5.1 – Herne Bay Seafront during 1953 Storm

Figure 5.2 - Flooding at Whitstable, January 1953

1978 Storm - The coincidence of high tides and storm force north easterly gales in January 1978 resulted in considerable damage to property on the coast at Herne Bay, but flooding was mainly limited to property along the seafront and just inland. The storm is estimated to have been a 1 in 20/30 year return period event with a still water level of +4.1mAOD. Although the waves were bigger than in 1953, the sea level was lower. This accounted for the severity of the damage but the depth of flooding to property was only in the order of 250 mm, except for basements. The number of properties flooded by this event was small.

The impact of this event was reduced because the sea defences had been raised following the 1953 floods. In addition, the seawall was not breached. Due to the orientation of its coastline in relation to the predominant direction of the 1978 storm there was little flooding at Whitstable as a result of this storm. However, significant flooding to houses along Faversham Road, Seasalter was reported and some of the properties on the beach were washed off their foundations.

Figure 5.3 – Damage at Herne Bay as a result of 1978 Storm

1996 Storm – This storm is estimated to be have had a return period of 1 in 10 year years, yet despite the fact that the wind was from the north-east (the worst direction), no significant flooding occurred at Herne Bay. The Neptune car park was flooded to a depth of up to 300mm in places with some water flowing from there down Market Street. There are no records of internal flooding to property during this event, although the impacts of this storm may well have been mitigated through the early deployment of sandbags. This storm occurred after the major sea defence works of 1992 at Herne Bay, which proved to be very effective as lesser storms prior to 1992 had caused property flooding on the seafront and in Market Street.

During this event flooding also occurred at a number of houses along Faversham Road. The seawall east of Reculver Towers also failed and only the rapid installation of emergency works prevented a full breach and extensive inland flooding.

Figure 5.4 – Failed Seawall at Reculver caused by the 1996 Storm

1987 Hurricane – Some flooding occurred to property abutting the Great Stour through Chartham, Canterbury and Fordwich as a result of the October 1987 hurricane. The river overtopped its banks at a number of locations, however, this mainly occurred just upstream of culverts that had been almost totally blocked by fallen trees and other debris.

April 2000 Floods – On 4 April 2000, 50mm of rain fell steadily over a twelve hour period on ground that was already saturated. This resulted in widespread flooding across the District from rivers, minor watercourses, surcharged surface water sewers and from surface water run off. Internal flooding to property was recorded at numerous locations within the District, with the worst affected area being Eddington near Herne Bay where flooding from the Plenty Brook resulted in flooding to 18 properties.

Winter 2000/2001 Floods – The winter 2000/2001 was the wettest since records began with over twice the average rainfall. There were also two days when about 50mm of rain fell over a twelve hour period (12 October 2000 and 8 February 2001) and in early November 2000 flood flows equating to a 1 in 50 year event were recorded in the Great Stour. Flooding occurred at locations throughout the District, although the sources varied considerably.

Given the extreme flood flows in the Great Stour, there were relatively few properties flooded. Those that were affected were generally as a result of overtopping of defences and not defence failure. The flooding from the Stour was partly due to the overtopping of the two storage reservoirs upstream of Ashford. These reservoirs were designed to accommodate a 1 in 100 year single storm event. However, a sequence of lesser storms occurred over a relatively short period. This did not allow the reservoirs to fully drain before the onset of the next storm, thus causing them to overflow.

Flooding directly resulting from other main rivers overtopping their banks, particularly the Little Stour, was quite high. Flooding from (at the time) non-main rivers, such as the Plenty Brook, was also a major cause of problems but the reasons for this are quite complex in a number of locations. Much flooding was as a result of surface water sewers and road drains not being able to cope with the volumes of water, particularly in rural areas where they became blocked with silt from fields. Again in more rural areas or on the outskirts of urban areas, unmaintained minor watercourses and significant run off from open fields resulted in localised flooding. Springs appeared throughout the District that had not been known to flow in living memory, with some of these causing flooding to houses.

One of the most distressing aspects was flooding to properties from foul sewers either backing up or when pumping stations had failed. In what was estimated to be a 1 in 100 year event, a combination of flooding from rivers, groundwater emergence, overland flow and runoff from farmland as well as highways and sewer surcharging caused flooding to properties in all of the villages along the Nailbourne and Little Stour - at Barham, Kingston, Bishopsbourne, Bridge, Patrixbourne, Littlebourne, Ickham and Wickhambreux. Some houses at Bishopsbourne and Patrixbourne remained flooded for months. In total across the District, 290 houses were known to have been flooded internally, although there were probably more unreported cases. Many other properties were saved from internal flooding by the provision of sandbags. The Flooding Scrutiny Panel Report at Appendix 8 details the event and also the various flood alleviation works carried out afterwards.

Figure 5.5 – Flooding from the Nailbourne at Barham

August 2007 Whitstable Flood – On 12th August 2007 flash flooding occurred in the low lying part of the Whitstable town centre as a result of 50mm of rain falling in two hours. This was estimated to be in the order of a 1 in 100 year rainfall event. At least 30 and probably nearer 50 houses were flooded internally due to surcharging of the old, often combined, sewers. There were also problems with overflowing of the Gorrell Tank (Southern Water) outfall system that is located adjacent to the harbour.

5.5 Post Flood Improvements

Significant improvements have been made to sea defences and flood alleviation systems across the District since the various flood events catalogued above. These are detailed in the table and plans at Appendix 2.

Since 1953 all seawalls protecting low-lying land have been raised, and where necessary reconstructed, to a level of at least 5.8mAOD (1m above the 1 in 200 year storm level). All seawalls are protected against failure by a large shingle beach, stabilised by a comprehensive system of timber groynes~~,~~. The shingle beach plays a significant role in reducing wave overtopping, as well as reducing the risk of the seawalls being undermined. In more recent years major sea defence improvement works have been carried out at Whitstable (1989 and 2006), Swalecliffe (1988), Hampton (1996), Herne Bay (1992) and Reculver (1998).

Figure 5.6 – Reduction of Overtopping due to 1990 Breakwater at Herne Bay

In response to the 2000/2001 flood events, a number of improvements were made to the Nailbourne through all of the villages. These works were mainly carried out to increase the capacity of the river channel and culverts. A new diversion channel was constructed at Littlebourne and improvements to highway drainage were carried out at a number of the villages. Improvements have also been made to the coastal brooks including a major flood storage lake on the Plenty Brook and a new outfall to the Swalecliffe Brook. Southern Water has also carried out a number of upgrades to its pumping stations reducing the risk of flooding from sewers. In general there has been an improved awareness of the potential for flooding from the smaller watercourses in the District.

6 Overview of Flood Risk

The topography and geology of the land within the boundaries of Canterbury's District are diverse and complex, as is the range of flood sources. This section of the SFRA therefore examines each source of flood risk and discusses the mechanisms by which flooding can occur.

6.1 Flooding from the Sea

The part of Canterbury District's shoreline that is low lying is approximately 10km long and is defended throughout its length. At each end of the District these defences protect lower-lying, fertile agricultural land and important infrastructure at Graveney/Seasalter to the west and Reculver/Northern Seawall to the east. The land levels in these areas are generally at or below the mean high water springs (MHWS) level of 2.7mAOD and consequently without the protection of the existing sea defences much of this land would be inundated on a regular basis. The defences also protect the low-lying urban areas of Whitstable, Swalecliffe, Hampton and Herne Bay. At Whitstable there are locations where the land and houses are at or slightly below the MHWS level of 2.7mAOD, whilst at Herne Bay the lowest land level is around 3.3mAOD. The defences are therefore essential to protect the coastal towns from regular flooding from the sea and in some cases permanent inundation.

The whole of the District's shoreline faces north and has the potential to be affected by North Sea surges, which can raise the sea level by up to 2.5m. However, due to the relatively shallow foreshore, wave heights are generally depth limited and are therefore relatively small, even during storm surges. The extreme sea levels that have been used by this appraisal are based on those published in the Extreme Sea Levels - Kent, Sussex, Hampshire and Isle of Wight Report (JBA, December 2004) Revision 10 together with the information obtained by more site specific studies carried out by Canterbury City Council. The predicted 1 in 200 year still water level for the current climate conditions that has been adopted by the Council is 4.78mAOD.

Given the presence of the existing sea defences, flooding from the sea can only occur as a result of either the existing defences breaching or being overtopped by wave action. Depending upon the location of the particular site with respect to the breach or overtopping event, the consequences can vary significantly. The condition of the seawall, its height, the level of the land immediately behind the seawall, the adequacy of the protecting shingle beach and its groynes, the maintenance regime and the proposals for future improvements to the sea defences will all affect the potential for a breach and the degree of overtopping. It has therefore been necessary to analyse the risk of flooding from the sea in great detail so as to be able to define as accurately as possible the risk at the six coastal floodplains – Seasalter, Whitstable, Swalecliffe, Hampton, Herne Bay and Reculver. Flood modelling has been carried out at these locations and this work is described in further detail in Section 9 of this report.

6.2 Flooding from Rivers

There are a number of watercourses within the District, which have been categorised as main rivers and as can be seen in the section on historic flooding, these have caused flooding problems in the past. The locations of these watercourses are shown on the map in Appendix 4 and are described as follows:

River Great Stour – The various tributaries of the Great Stour meet at Ashford, the river then flows unimpeded through rural chalk downs from south west to north east bisecting the District. It passes through the village of Chartham into Canterbury's city centre, where it is highly modified. The river splits into three channels and a complicated series of sluices, gates and mill races control river flows. Localised flood walls provide protection to some pockets of development. These structures have an important role to play in managing flood risk within the city.

Downstream of the city the river enters the tidally influenced Lower Stour at Fordwich and eventually flows into the sea near Sandwich. Upstream of Canterbury, two flood storage reservoirs, at Hothfield and Aldington, were constructed south of Ashford in the early 1990s. These, together with natural flood storage on the agricultural land between Ashford and Canterbury, provide protection against flooding to most parts of the city for events up to around 1 in 100 years. However, whilst these flood storage reservoirs provide a reasonably high standard of protection against a single larger return period event, the standard of protection against two consecutive lesser events is limited by the time taken to discharge the reservoirs. Flood modelling the River Great Stour has been carried out throughout Canterbury's city centre and this work is described in further detail in Section 9 of this report.

Whilst the majority of the city is outside of the extents of the predicted 100 year flood event, the villages of Shalmsford Street, Chartham and Fordwich are exposed to a greater risk of flooding. At this stage this risk has not been quantified.

Petham Bourne – The Petham Bourne is not classified as a main river and is a tributary of the Great Stour joining it at Shalmsford Street. It is groundwater fed and flows very infrequently; 1930 and 2000/2001 are the only recorded events. Its route is poorly defined in places but when it does flow there is a risk to property adjacent to it, particularly at Shalmsford Street.

Nailbourne/Little Stour – The Nailbourne is a chalk fed stream, which rises during prolonged periods of rainfall. Its source is at Lyminge and, within the District, it flows through the villages of Barham, Kingsdown, Bishopsbourne, Bridge, Patrixbourne and Bekesbourne. The Nailbourne eventually joins the Little Stour near Littlebourne, which then flows through the villages of Wickambreux and Seaton before its confluence with the Great Stour at Stourmouth.

Flow in the Nailbourne is intermittent, locally reckoned to be on average once every seven years. However, in recent years it has flowed in 2000/2001, 2003 and 2010. The significant flooding in 2000/2001 was estimated to have a return period of between 50 and 100 years. Property close to the river in all the villages was affected to some extent. Considerable improvements to the river have been carried out since 2001 but there are still a number of restrictions such as road culverts where localised flooding can occur upstream and it is considered that flood risk to parts of all the Nailbourne/Little Stour villages is in the order of 1% - 2% annually (estimated return period between 50 and 100 years).

Sarre Penn – The Sarre Penn is sourced at Dunkirk and runs north of Canterbury at Harbledown through to Broad Oak and then parallel to the A28 to Sarre, eventually joining the River Wantsum. The Sarre Penn flows predominantly through agricultural land that is remote from developed areas, however, there are localised land drainage problems associated with this watercourse, particularly in north Canterbury and where road culverts restrict flow. Where property is located in close proximity to the Sarre Penn there maybe a risk of flooding, consequently before further development adjacent to this watercourse the risk of flooding would need to be investigated in greater detail.

Oyster Coast Brooks – The Environment Agency, in the Stour CFPM, has grouped together the five short rivers known as Gorrell Stream, Kite Farm Ditch, Swaleciffe Brook, Westbrook and Plenty Brook and refers to them as the Oyster Coast Brooks. They are all similar in that they are characterised by a clay catchment, are heavily modified, have a short and steep channel gradient and a tide-locked outfall controlled by a sluice gate. The rivers respond quickly to rainfall due to the urban area through which they mainly flow, the steepness of the catchment and the clay geology. The steep gradient means that the rivers drain into the sea very quickly so peak flows are of a short duration. However, the peak can be influenced by tide locking which makes the effects of flooding much worse. Various structures and culverts along their routes restrict flow, as does the typical narrow channel section. Significant recent development that has taken place beside these rivers has exacerbated flood risk to some degree.

The Gorrell Stream has its source at Duncan Downs above Whitstable and flows steeply downhill into the town at St Andrews Close. It is then in a defined channel with concrete sides, with short lengths culverted, through to Belmont Road. Thereafter through to its outfall, a length of 1.1km, the stream is fully piped (1400mm diameter) and is designated as a public surface water sewer maintained by Southern Water. The Gorrell Tank, at the stream's outfall, has a capacity of 18,000 cubic metres. There is a gravity outfall into Whitstable Harbour plus a pumping station to deal with high flows discharging to a sea outfall. Because of the complex system of interconnecting sewers, the potentially high flow rate and the reliance on a pumped outfall, the lower Gorrell catchment through the town of Whitstable is particularly at risk from flash flooding, as occurred in the winter of 2000/2001 and August 2007.

The Kite Farm Ditch has its source within the Chestfield Golf Course and is mostly natural open channel, although it is culverted where it passes under the Thanet Way, railway line and various other roads. It discharges to the sea at the Swaleciffe Sea View Caravan Park via a sluice gate (operated by Canterbury City Council) which is normally left fully open, but is closed to prevent high tides causing levels in the watercourse to back-up. The greatest flood risk is at the lowest section, along Colewood Road. After passing under the railway, the stream emerges briefly into an open ditch but very soon leads into a Southern Water surface water sewer. This picks up the flow from other surface water sewers and at the junction of Colewood Road and St John's Road the surface water sewer outfalls into the open channel that runs alongside the road leading to the caravan park and thence to the sea. This whole area between the railway line and the sea is virtually flat, meaning that flow rates in this part of the sewer/ditch system are always low. Consequently high rainfall can rapidly lead to surface water sewers surcharging, which is exacerbated whenever the outfall is tide-locked. This was the cause of several houses in the area suffering internal flooding during the winter of 2000/2001.

The Swalecliffe Brook rises close to the A290 midway between Blean and the Thanet Way at Whitstable and then runs in a northerly direction for just over 8km until it reaches the sea at Long Rock, Swalecliffe. However a sequence of ditches can claim to extend the source of the Brook several kilometres further inland. Most of the Swalecliffe Brook's course is through fields and woodlands so any flooding has little impact on roads or houses. However, properties backing onto the watercourse at Chestfield and through the built-up area of Swalecliffe, north of the Herne Bay Road, are vulnerable to flooding. The Brook is carried under the earth-bund coast protection at Long Rock in a culvert fitted with two sluice gates (both operated by Canterbury City Council). The winter of 2000/2001 showed that even with both sluices fully open, the flow in the Brook was so great that the culvert formed a constriction which prolonged the upstream flooding across the playing fields. This problem was addressed in 2002 by installing three, 900mm diameter pipes through the earth bund near the culvert, each fitted with a flap-valve on its seaward side. After the bund, the Brook enters the Long Rock Site of Special Scientific Interest. Over the last few decades the mouth of the Swalecliffe Brook has been gradually pushed to the west as a spit of beach shingle is slowly extended by the natural east-west littoral drift. Generally there is sufficient flow in the Brook to keep the mouth clear but low summer flows mean that from time to time it is completely blocked by shingle and has to be cleared by machine. These works are undertaken by the Environment Agency.

The Westbrook rises in Thornden Wood and, after just over 5 kilometres, reaches the sea at Hampton Pier Avenue. Most of its course lies through fields and woodlands but when the Westbrook emerges from under the A2990 (the old Thanet Way) and the railway line, it enters the urban area,of Studd Hill – Hampton, where properties adjacent to the brook are at risk of flooding. At its mouth the Westbrook is carried under the concrete sea wall by a short culvert, which is controlled by a sluice gate operated by Canterbury City Council. As well as some houses at Hampton, infrastructure is also vulnerable to flooding from the Westbrook. A 500m section of Whitstable Road/Sea Street was inundated in April 2001 including the Sea Street / Hampton Pier Avenue junction, which caused considerable disruption to traffic. The bridge providing access into the Studd Hill Estate over the Westbrook from Hampton Pier Avenue is also vulnerable.

The Plenty Brook rises on the northern edge of West Blean Woods and runs slightly east of north for some 11 kilometres until it discharges to the sea at Herne Bay, close to the Clock Tower. For the majority of its length it runs in a natural open channel but once entering a culvert to pass under the railway line it stays underground for 1.5km, all the way to its outfall. The culvert follows the line of Cherry Gardens, Dering Road, Beach Street and finally the alleyway that runs diagonally from Mortimer Street to Central Parade. The outfall is controlled by a sluice gate operated at the Neptune car park. The culverted section is a designated Southern Water public surface water sewer and is a brick lined structure of between $2m^2$ and $3m^2$ cross sectional area. There are a number of surface water inlets to the culvert draining parts of the built up area of Herne Bay. Consequently when the culverted section is running at full capacity, road gullies and manhole covers can begin to surcharge causing localised flooding to roads. Serious flooding from the Plenty Brook occurred in April 2000 and February 2001 as a result of storm events estimated to have a return period of between 10 and 20 years. These storms resulted in a large number of properties both north and south of the railway culvert being affected. This was mostly attributed to intense rainfall over a short time generating such a high runoff that the culvert mouth leading the Plenty Brook under the railway was unable to cope. As a result of those events, numerous improvements have been made to the watercourse. The main ones were the construction of two new storage lagoons, one on line and one off line, at the Herne Bay Golf Club and increased capacity to existing storage reservoirs. These improvements are designed to reduce the flood risk from the river to Herne Bay and Eddington and now provide a standard of protection between 1 in 50 and 1 in 100 years.

6.3 Flooding from Surface Water Runoff and Overland Flow

Overland flooding typically occurs in natural valley bottoms as normally dry areas become covered in flowing water and in low spots where water may pond. This flooding mechanism can occur almost anywhere, but is likely to be of particular concern in any topographical low spot, or where the pathway for runoff is restricted by terrain or man-made obstructions. Parts of the District, especially at Whitstable, Herne Bay and north Canterbury are potentially vulnerable to this type of flooding. There are also a number of villages situated within valleys or at the base of hills that are also at risk and have been flooded by this mechanism in the past. In particular Littlebourne, Bridge and Bishopsbourne, although this problem can occur at many of the villages within the District, particularly affecting isolated rural communities.

Whitstable town centre lies within a valley formed by fairly steep slopes to the south, east and west. The sea borders it to the north. Although there are some individual low spots, the centre generally has a gentle incline towards the sea. Any significant overland flow would therefore disperse eventually to the sea through the town's drainage system. The slopes on the three sides are mainly developed with a surface water sewer network and hence the risk of major overland flow is reduced. There is no historical evidence of any serious flooding in the area as a direct result of overland flow. All the roads within the town centre are drained by a system of highway gullies, which drain to the public sewer network. It is accepted that parts of this system are old and in places localised ponding and blockages in gullies takes place during heavy rain. Kent Highways is aware of the problem areas and maintain the problematic parts of the system more frequently than elsewhere. Although no serious flooding has occurred in recent times as a direct result of overland flow, flood events in winter 2000/2001 and again in August 2007 did cause internal flooding. This resulted from a combination of river flooding and sewer surcharging. The topography of the town has exacerbated the problem and its effects. Those events are described elsewhere in this report.

The situation at Herne Bay is similar, with the town centre lying within a valley formed by fairly steep slopes to the east and west and gentle slopes to the south and the sea to the north. Consequently, during extreme and intense rainfall events there is potential for overland flow to be focussed on the lower-lying areas of this urban catchment. There is also a physical barrier to any overland flow draining naturally to the sea. This is the High Street, which would block the flow from the south and could potentially result in flooding to the lower land immediately to the south of it. As described elsewhere in this report there has been surface water flooding in lower lying locations but this has been primarily as a result of the sewer network becoming surcharged.

In Canterbury the main potential problem area is the north of the city from Harbledown round to Broad Oak. The problem is exacerbated by non-functioning land drains, poorly maintained minor ditches and unchecked water flow across grassed hillsides. Particular areas where flooding as a result of overland flow has occurred are downhill from Dukes Meadow through to the cemetery, parts of St Stephens immediately below the university grounds and the northern part of Hales Place. As elsewhere, the flooding is often also due to a combination of surcharging and under-capacity surface water sewers, which themselves lead into the very old sewer system in the older parts of the city.

In the rural area overland flooding has occurred at Littlebourne and Bridge and has the potential to occur at Barham, Bishopsbourne, Kingston, Sturry, Herne and Petham. All of these villages have suffered some degree of flooding in recent years often resulting from a combination of road flooding, watercourses flowing out of bank, ground water and springs as well as water coming off fields. It is considered that changes to farming practices may well exacerbate the potential for overland flooding in rural areas and on the outskirts of urban areas. Two particular potential causes are the grubbing up of many of the orchards traditional to Kent over the last few decades and the removal of hedgerows and ditches. It is acknowledged that orchards significantly hold up surface water naturally and their removal increases the rate of run off from fields. The reduction in hedgerows and ditches has meant that water is not so well channelled, flow downhill increases and often this can be very silt laden, thus quickly blocking gullies and drains. A further perceived cause of increased risk of overland flow is the ploughing of land downhill rather than parallel to the contours of the slope. Very recently a significant increase in risk may be due to the erection of massive expanses of polytunnels over fields, particularly used for growing strawberries in this District. Unless substantial and effective drainage measures are put in place in conjunction with these practices then considerable increased surface water runoff from these areas will occur, exacerbating flood risk to downstream areas of the catchment. This needs to be taken into consideration when planning both the erection of polytunnels and any development in their vicinity.

The Historic Flooding map in Appendix 2 highlights the locations where surface water flooding has been recorded. However, it should be noted that there may well be other historic flooding locations where no records are held and so those locations are not shown on the maps. Ensuring that surface water runoff from new development is controlled in a sustainable manner is an essential part of the flood risk management process and consequently PPS25 sets out clear guidelines for developers. These have been amplified as part of this SFRA to make sure that surface water management issues specific to the District are taken into account in the planning process. This is discussed in more detail in Section 10 of this report. It is also essential that the site-specific risks of flooding as a result of surface water or overland flow are considered as part of any site-specific FRA. Such appraisals should take into account the topography and nature of the surrounding land so that potential flow paths can be established. Scheme designs should also be checked to ensure that any potential flow paths through the site are not obstructed such that they could cause water to pond. In the Flood & Water Management Act 2010 and the Flood Risk Regulations 2009, particular concern is raised with respect to surface water flooding and measures to prevent / reduce such flooding will be implemented. The exact requirements of the Act and Regulations have yet to be defined but they will certainly impact upon developments and will need to be taken into consideration as part of the flood risk assessment process.

6.4 Groundwater Flooding

Water levels below the ground rise during wet winter months, and fall again in the summer as water flows out into rivers. In very wet winters, rising water levels may lead to the flooding of normally dry land, as well as reactivating flow in 'bournes' (streams that only flow for part of the year). Where land that is prone to groundwater flooding has been built on, the effect of a flood can be very costly, and because groundwater responds slowly compared with rivers, floods can last for weeks or months. Groundwater flooding generally occurs in rural areas although it can also occur in more urbanised areas where the process known as groundwater rebound can cause localised flooding of basements. This increase in the water table level is occurring as a result of the decrease in groundwater extraction that has taken place since the decline in urban aquifer exploitation by heavy industry.

Data on groundwater flooding has been compiled by the British Geological Society (BGS) and is illustrated on mapping, which is the product of integrating several datasets: a digital model of the land surface, digital geological map data and a water level surface based on measurements of groundwater level made during a particularly wet winter. This dataset provides an indication of areas where groundwater flooding may occur, but is primarily focussed on the groundwater flooding potential of the chalk strata of southern England. Chalk shows some of the largest seasonal variations in groundwater level and so is particularly prone to groundwater flooding incidents.

Inspection of the BGS dataset shows that the Stour Valley is an area at high risk of groundwater flooding. The sandstone area to the south and east of the River Stour is classified as being at medium risk whilst the remainder of the District is located within a low risk area. The sands in the centre and north east of the District also have moderate to significant running sand potential, indicating that the lithology is suitable for fluidisation of the sand by the presence of groundwater and that groundwater can be conveyed through the sand. These characteristics mean that groundwater flooding can be of localised importance and consequently, site-specific FRAs will need to investigate any localised risks of groundwater flooding.

In the higher parts of the District the extensive fissures in the Chalk provide considerable storage for groundwater. Groundwater flooding from the chalk bournes (Petham Bourne and Nailbourne) was extensive in the winter of 2000/2001 and there have also been problems as a result of high groundwater levels along the Nailbourne in 2003 and 2010. This is described in more detail elsewhere in this report under historic flooding.

Specific areas of groundwater emergence are at Bishopsbourne, Patrixbourne, Duncan Downs at Whitstable and parts of the south east of the Whitstable town centre and Thurston Park area. It is possible that the problems in Whitstable are due to an underground watercourse as opposed to groundwater flows, although this has not been verified. There have also been reported groundwater problems in the developed parts of Seasalter, again it is understood that these are more likely due to minor watercourses and drainage ditches that have been in-filled, restricting flow paths.

Although not strictly a groundwater flooding problem, there is also a need to highlight flooding problems in the villages of Chestfield and Blean. At both these villages there has been localised flooding in the past due to a combination of causes. Particularly at Chestfield but to also to a lesser extent at Blean, the upper soil geology is a thick layer of stiff London Clay with only a thin band of topsoil / soft clay overlying it. During periods of prolonged winter rainfall the soil becomes saturated resulting in water lying on the surface for long periods of time. There has been considerable development in the past at both these villages and many local ditches and field drains have been filled in or inadequately piped resulting in there being nowhere for the standing water to go.

6.5 Flooding from Sewerage Infrastructure

In urban areas, rainwater is frequently drained into surface water sewers or sewers containing both surface and wastewater known as “combined sewers”. Flooding can result when the sewer is overwhelmed by heavy rainfall, becomes blocked or is of inadequate capacity, and this will continue until the water drains away. When this happens to combined sewers, there is a high risk of land and property flooding with water contaminated with raw sewage as well as pollution of rivers due to discharge from combined sewer overflows.

In the three main developed locations of Canterbury, Whitstable and Herne Bay most of the sewers in the more established areas are combined and, particularly in Canterbury city centre, very old.

Flooding from sewers has occurred in all these locations. There has also been flooding from sewers (both foul and surface water) in recent years in the villages along the Nailbourne valley, at Blean, Fordwich, Chestfield, Lower Herne, Eddington, South Street (Whitstable), St Thomas Hill area (Canterbury), Seasalter Cross/Church Lane and Reculver Road in Beltinge. At Fordwich, Chestfield and Eddington extensive works by Southern Water appear to have resolved many of the surcharging problems.

Along the Nailbourne valley, the villages of Bridge, Patrixbourne and Bekesbourne have been worst affected by groundwater and infiltration into the foul sewer causing it to surcharge and the subsequent need to pump the flow from sewers into the Nailbourne river. Properties immediately adjacent to the river have suffered flooding. Southern Water is currently carrying out a detailed investigation into this problem with a view to instigating remedial measures.

In Whitstable there have been three incidences of flooding from sewerage infrastructure over the last ten years. In each case very heavy rainfall over a short period of time has overwhelmed the system with local drains being unable to cope and flooding to property resulting, some of which has been contaminated with effluent. On each of these occasions there have been problems with the sea outfall pumping station at the Gorrell Tank and also high flows in the Gorrell Stream. The worst affected locations have been in the area just south of the Gorrell Tank, which is very low lying, but other parts of the town at a higher level and also some distance from the outfall, have been affected. Generally the risk of flooding from sewers in Whitstable is moderate, however, the lower parts of the town close to the seafront the risk are at an increased risk.

In the town of Herne Bay there had been occurrences of regular surcharging of the combined sewer system and localised flooding up to the early 1990s, when a new tank sewer and pumping station was constructed. Whilst this significantly reduced the problem, there have been localised flooding incidents from the sewer system on a number of occasions since that time with a more widespread event in September 2010. It is considered that these events were largely due to a combination of human error and mechanical failures of equipment and in theory the risk of flooding from sewers in Herne Bay is low.

Despite the age of much of Canterbury's sewerage infrastructure, the instances of sewer flooding have been quite low in the city and usually combined with exceptionally high flows in the River Great Stour. Apart from some known trouble spots, which would require detailed investigation for any proposed development, the risk of flooding from sewers in the city is considered to be low.

In the village of Blean the public sewers have a limited capacity to manage heavy rainfall. For any future development there is a need to carefully consider surface water disposal with attenuation probably required for even small sites and the possibility of the use of deep bored soakaways.

6.6 Flooding from Reservoirs and Artificial Waterways

Non-natural or artificial sources of flooding can include reservoirs, canals and lakes where water is retained above natural ground level. Operational and redundant industrial processes including mining, quarrying and sand and gravel extraction, are also important as they may increase floodwater depths and velocities in adjacent areas. The potential effects of flood risk management infrastructure and other structures also need to be considered. Reservoir or canal flooding may occur as a result of the facility being overwhelmed and/or as a result of dam or bank failure. Also, any man-made drainage system such as a drain, sewer or ditch could potentially cause flooding.

There are no potable water reservoirs within the District nor are there any artificial waterways such as canals. There are, however, a number of impounding or storage reservoirs or balancing lakes that have been constructed to reduce downstream flood risk on watercourses. When the A290 (new Thanet Way) was built in 1998/1999 balancing lagoons generally of size up to 5,000m^3 were constructed at Swalecliffe, Greenhill and Eddington to attenuate the surface water run off from the road. At Eddington there are 26,000m^3 (Southern Water), 35,000m^3 (EA) and 10,000m^3 (private) balancing lagoons to attenuate the flow of the Plenty Brook. All of the above only begin to fill at times of heavy rainfall and have restricted outlet devices, but also have bypass mechanisms to prevent excessive overtopping of their banks. They are all of fairly recent construction and designed to minimise the risk of rapid flooding to property downstream from them. There is a large balancing pond/lake on the Nailbourne with dam and controlled outlet at

Bourne Park (near Bishopsbourne). Its structural condition is unknown but any failure would be likely only to result in flooding to farmland with no property immediately at risk.

There are numerous artificial lakes throughout the District but the large ones are mainly just off the Stour between Chartham and Thannington and at Fordwich and Westbere. These are all old sand/gravel workings and, as such, are excavations below surrounding ground level with no embankments or control structures apart from some minor weirs. It is not considered likely that these lakes would themselves cause flooding and they can actually help to attenuate surface water and watercourse flow. However, during exceptionally wet weather these lakes can fill to overflowing and add to any groundwater and overland flow flood risk.

7 Flood Risk and Climate Change

When the impact of climate change is considered it is generally accepted that the standard of protection provided by current defences will reduce with time. The global climate is constantly changing, but it is widely recognised that we are now entering a period of accelerating change. Over the last few decades there have been numerous studies into the impact of potential changes in the future and there is now an increasing body of scientific evidence, which supports the fact that the global climate is changing as a result of human activity. Past, present and future emissions of greenhouse gases are expected to cause significant global climate change during this century.

The nature of climate change at a regional level will vary: for the UK, projections of future climate change indicate that more frequent short-duration, high-intensity rainfall and more frequent periods of long-duration rainfall of the type responsible for the recent UK flooding could be expected.

These effects will tend to increase the size of flood zones associated with rivers, and the amount of flooding experienced from other inland sources. The rise in sea level will change the frequency of occurrence of high water levels relative to today's sea levels. It will also increase the extent of the area at risk should sea defences fail, although this increase will be comparatively small in the District due to the valley topography of the coastal floodplains. Changes in wave heights due to increased water depths, as well as possible changes in the frequency, duration and severity of storm events are also predicted.

7.1 Potential Changes in Climate

Global sea levels will continue to rise, depending on greenhouse gas emissions and the sensitivity of the climate system. The relative sea level rise in England also depends on the local vertical movement of the land, which is generally falling in the south-east and rising in the north and west. Annex B of PPS25 provides allowances for the regional rates of relative sea level rise and these are shown in Table 7.1.

	Net Sea Level Rise (mm/yr) Relative to 1990			
Administrative Region	**1990 to 2025**	**2025 to 2055**	**2055 to 2085**	**2085 to 2115**
East of England, East Midlands, London, SE England (south of Flamborough Head)	4.0	8.5	12.0	15.0
South West	3.5	8.0	11.5	14.5
NW England, NE England (north of Flamborough Head)	2.5	7.0	10.0	13.0

Table 7.1 - Recommended contingency allowances for net sea level rise

When these values are applied to the current day predicted extreme sea levels it can be seen that the increase in sea level is significant and is not linear. The 1 in 200 year sea levels have therefore been calculated for four time steps between the time of this report (2010) and the year 2110 and are summarised in Table 7.2 below.

Year	1 in 200 year extreme water level (mAOD)
2010	4.78
2025	4.84
2055	5.10
2085	5.46
2110	5.80

Table 7.2 – Climate change impacts on extreme sea levels

To ensure that any recommended mitigation measures are sustainable and effective throughout the lifetime of the development, it is necessary to base the appraisal on the extreme sea level that is commensurate with the planning horizon for the proposed development. For residential development this is taken as 100 years and for commercial development a 60 year design life is assumed.

Annex B of PPS25 also provides guidance on sensitivity allowances for other climatic changes such as increased rainfall intensity and peak river flows. These are shown in Table 7.3 below.

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%		+20%	
Offshore wind speed	+5%		+10%	
Extreme wave height	+5%		+10%	

Table 7.3 - Recommended national precautionary sensitivity ranges

7.2 Impacts of Climate Change on the SFRA Study Area

The Environment Agency Flood Zone maps are based on current day sea levels and climate conditions. However, in order to gain an understanding of the impact of climate change with respect to both rising sea levels and increased rainfall intensity, the Flood Zone maps have been redrawn using the 2110 predicted extremes. For the coastal flood zones at Seasalter through to Reculver the impact will be comparatively small as the land slopes away quite steeply from the coastal floodplains, thus any rise in predicted flood levels results in a relatively small increase in the extents of the floodplain. East of Reculver, however, the impact will be more pronounced due to the relatively flat topography of the low-lying hinterland.

Inland, for the River Great Stour, the impact of the 20% increase in peak river flows has been taken into account as part of the hydraulic flood modeling study, although this is only for the modeled extents through the city itself. For all the other rivers, hydraulic flood modeling has not been undertaken and therefore it has not been possible to quantify the impacts of a 20% increase in peak flows. The 2110 climate change Flood Zone maps are included in Appendix 3 of this report.

The breach and wave overtopping modelling that has been undertaken as part of this SFRA has been carried out using both the current day conditions and using increased wave and water level values commensurate with the predicted 2110 climate. These increases have a significant impact on the outcome of the modelling.

When the dynamics of a breach are considered, the increase in sea level over the next 100 year period will result in a significantly increased volume of flow through the breach at the peak of the event. Higher water levels will also allow larger wave heights to be sustained closer inshore in combination with the predicted increase in offshore wind speeds, it is estimated that wave overtopping could increase by a factor of between 20 and 100, depending upon location, by 2110. The impact of these climatic changes is illustrated clearly by the Hazard Maps included in Appendix 5.

The District has many watercourses that are particularly flashy in their response to intense rainfall and historically this has caused many problems where they flow through urbanised areas, especially where they are culverted or form part of the surface water sewerage network and have tide locked outfalls. Consequently, increases in peak rainfall intensity and peak river flow are likely to significantly increase the risk of flooding from these watercourses.

Climate change will inevitably result in an increased risk of flooding from all sources. Consequently, the potential impacts of climatic change will require careful consideration before sites for development are allocated. The reliance of the towns of Whitstable and Herne Bay on coastal flood defence infrastructure will increase over this next century and as sea levels increase, so will the consequences of failure of these defences. It is therefore necessary to ensure that new development is designed so that these residual risks are mitigated.

By managing surface water in a sustainable manner, through the use of SuDS for example, it is possible to ensure that new development does not exacerbate flood risk on site or elsewhere within the catchment. Taking climate change into account at the planning stage will ensure that its impacts are mitigated, thus the risk of flooding can be managed throughout the next 100 years.

8 Flood Risk Management Practices

8.1 Existing Sea Flood Defence Infrastructure

Over 10km of the District's 21km coastline is low-lying, which, without the protection of the existing sea defence infrastructure, would be inundated on a regular basis. With the exception of the agricultural land at the east and west, the land behind the defences is highly developed and includes the towns of Whitstable and Herne Bay. In order to protect these developed areas sea defences have been constructed along the entire length of the District's low-lying frontage. These are extensive formal defences - mainly comprising a concrete seawall, fronted by a large shingle beach, kept in place by timber groynes.

Figure 8.1 – New sea defences under construction at Herne Bay in 1990

The beaches, as well as protecting the seawall against wave attack and undermining, also contribute to the overall level of protection by considerably reducing the amount of wave overtopping. The groynes are generally close spaced to ensure that a sufficient volume of beach is maintained within each groyne bay. At the majority of locations there is a relatively stable beach. The beaches are monitored at least three times every year as part of the Regional Strategic Coastal Monitoring Programme and the data analysed regularly to ensure the profile of the beach remains within the design limits.

The Council has an annual beach recycling contract to deal with any areas where the beach is eroding. It also has an adequate annual maintenance budget to repair groynes and the seawall and to make minor improvements. Over the last twenty years major capital projects have been carried out to bring all defences protecting developed areas up to the 1 in 200 year design standard. There is also a long-term capital programme for further improvements to the defences, which mainly comprises of raising seawalls, to sustain this standard of protection in line with projected rising sea levels.

Section 4.3 of this report describes the four Flood and Coastal Erosion Risk Management Strategies covering the short, medium and long term proposals to maintain and improve the sea defences over time and also the Council's approved Policy Statement on Flood and Coastal Defence. These all reiterate the need for, and the Council's commitment to, continued maintenance of the defences and planned beach replenishments where necessary. The strategy reports also highlight the need for the raising of seawalls in some locations by up to 0.7m, probably in 20 to 30 years time. That work is included in the overall costs for schemes that are in the Environment Agency's Medium Term Plan. It should be noted that the costs for raising seawalls is relatively low and could be covered from the Council's maintenance budget if carried out in stages should Central Government funding be limited in the future.

The coastal flood defence assets along the District's coastline are identified on the map in Appendix 4. All relevant data, including type and construction, standard of protection, crest height, condition etc is summarised in the accompanying table also in Appendix 4.

8.2 Existing River Flood Defence Infrastructure

With the exception of the various floodwalls and sluice gates on the Great Stour through Canterbury's city centre, there are very few physical flood defence structures on the watercourses in the District. However, many of the watercourses within the District have benefited from flood alleviation schemes and various improvement works over the last twenty years, particularly after the 2000/2001 floods. Due to the nature of these schemes it is more appropriate to describe these within the main document rather than highlighting on a map. The key information is therefore summarised in Table 8.1 below.

Watercourse	Improvement Works Undertaken
Great Stour	Construction of major flood storage reservoirs upstream of Ashford at Hothfield and Aldington in 1990 which improved the standard of protection to 1 in 100 (single event) through Canterbury (see also Section 5.4 of this report). Minor improvements to weed screens, sluices and weirs through the city centre, particularly at Barton Mill, since 2000. Programme of river training works including dredging and bank cutting back downstream of Fordwich to improve flow.
Nailbourne	Recutting of banks and watercourse bed throughout the length from Barham to Bishopsbourne to improve flow and remove obstructions. Flood walls and new weedscreens at Barham. New, improved capacity, road culverts at Barham, Kingston and Bishopsbourne. Major capital project on river at Bridge in 1995. New diversion channel, deepening of ford and other works at Patrixbourne.
Little Stour	Flood relief diversion channel from Littlebourne to Wickhambreux. Removal of obstructions and improved maintenance to channel downstream of Littlebourne.
Gorrell Stream	Improved regime and additional pump by Southern Water at Gorrell Tank outfall. New weed screen at entry to piped section. Clearing out of channel and removal of obstructions plus improvement works by EA commenced in September 2010.
Kite Farm Ditch	Recutting of banks and watercourse bed through majority of open section plus weed screen improvements works by EA commenced in September 2010.
Swalelciffe Brook	A second outfall structure constructed alongside existing outfall to double discharge capacity to the sea.
Plenty Brook	New outfall structure as part of sea defence improvements in 1990. Clearance of obstructions and minor improvements to piped section by Southern Water. New weed screen and channel improvements at Eddington. Full clearance and extension to total 26,000m^3 capacity of Southern Water holding reservoir at Eddington. Improvements to capacity of Kent Highways A299 balancing lagoons. New 35,000m^3 on line balancing lagoon at Bullockstone and 10,000m^3 off line holding lagoon below Herne.

Table 8.1 – Recent Improvement Works to Rivers within the District

Figure 8.2 – Improvement to the Swalecliffe Brook Outfall

8.3 Emergency Planning and Response

The Council has defined responsibilities under the Civil Contingencies Act 2004 to assess risk, and respond appropriately in case of an emergency, including a major flooding event. The Council's primary responsibilities are:

- to assess the risk of an emergency occurring
- to assess the risk of an emergency making it necessary or expedient for the person or body to perform any of his or its functions
- to maintain plans for the purpose of ensuring, so far as is reasonably practicable, that if an emergency occurs the person or body is able to continue to perform its functions;
- to maintain plans for the purpose of ensuring that if an emergency occurs or is likely to occur the person or body is able to perform its functions so far as necessary or desirable for the purpose of preventing the emergency, reducing, controlling or mitigating its effects, or taking other action in connection with it.

To meet the requirements of the Civil Contingencies Act the Council has produced a Local Multi-Agency Flood Plan. The purpose of the plan is to set out all the principles that will govern the multi-agency response to a significant flood event in the Canterbury District. The plan sits underneath the Pan Kent Multi Agency Flood Plan. The SFRA provides a summary of the sources and mechanisms of flooding within the District and may therefore be used to inform the assessment of flood risk in response to the requirements of the Act.

If flood warning systems are to have any value they must give people sufficient notice so that they can make appropriate and timely preparations and responses in order to reduce the resultant damage and distress. For Canterbury District this is achieved through District flood emergency plans. At the District level, the main emergency response is carried out by Canterbury City Council with back-up from Kent County Council's emergency planning department and the emergency services. The essence of the plans, and in particular what will actually be done and the systems that are in place to do it, is given in the Kent County Council document "Co-ordination Plan for Major Emergencies" and the Canterbury City Council documents "Major Emergency Plan" and "Flood Emergency Plan".

The Council has a duty engineer standby system set up to respond to flood warnings and flood emergencies. There are 12 engineers on the duty standby team and one of these, by rota, is always on duty such that there is cover 365 days a year and 24 hours a day. Because of the size of the team there will always be a number of engineers who are not on duty but who would also be available to respond to a call should the need arise. On top of this, there are other engineering staff, not on the duty rota, that are available to assist at relatively short notice. The majority of the duty standby team are experienced coastal engineers who have been on the team for a long time. Considerable experience of actual emergency flood conditions and actions was gained as a result of the significant flooding and numerous Severe Flood Warnings during the fluvial flood events of winter 2000/2001. The duty engineers receive warning information from the Council's central control, which is permanently manned by at least two persons.

When a Flood Alert is issued, the duty engineer will ensure, by visual inspection, that all appropriate floodgates in the seawalls are properly closed and, if they are not, make arrangements to have them closed. The duty engineer can monitor actual sea conditions using data from a wave and tide recorder on Herne Bay Pier, which can be obtained online in real time, and take any further action deemed appropriate. This may include upgrading the local Flood Alert to a Flood Warning. If conditions deteriorate, the Council's Major Emergency Plan is activated. This plan sets out all the necessary actions to be taken including action by the Council's emergency response contractor, evacuation procedures and the setting up of emergency rest centres. There is a specific Sea Flood Emergency Plan, which is updated annually, with particular reference to actions needed during sea flooding. A similar system is also in place for river flooding with procedures for opening river sluice gates and monitoring river levels. There are river level sensors on both arms of the Stour through the centre of Canterbury, which will automatically give a warning to the duty engineer if the level is above the set alarm value.

8.4 Flood Warning

The Environment Agency monitors rainfall, river levels and tides, as well as employing state of the art forecasting techniques. Based on the information received from these flood warning systems, Flood Warnings are issued using a set of three codes, each indicating the level of risk with respect to flooding. The warnings issued are as follows:

Flood Alert - indicates that flooding is possible and that people should make simple preparations (e.g. check that domestic flood gates/boards are ready to be put in place, move small valuable items upstairs, check travel plans) and remain vigilant.

Flood Warning - indicates that flooding of homes is expected and people should take specific actions (e.g. move/raise belongings, put in place flood boards, move to places of safety).

Severe Flood Warning – to be used in extreme circumstances to tell people that flooding will/is posing a significant risk to life or significant disruption to communities which could also cause risk to life.

Flood warning procedures are in place for the following locations within the District.

- Coastal areas at Graveney and Seasalter (part of EA Area Code 073FWC2)
- Coastal areas at Whitstable (EA Area Code 073FWC4)
- Coastal areas at Swalecliffe, Hampton, Herne Bay and Reculver (part of EA Area Code 073FWC5)
- The tidal Great Stour downstream of Fordwich including Grove Ferry and Plucks Gutter (part of EA Area Code 073FWC6E)
- The Great Stour from Shalmsford Street through Chartham and Canterbury to Fordwich (part of EA Area Code 073FWF6A4)
- The Westbrook including the Plenty Brook (EA Area Code 073FWF9A2)
- The Swalelciffe Brook including the Gorrell Stream and Kite Farm Ditch (EA Area Code 073FWF9A3)
- The Nailbourne and Little Stour from Barham to Stourmouth (part of EA Area Code 073FWF6A7)

Further information relating to the flood warning areas and procedures can be found on the Environment Agency's website.

9 Flood Risk Modelling

9.1 Overview

One of the primary objectives of the SFRA is to refine the quality of flood risk information available to decision makers so that planning decisions can be better informed. Without detailed analysis of flood risk, the only available information is the Environment Agency's Flood Zone mapping; however, this is far too coarse and does not recognise the presence of the existing flood defences. Consequently, as part of the SFRA, detailed hydraulic modelling has been undertaken to analyse the risk of flooding and quantify the impacts of flood events that may occur as a result of a breach or overtopping of the sea defences or banks of the River Great Stour.

In order to quantify the consequences of a flood event along the coastline and from the River Great Stour, numerical modelling has been undertaken to inform the SFRA. The modelling methodologies are explained further in the following sections, and the results of all of the scenarios run are plotted on the series of District wide maps located in Appendix 5 and 6 of this report.

9.2 Breach Analysis at the Coast

Through discussion with the Council's Engineering Team and the Environment Agency, locations for potential breaches in the flood defences have been identified. These locations were chosen on the basis of defence type, condition, exposure and the likely consequences of a breach. All breach scenarios were run using the 1 in 200 year extreme sea levels for both current day and with an allowance for climate change for the year 2010.

At each breach location, the specific characteristics of the defence structure and the immediate hinterland have been examined. This information was then used to determine the size and nature of the breach used in the model. The breach characteristics are summarised in Table 9.1 below for each location. The location of each breach is shown on the maps included in Appendix 5 of this report.

Code (refer to App 5)	Modelled Breach Location	Description	Width (m)	Breach Invert mAOD	Time breach open (Hrs)	Defence Crest Height [2010] mAOD	Defence Crest Height [2110] mAOD
S1	Seasalter (west)	Full breach	50	3	30	6.0	6.0
S2	Seasalter (east)	Full breach	50	2	30	5.5	5.5
W1	Whitstable Tennis Courts (east)	Full Breach	20	2.9	30	5.8	6.5
W2	Whitstable Harbour (east)	Open Flood Gate	6	5	30	5.8	6.5
H1	Herne Bay Central	No breach – overtopping only	-	-	-	5.8	6.5
R0	Reculver (west of Towers)	No breach – overtopping only	-	-	-	6.4	6.4
R1	Reculver (west)	Full Breach	100	2.5	30	6.7	6.7
R2	Reculver (east)	Full Breach	100	2.5	30	6.7	6.7

Table 9.1 – Breach locations and characteristics

9.3 Wave Overtopping

As well as flooding resulting from a breach in the coastal flood defences, some of the low-lying areas of the District are also at risk from wave overtopping. During an extreme storm event the combination of high water levels and large waves can result in significant volumes of water overtopping the seawalls as waves break against and over the defences.

In order to ensure that the flood risk modelling undertaken as part of this SFRA is representative, it is therefore necessary to include the impacts of wave overtopping within the overall breach and flood propagation modelling. Analysis locations were chosen on the basis that they would be subjected to wave overtopping under extreme conditions and were generally areas where breaching of the sea defences would be unlikely because of the nature of the defences and hinterland.

Beach and structure profiles were derived using survey data taken from the Southeast Strategic Regional Coastal Monitoring Programme and from information provided by the Council's Engineering Team. The peak overtopping rate was then used to derive an input hydrograph of overtopping volume that is representative of a typical storm duration of a single tidal cycle. This was then applied along a linear boundary equivalent to the length of frontage over which overtopping was modelled. The locations of the overtopping frontages are shown on the maps included in Appendix 5 of this report. A summary of the overtopping boundary conditions used is given in Table 9.2 below.

Code	Modelled Overtopping Location	Description	Over-topping boundary length (m)	Time Applied (Hrs)	Over-topping Rate [2010] l/s/m	Over-topping Rate [2115] l/s/m	Defence Crest Height [2010] mAOD	Defence Crest Height [2110] mAOD
SOT1	Seasalter Overtopping (West)	Wave overtopping	5029	1 tide	8	Overflow	6.0	6.0
SOT2	Seasalter Overtopping (East)	Wave overtopping	792	1 tide	8	Overflow	5.5	5.5
WOT1	Whitstable Overtopping	Wave overtopping	1852	1 tide	1	18	5.8	6.5
WOT2	Whitstable Overtopping	Wave overtopping	511	1 tide	1	18	5.8	6.5
SCliffe WestOT	Swalecliffe Overtopping	Wave overtopping	312	1 tide	Overflow	Overflow	5.0	5.0
SCliffe EastOT	Studd Hill Overtopping	Wave overtopping	2270	1 tide	0.1	5	6.7	6.7
HampOT	Hampton Overtopping	Wave overtopping	368	1 tide	9	140	6.2	6.2
HOT	Herne Bay Overtopping	Wave overtopping	1110	1 tide	0.2	13	5.8	6.5
ROT1	Reculver (west) Overtopping	Wave overtopping	181	1 tide	18	500	6.4	6.4
ROT2	Reculver (east) Overtopping	Wave overtopping	4666	1 tide	2.3	63	6.7	6.7

Table 9.2 – Overtopping frontages and characteristics

9.4 Modelled Scenarios at the Coast

As well as identifying the location and characteristics of each breach and overtopping site, the likelihood of combined events has also been taken into consideration. Whilst a comprehensive probabilistic assessment has not been undertaken, a pragmatic and precautious approach has been adopted.

Whilst PPS25 promotes a precautionary approach to flood risk management, it is also necessary to ensure that the SFRA presents a realistic appraisal of risk and this ethos is important when considering the number of breaches and wave overtopping events that could occur concurrently.

In order to achieve the correct balance between precaution and realism, the likelihood of combined failures and overtopping events has been discussed with both Environment Agency and Council Engineers. The outcome of this process was a matrix of the individual overtopping and breach events that have then been combined to represent the impact of a storm event on each of the north Kent coast towns within the District. It has been assumed that both breach and wave overtopping events would occur concurrently and a summary table showing the matrix of combined events for each town/frontage is included in Appendix 5.

9.5 2D Hydrodynamic Model Set-up

The software package that has been used to undertake the breach and wave overtopping analysis was TUFLOW (version 2009-07-AF-iSP), which is a two-dimensional finite difference flood simulation model. The TUFLOW model operates within the Surface Water Modelling System (SMS v10.1.1), which is a comprehensive environment for one, two, and three-dimensional hydrodynamic modelling.

The TUFLOW model utilises a three dimensional digital elevation model (DEM) that is created from spot height data and uses this to model the propagation of floodwater across a defined landscape. The data used to create the DEM in this instance was the Environment Agency's Lidar data, which was supplied at a 2m resolution for the entire study area.

The model boundaries were set to include the entire area shown within Environment Agency's Zone 2 flood risk area within Canterbury's district (coastal) boundaries. To ensure that the model boundaries were representative, the coverage was also extended to include parts of the Swale and Thanet Districts. This allows floodwater to propagate to the physical boundaries of the floodplain rather than 'glass walling' against the District boundaries. From the DEM, a 2D grid with points every 10m was then created for use in the TUFLOW model. This resolution gives a reasonable representation of the geographical features within the model and was considered to be the optimum balance between model performance and computer processing time.

Each model was run for a minimum time of 30 hours (simulated) for frontages including breach scenarios and a minimum of 10 hours (simulated) for frontages with overtopping boundaries only.

9.6 Modelling Outputs

Flood depth and extents maps have been produced for both the current climate, and future climate conditions, and these are included in Appendix 6. Although these maps provide an indication of flood depths within each flood compartment, due to the complexity and scale of each of the modelled flood compartments, it is not possible to show the predicted depth and velocities within the SFRA at a scale that will allow this data to be interpreted at a site-specific scale. However, for each of the 10m grid cells, information on flood depth and velocity has been recorded for every 10 second interval throughout the entire 30 hour model simulation.

Consequently, in order to maximize the value of this information and facilitate the appraisal of flood risk at a strategic level, the use of hazard mapping has been adopted within the SFRA.

The Hazard Maps provide a graphical representation of the hazards associated with flooding, expressed as a function of depth and velocity. In the report 'Flood Risks to People' (R&D output FD2320/TR2) a methodology for quantifying flood hazard is set out using the following equation:

$$HR = ((v + 0.5)\ d) + DF$$

where, HR = flood hazard rating

d = depth of flooding (m)

v = velocity (m/sec)

DF = debris factor (as defined and evaluated in report FD2320/TR2)

The depth and velocity outputs from the breach analysis have therefore been processed for every one of the 14 modelled scenarios to give a hazard rating for each of the 10m grid cells contained within the model. The value associated with each cell is then used to assign a Hazard Rating based on the four hazard classifications shown in Table 9.4

Hazard Rating (HR)	Degree of flood hazard	Description
< 0.75	Low	Caution – shallow flowing water or deep standing water
0.75 to 1.25	Moderate	Dangerous for some, i.e. children – deep or fast flowing water
1.25 to 2.5	Significant	Dangerous for most people – deep fast flowing water
> 2.5	Extreme	Dangerous for all – extreme danger with deep and fast flowing water

Table 9.4 – Classification of Hazard Rating Thresholds

Assessing the risk of flooding as a degree of hazard allows a simple and robust method of risk analysis across the entire district. Also, because of the way in which the hazard classifications are derived, it is possible to combine the outputs of all modelled scenarios to give a single hazard map that is representative of hazards associated with each of the modelled scenarios. Whilst this process allows the flood risk information from all scenarios to be collated into a single map, it does not result in the hazard rating being increased as a consequence of two exclusive events affecting a single site.

For instance, if a particular site has a hazard rating of 1.0 from Scenario A and 1.0 from Scenario B, the combined hazard rating is 1.0. However, if the same site were to be affected by a third scenario which resulted in a hazard rating of 1.5, the combined product of the three would be 1.5.

The Hazard Maps for both the current day and future climate change conditions are included in Appendix 5 for all flood risk areas that have been hydraulically modelled as part of this SFRA process.

9.7 Fluvial Modelling – The River Great Stour

In conjunction with the coastal modelling that has been undertaken for the district, there has also been a requirement to identify the potential risk of flooding as a result of an extreme fluvial event in the River Great Stour, which runs through the centre of Canterbury.

A separate flood risk mapping and hydraulic modelling study was commissioned by Canterbury City Council in 2008, which identified the risk of flooding to Canterbury City from the Great Stour for a range of return periods (Hydraulic Modelling and Flood Risk Mapping of the Great Stour – Canterbury, Herrington Consulting, November 2008). The model was constructed using a 1D hydraulic model embedded within a 2D hydrodynamic model and the following return period events were tested, all of which were simulated for a period of 100 hours;

(a) 1 in 5 year flow conditions (current day)
(b) 1 in 20 year flow conditions (current day)
(c) 1 in 50 year flow conditions (current day)
(d) 1 in 100 year flow conditions (current day)
(e) 1 in 100 year flow conditions (plus climate change to 2110)

This model was reviewed by the Environment and verified fit for purpose for informing site-specific flood risk assessments.

For the purposes of the SFRA the outputs from the modeling for scenarios (d) and (e) above have been mapped, with the results delineating both the flood depths and hazard mapping for the Great Stour on the district wide maps located in Appendix 5 and 6 respectively.

It should be noted that because the current flood defence infrastructure along the river was included within the model setup, the predicted flood extents could not be used to update the Flood Zone maps. It is for this reason that the flood maps, including an allowance for climate change, which are located in Appendix 3 only contain revised information for the coastal regions.

10 Guidance for Site Specific FRAs

10.1 When is a Site-specific FRA Required?

The role of the site specific FRA is to examine and quantify the risk of flooding to a particular site or development. However, the FRA also has to consider the impact that the proposed development may have on flood risk to areas outside of its own boundaries. Consequently, whilst the Flood Zone category is an important factor in triggering the requirement for a FRA, it is also necessary to consider areas of the District in which development could result in the exacerbation of flooding elsewhere.

A description of the flood zones and the specific circumstances that will require a planning application to be accompanied by a site-specific FRA are summarised below. However, for more general guidance on FRA requirements the Environment Agency has developed a web-based flowchart that can be accessed from the following link.

http://www.environment-agency.gov.uk/research/planning/93498.aspx

Flood Zones 1 – Low probability of flooding – This zone is assessed as having less than a 1 in 1000 probability of river or sea flooding in any one year.

> *If the site is less than 1 hectare then a site-specific FRA will only be required if it lies within an area defined by either the Critical Drainage Zone or the Overtopping Hazard Zone, or if it is identified by the Council as being a site with specific critical drainage problems, or is located within 20m of a main river.*

Flood Zone 2 – Medium probability of flooding – This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding or between 1 in 200 and 1 in 1000 probability of sea flooding in any one year.

> *A site-specific FRA will be required and this will need to be prepared in accordance with the requirements set out in PPS25, paragraphs 10 - 13 and annex E.*

Flood Zone 3 – High probability of flooding - This zone comprises land assessed as having a 1 in 100 or greater probability of river flooding or 1 in 200 or greater annual probability of sea flooding in any one year.

> *A site-specific FRA will be required and this will need to be prepared in accordance with the requirements set out in PPS25, paragraphs 10 - 13 and annex E. The requirement for compensatory flood storage needs to be taken into account for developments within the river flood zone.*

Overtopping Hazard Zone - As a District that has approximately 21km of shoreline, much of it developed, there is a need to consider the way in which flood risk is managed in those areas that are affected by wave overtopping. The land along the seaward side of Faversham Road Seasalter is specifically designated as being a Wave Overtopping Hazard Zone. This is because even for storms of relatively frequent return period (1 in 10 years and above) there is a risk of flooding due to wave overtopping. For development within this wave overtopping zone there are hazards associated with localised flooding, structural integrity of buildings and safe access and egress to the buildings. When the impact of climate change is also taken into account, the impacts of wave overtopping on development within this zone will become more severe. Consequently it is the view of both the Council and the Environment Agency that the SFRA should put in place measures to ensure that development in these locations is appropriate.

The effects of wave overtopping are illustrated by the photograph in Figure 10.1 below, which shows wave overtopping and the onset of localised flooding at an area that is classified as a Zone 1 flood risk area. Given that many areas that are subject to wave overtopping are located within Zones 2 or 3, it is quite possible that the initial or even the total flood extent would be due to wave overtopping and thus the overtopping issues should be dealt with as part of the site-specific FRA. However, for development sites located within 30m of the landward crest of the seawall, it will be necessary for a FRA to be prepared that addresses the hazards specifically associated with wave overtopping.

A site-specific FRA will be required and this will need to be prepared in accordance with the requirements set out in PPS25, paragraphs 10 - 13 and annex E. In particular this will need to examine the impacts of wave overtopping on the proposed development under current and future climatic conditions.

Figure 10.1 - Wave Overtopping eastern Herne Bay

Definition of the Functional Floodplain in Locations Seaward of the Seawall

PPS25 splits Flood Zone 3 into two sub-divisions: Flood Zone 3a, defined as "land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any one year" and Flood Zone 3b, defined as The Functional Floodplain or "land where water has to flow or be stored in times of flood. … land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes".

There are many locations within the District where there are areas of Flood Zone 3 located seaward of the existing seawall. In some locations the level of the land/beach is above the predicted 1 in 20 year extreme level and could be misconstrued as being classified as Zone 3a rather than in Zone 3b. However, when the potential for beach drawdown and wave run-up is taken into consideration alongside the impacts of rising sea levels it is probable that areas of land/beach that are seaward of the seawall could be affected by wave run-up even if they were above the predicted 1 in 20 year still water level (SWL).

All undeveloped areas in front (seaward) of the sea wall are therefore defined as being included in the Functional Floodplain (Zone 3b).

For development that is permitted in the Functional Floodplain (Zone 3b), as set out in PPS25 Tables D1 and D2, the applicant will have to take the following requirements into account:

- The impacts of rising sea levels over the lifetime of the development including the increase in wave height and in other parameters consequent on the rising sea levels.
- The potential for beach drawdown.
- The degree of wave run-up that would occur for a range of wave height and water level combinations.

Development in the Functional Floodplain in Locations Seaward of the Seawall

A site-specific FRA will be required and this will need to be prepared in accordance with the requirements set out in PPS25, paragraphs 10 - 13 and annex E. In particular this will need to examine the potential for beach drawdown under storm conditions and the potential for wave run-up under current and future climatic change scenarios. Flood extents and depths within the site shall be established by taking into account the dynamic nature of the land/beach in front of the seawall and the potential for wave run-up.

The only development which will be permitted in the Functional Floodplain seaward of the sea wall is that listed in Table D2 of PPS25 under Water-compatible Development, together with essential infrastructure and works of, or associated with, coast protection and flood control.

Critical Drainage Zone – There are no designated Critical Drainage Areas under the Town and Country Planning (General Development Procedure) (Amendment) (No. 2) (England) Order 2006, which introduced the concept of Critical Drainage Areas as "an area within Flood Zone 1 which has critical drainage problems and which has been notified to the local planning authority by the Environment Agency". However, there are two specific areas where drainage and localised surface water flooding have been a problem for many years. These are at Chestfield and Blean. At these two locations particular care needs to be taken with the disposal of surface water to ensure that any flooding in the villages is not exacerbated. There are also some smaller individual locations where there have been recurrent surface water flooding problems that any development would need to take account of. All the known "drainage/flooding hotspots" are shown on the mapping in Appendix 2.

Particularly at Reculver, behind the Northern Seawall, but also throughout much of the rural area close to the Stour, there is land that is drained by man-made watercourses that discharge to the main river or the sea. This drainage network is maintained and managed by the River Stour (Kent) Internal Drainage Board (IDB). At Graveney a similar situation applies with respect to man-made watercourses maintained by the Lower Medway IDB.

Any new development that increases the rate and volume of surface water runoff from a site will have the potential to increase the burden on this heavily managed network of watercourses. If surface water runoff in these areas is not managed appropriately then there is a risk that the capacity of the pumps and tidal outlets that are used to drain the land will be exceeded. This will exacerbate the risk of flooding and therefore it is imperative that surface water drainage in these areas is managed responsibly.

In addition, many of the higher areas of the District fall within the upper catchment areas of the main rivers that flow through Canterbury, Whitstable and Herne Bay. These watercourses are already identified as posing a significant risk of flooding. Consequently, in order to ensure that this risk is not exacerbated by increased runoff from new development, specific policies have been developed.

To cover critical drainage issues the Council has adopted a specific policy (Local Plan Policy C31).

> *All development proposals within the areas at risk of flooding or increased surface water run-off shall be subject to a Drainage Impact Assessment including a Flood Risk assessment where relevant. The assessment shall be in accordance with the principles of PPS25, Sustainable Drainage Systems (SuDS) and the Council's Guidance Note*

Sites larger than 1 hectare – In accordance with the guidance set out in PPS25, planning applications for development on sites greater than 1 hectare will need to be accompanied by a site-specific FRA even if it is outside of Zones 2 or 3. This is to ensure that development will not be affected by flooding from other sources such as overland flow or groundwater flooding. The site-specific FRA will also need to demonstrate through the development of a Surface Water Management Strategy that the proposals will not have an adverse impact on flood risk to areas outside of the site boundaries.

The application will need to be accompanied by a site-specific FRA. This will need to include a Surface Water Management Strategy and will also need to demonstrate that, where possible, a sustainable drainage (SuDS) approach has been adopted.

Development within 20m of a Main River – Applications containing culverting or obstruction to the flow of a watercourse, or works within 20m of the top of the bank of a Main River require a site-specific FRA and consent from the Environment Agency.

The application will need to be accompanied by a site-specific FRA. This will need to include design details of the culvert and proposed flow control structure and will require Land Drainage consent from the Environment Agency

Development within 15m of the landward toe of a tidal defence – Applications containing works within 15m of the landward toe of one of the Environment Agency's tidal defence structures or the Council's sea and coastal defence structures require the consent of the relevant authority and such mitigating works as considered necessary by the authority.

Such works will require Land Drainage Act consent from the Environment Agency or Coast Protection Act consent from Canterbury City Council.

Development within 8m, or connection to an IDB Watercourse – Applications containing culverting or obstruction to the flow of a watercourse, or works within 8m of the top of the bank of an IDB watercourse or including proposals to discharge surface water into any IDB watercourse require the consent of the relevant IDB.

In addition to any site-specific FRA that may be required, the applicant will need to consult with the IDB and gain consent for any works within this zone and/or connections to the IDB watercourse.

10.2 FRA Requirements

The minimum requirements for a flood risk assessment are described in Annex E of PPS25. Further guidance is provided by the Practice Guide companion to PPS25. The FRA must be appropriate to the scale, nature and location of the development, and consider all possible sources of flood risk, the effects of flood risk management infrastructure and the vulnerability of those that could occupy and use the proposed development.

One of the requirements of both the Exception Test and Annex E of PPS25 is that the FRA demonstrates that the development will be safe, without increasing flood risk elsewhere. To be classed as safe, there are a number of key requirements that need to be satisfied. These are as follows and shall be based on the flood level with an allowance for climate change being taken into consideration:

- That a safe access route to and from any residential development can be provided or in exceptional circumstances that a safe refuge above design flood level can be provided. The safe refuge shall have a means of escape by which residents can be rescued by the emergency services from a door or freely opening window of sufficient size.
- Living accommodation should be set at least 300mm above the design flood level.
- Sleeping accommodation should be set at least 600mm above the design flood level.

For fluvial flooding, the design flood level should be taken as the 1 in 100 year predicted flood level, for tidal and coastal flooding the 200 year return period event should be used. In both cases the impacts of climate change should be included to cover the lifetime of the building, which shall be taken as 100 years for residential and 60 years for commercial developments.

In much of the low-lying parts of the coastal areas of Seasalter, Whitstable, Swalelciffe, Hampton, Herne Bay and Reculver, when the predicted extreme sea levels shown in Table 7.2 are compared with the level of the land, there is a significant difference. However, it is generally not appropriate to use these open sea extremes to predict flood levels in locations that are protected by defences. Consequently, for all coastal flooding scenarios it is recommended that the outputs from the breach and wave overtopping modelling are used to define the design flood level at individual sites.

This information can be provided at a site-based scale and would include depth, velocity and water surface elevation. To obtain site specific outputs from the hydraulic model, please initially contact Canterbury City Council's engineering team on 01227 862000 for further details. Where site-specific information is not readily available and the model has to be interrogated the cost to provide this data will be charged to the applicant.

10.3 Specific FRA Guidance

The Exception Test - As set out in section 3.5, for the Exception Test to be passed there are three criteria that all must be satisfied. The third criterion (c) is the requirement that a FRA can demonstrate that the development will be safe and advice on this is given under the sub-headings following this one. The two other criteria relate to the requirements that - it can be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk (a) and the development is on developable or previously developed land (commonly known as brownfield land) (b).

It is confirmed that all the designated residential and mixed use sites, within Flood Zones 2 & 3, that are listed in the approved Local Plan (see also Appendix 7) are brownfield sites and hence they pass part (b) of the Exception Test. It is also confirmed that the Local Plan sites within Flood Zones 2 & 3 do provide wider sustainability benefits to the community that outweigh flood risk and hence also pass part (a) of the Exception Test. Following consultations for the Local Plan, including consultation with the Environment Agency, it was agreed that the City Council had to assess the potential of its town centre sites to stimulate regeneration and that these were the only deliverable options. The benefits of providing improved retail areas, particularly in Whitstable and Herne Bay, together with a network of other social and leisure services is considered to outweigh flood risk – provided that risk is properly managed.

The City Council has already allocated land outside of the flood risk area in the Local Plan and some of these sites have been or are being developed. However, to meet the objectives of the Local Plan, development sites that are within the town centres themselves are also needed. The sites are all located in an existing urban (town centre) area immediately adjacent to existing services and transport links and the developments can be provided within the existing infrastructure without any significant impact on resources whilst enhancing the overall sustainability of the community – all in accordance with the aims of the Local Plan. It should be noted that the Strategic Housing Land Availability Assessment (SHLAA) sites in Appendix 7 may not necessarily be brownfield sites or have sustainability benefits to the community and these would need to be examined individually for parts (a) & (b) of the Exception Test.

Safe Access Route - With the exception of development on the fringes of the sea floodplains it is clearly not possible to provide a safe and dry access route from a new development within the sea floodplain to an area outside the flood zone. This is of particular concern for potential development of brownfield sites in the larger floodplains within the towns of Whitstable and Herne Bay. In order to allow development, which would otherwise pass all the other requirements of PPS25, it is necessary in exceptional circumstances to accept alternative arrangements, whereby occupants can seek refuge within the building itself. This will only be acceptable if access can easily be gained internally within the building to a suitably sized area that is raised at least 600mm above the 1 in 200 year predicted sea level including for climate change and shall have a means of escape by which residents can be rescued by the emergency services from a door or freely opening window of sufficient size..

Floor Levels – Whilst the use of breach and overtopping modelling has shown that inland flood depths will be much less than those predicted using open sea extremes, in many cases it will not be possible to raise ground floors above the 1 in 200 year (plus climate change) flood level. This can generally be overcome by opting for a 3 storey town house style dwelling with garage, utility and storage areas located on the ground floor, alternatively buildings can be designed such that the ground floor is for non-residential usage, such as commercial or retail.

Flood Resilient Construction - During a flood event, floodwater can find its way into properties through a variety of routes including:

- Ingress around closed doorways.
- Ingress through airbricks and up through the ground floor.
- Backflow through overloaded sewers discharging inside the property through ground floor toilets and sinks.
- Seepage through the external walls.
- Seepage through the ground and up through the ground floor.
- Ingress around cable services through external walls.

Since flood management measures only manage the risk of flooding rather than eliminate it completely, flood resilience and resistance measures may need to be incorporated into the design of the buildings. The two possible alternatives are:

Flood resistance or 'dry proofing', where flood water is prevented from entering the building. For example using flood barriers across doorways and airbricks, or raising floor levels. Such measures are generally only considered appropriate for some 'less vulnerable' uses and where the use of an existing building is to be changed and it can be demonstrated that no other measure is practicable.

Flood resilience or 'wet proofing', accepts that flood water will enter the building and allows for this situation through careful internal design for example raising electrical sockets and fitting tiled floors. The finishes and services are such that the building can quickly be returned to use after the flood.

In most cases the risk of new development being affected by flooding is very low, nevertheless, by incorporating flood resilience into the design of the building it is possible to reduce both the damage caused by a flood and the repair bill. It can also shorten the time before the occupants can return. Details of flood resilience and flood resistance measures can be found in the document 'Improving the Flood Performance of New Buildings; Flood Resilient Construction', which can be downloaded from the Communities and Local Government website.

Typical applications that are recommended for residential development located within a flood risk area are as follows:

- Solid concrete floors should be used instead of suspended floor construction as they can provide an effective seal against water rising up through the floor, provided they are adequately designed. Solid concrete floors generally suffer less damage than suspended floors and are less expensive and faster to restore following exposure to floodwater.

- The use of stud walls and plasterboard on the ground floor of new buildings should be avoided wherever possible as these absorb water and generally have to be removed and replaced after a flood event.

- Electricity sockets should be located at least one metre above floor level (or well above likely flood level) with distribution cables dropping down from an upper level. Service meters should also be at least one metre above floor level (or well above likely flood level) and placed in plastic housings.

- Boilers, should be mounted on a wall above the level that floodwater is likely to reach.

- The use non-return valves or 'anti-flooding devices' at the inspection chamber may be considered beneficial. These should only be installed in the sewer of a property upstream of the public sewerage system.

- Demountable defences - There is now a range of products available that can be used to protect properties from flooding and these generally take the form of plastic covers that clip in place over doors, windows and air bricks. The use of such measures should, however, be seen as a method of managing residual flood risk rather than as a primary defence.

10.4 Surface Water Management and Drainage Requirements

It is essential that the post-development runoff regime does not increase flood risk either on-site or elsewhere within the catchment. Re-development of existing sites also offers an opportunity to improve the existing runoff regime and reduce flood risk. In view of the significant surface water and watercourse flooding that occurred across the District during 2000/2001 the Council has a policy that a Drainage Impact Assessment be submitted as part of the consideration for a new development where there is a risk of flooding from whatever source. This Guidance Note is included at Appendix 9. The key requirements and objectives of the assessment are:

- If the site is a greenfield site, or brownfield site where there are known flooding/drainage problems, then the assessment will need to demonstrate that the maximum rate of surface water runoff from the site is controlled such that it does not exceed 4 litres per second per hectare or the pre-developed greenfield runoff rate if lesser. If the surface water discharge is to an existing land drainage system it may be necessary to observe lower limits subject to specific calculations.

- Where brownfield sites are to be re-developed, it will be necessary to demonstrate that the post-developed site will not increase the rate of surface water runoff and the aim shall be to reduce the runoff rates from previously-developed sites as much as is reasonably practicable.

- Where the surface water runoff from the developed site under the 100 year rainstorm (with an appropriate allowance for climate change, see Table 7.3) is calculated to be in excess of 4 l/sec/ha, attenuation is to be used to reduce the maximum flow from the site to that value. Attenuation should be by means of SuDS type systems as summarised in Section 13 unless it can be proved that these would be unsuitable and not applicable to the site. In that case attenuation should be by means of temporary storage, either located above or below ground, utilizing oversized pipes, underground tanks or other approved means.

- Where surface water runoff from the developed site will ultimately discharge into land drainage systems, watercourses, rivers or offsite lakes and ponds, either directly or via existing sewers, the ability of that system to cope with the additional flow of water from the developed site shall be demonstrated and if necessary measures must be taken beyond the development site to prevent any increase in flood risk resulting from the runoff from the site.

- Depending upon the location and circumstances of the development, the Council may require the developer to carry out or make a contribution to future offsite flood defence or alleviation works within the drainage catchment area for the purposes of both the protection of the new development and exiting development that may be affected.

- For all development, the assessment should demonstrate that no flooding of property either on or off the site will occur as a result of a 1 in 100 year storm event (including an appropriate allowance for climate change) as a result of the development. Wherever practicable it should aim to reduce the risk of flooding.

11 Sustainable Urban Drainage (SUDS)

11.1 Overview

PPS1 "Delivering Sustainable Development" and PPS25 require that LPAs should promote Sustainable Drainage Systems (SuDS) and ensure that their policies encourage sustainable drainage practices in their Local Development Documents. SuDS is a term used to describe the various approaches that can be used to manage surface water drainage in a way that mimics the natural environment.

The management of rainfall generated surface water is considered an essential element for reducing future flood risk to both the site and its surroundings. Indeed maintaining the existing rate of discharge from urban sites, even after climate change has occurred, is one of the most effective ways of reducing and managing flood risk in watercourses.

In addition, appropriately designed SuDS can be utilised such that they not only attenuate flows but also provide a level of improvement to the quality of the water passed on to watercourses or into the groundwater table. This is known as source control and is a fundamental part of the SuDS philosophy.

11.2 SuDS at the Planning Stage

At the conceptual stage of the scheme design it is necessary to make an assessment of the way in which the surface water discharge from the site will be managed and the options that are available to achieve this without increasing the risk of flooding. One factor that is key in this decision making process is the type of superficial and underlying geology, as this has a fundamental impact on the approach to be followed for the SuDS system. There are two fundamental variations in SuDS, these are:

- Infiltration within the attenuation facilities to partly or fully dispose of runoff

- Not using any infiltration techniques but providing attenuation facilities that maintain the discharges at pre-development levels

Either of these approaches balance the increase in runoff due to climate change and hence minimises the effect of any development work on the receiving watercourses.

Large increases in impermeable area contribute to significant increases in surface runoff volumes and peak flows and could increase flood risk elsewhere unless adequate SuDS techniques are implemented. It is relatively simple to avoid the increase in peak flows by providing attenuation or detention storage that temporarily stores the required amounts of runoff within the site boundary. SuDS elements may also be able to prevent increases in surface runoff volumes where significant infiltration is practicable.

11.3 Application of SuDS

Part H of the Building Regulations recommends that wherever practicable, appropriate SuDS elements should be incorporated into the drainage system. It also sets out a hierarchy for surface water disposal and infiltration is the preferred method for achieving this. If this is not possible, the next favoured option is to discharge to a watercourse. Only if neither of these options are achievable should the site discharge rainwater to a sewer.

A range of typical SuDS components that can be used to reduce flood risk and improve the environmental impact of a development is listed in Table 11.1 below along with the relative benefits of each feature and the appropriateness for different site specific variables.

SuDS Feature	Biodiversity enhancements	Water quality improvement	Suitability for low permeability soils ($k<10^{-6}$)	Ground-water recharge	Suitable for small / confined sites?
Wetlands	✓	✓	✓	✗	✗
Retention ponds	✓	✓	✓	✗	✗
Detention basins	✓	✓	✓	✗	✗
Infiltration basins	✓	✓	✗	✓	✗
Swales	✓	✓	✓	✓	✗
Filter strips	✓	✓	✓	✓	✗
Rainwater harvesting	✗	✓	✓	✓	✓
Permeable paving	✗	✓	✓	✓	✓
Green roofs	✓	✓	✓	✗	✓

Table 11.1 – Environmental improvements achievable through SUDS

As well as, or often in conjunction with, the SuDS features listed above there is the use of underground storage tanks, oversized pipes, flow control devices and similar attenuation methods that are particularly relevant to smaller and confined sites. Those devices can be very successful in limiting surface water discharge from a development to prevent flooding.

A description of the key benefits of the SuDS features listed in Table 11.1 is given below. For any retention or detention system it is important that the design allows for sufficient capacity to be available at the start of any storm allowing for the possibility that the system may already be partially full from a previous storm event

Wetlands – These provide a range of habitats for plants and wildlife as well as biological treatment. Linear wetlands can also provide green corridors.

Retention ponds – These open water bodies can significantly enhance the visual amenity of a development and provide wildlife habitat improvement opportunities.

Detention basins – These provide treatment by detention and can be designed as an amenity or wildlife habitat.

Infiltration basins - Treatment by detention and filtration. Potentially compatible with dual-use e.g. sports pitches, play areas, wildlife habitat. Can be any shape, curving or irregular, with scope for improved visual amenity.

Swales – Generally used to convey water to storage facilities and provide treatment by filtration. Swales are designed to remain dry between rainfall events and can be planted with trees and shrubs to provide green links/corridors. The preferred design will include as much infiltration as the surrounding ground can accommodate.

Rainwater harvesting – Provides attenuation and allows rainwater to be reused within the development, reducing the pressure on potable water supplies.

Porous and pervious paving – These can provide large areas of permeable surface and promote infiltration. They can attenuate runoff at source and discharge it after a significant delay. On all sites that are suitable for infiltration, unlined systems are to be encouraged as these pavements can infiltrate large amounts of water due to the large surface area contact with the ground.

Green roofs – As well as providing improved biodiversity opportunities, vegetated roofs reduce the volume and rate of surface water runoff and remove pollution.

From the soil and geology information provided in Section 2, it can be seen that the ground conditions across the District vary greatly. Consequently the applicability of different types of SuDS will be very much dependent on the site location. Where ground conditions are suitable, infiltration should be the first choice for surface water discharge. The benefits of using infiltration as part of a sustainable drainage system include:

- Infiltration of good quality surface water helps to recharge the aquifer and may benefit local groundwater use or groundwater dependent ecosystems.
- In naturally permeable soil locations, infiltration may mimic the natural water cycle otherwise lost under the development process
- Significant flow attenuation may be provided

However, the vast majority of development proposed in the District is likely to be in Canterbury itself and the coastal towns of Whitstable and Herne Bay. In these locations it is unlikely that infiltration will be an effective method of discharging surface water, however, it should be recognised that the level of detail contained within the geological and soils maps published as part of this SFRA is not appropriate for site-specific decision making. Consequently it may be necessary to investigate ground conditions in greater detail, particularly in Canterbury, before ruling out infiltration as an option.

11.4 Constraints on Discharges to Ground

There are some locations within the District that are shown by the Environment Agency's Groundwater Source Protection Zone map to be within areas where infiltration is controlled. These are primarily located south of Canterbury and particularly at Chartham and Barham.

The nature of an aquifer body and the groundwater within it provide significant constraints when considering the potential of SuDS that rely on infiltration to the ground to provide the means of surface water drainage, storage and flow attenuation. The main constraints associated with infiltration in these areas include contamination from brownfield sites and road drainage and seepage from poor quality surface water bodies.

It is possible to check whether a site is within a groundwater source protection zone by referencing the Environment Agency's 'What's in your backyard?' section of their website. If a particular site is shown to be within a groundwater source protection zone then whilst this does not preclude the use of infiltration, the following design issues will need to be taken into account:

- Soakaways must be constructed such that they do not exceed 3m in depth below the existing ground level.
- In order for water to be discharged to the ground, it must be demonstrated that an unsaturated zone will be available between the discharge point and the groundwater table at all times of the year. Advice on ground water levels may be available from the Environment Agency.
- Assuming that the above can be satisfied, runoff from roofs will need to be discharged to the soakaway via sealed downpipes. This arrangement must be capable of preventing both accidental and unauthorised contamination of the roof water
- All discharge must be into a clean, uncontaminated area of natural ground.

11.5 Sustainable Homes

Canterbury City Council currently requires that new residential development meets Level 4 of the Code for Sustainable Homes (or BREEAM 'very good' for non residential development). This means that all development needs to meet a defined environmental standard. Surface water runoff management is a key part of the Code for Sustainable Homes and there are 'mandatory' elements attached to this part of the Code. It aims to design surface water drainage for housing developments which avoid, reduce and delay the discharge of rainfall run-off to watercourses and public sewers using SuDS techniques as described above. This will protect receiving waters from pollution and minimise the risk of flooding and other environmental damage in watercourses.

These, mandatory elements include:

- Check that an appropriately qualified professional has been appointed

- Check that an appropriate Flood Risk Assessment (FRA) has been carried out

- Check that allowances have been made for climate change over the lifetime of the development in all post-development calculations

- Where the impermeable area draining to watercourses or sewers has increased, check that the appropriately qualified professional's report contains the following:

  - Peak rate of run-off calculations

  - Volume of run-off calculations.

12 Proposed Development Sites

As part of the Local Plan, LDF process and initial assessment of SHLAA sites a large number of residential and mixed use sites are being proposed and brought forward for appraisal that are within flood risk areas and the SFRA is one of the principal evidence based documents that can be used to assess them. In order to allow each of the individual sites to be tested and compared against the others so that the risks can be appraised in a sequential manner, detailed information on each site is required.

Each of the proposed sites that are within flood risk areas has therefore been examined in detail together with the outputs from the breach and wave overtopping analysis and river modelling where available. This provides site-specific information on flood depths, velocities and the Hazard Rating value etc. This information has been summarised for each site along with the following site-specific data:

- Flood Zone
- Flood Zone including climate change
- Indicative Site elevation
- Flooding mechanism(s)
- Depth and Flood Extents Mapping
- Hazard mapping
- Geology
- Soil characteristics
- Proximity to Groundwater Protection Zone

In addition to the above, for each site, the results of the breach and overtopping scenarios are tabulated to provide site-specific data. The detailed site appraisals are included in Appendix 7 of this report. It should be noted that the sites included in Appendix 7 are only allocated Local Plan sites and those proposed SHLAA (initial assessment) sites that have been identified for further testing that are within the flood risk area. This does not include any potential windfall sites or sites that have not, as at July 2011, yet been tested under the LDF process.

13 Policy Recommendations

The Council's preferred option for reducing flood risk within its boundaries is to avoid inappropriate development in areas at highest risk within the broad character areas of the District. The planning process should be used to steer more vulnerable development to areas of lower risk and, where development is at higher risk, to ensure that new development is appropriately designed to manage residual risk throughout the lifetime of the development.

This approach fully supports the overarching objectives of PPS25 and wider government policy. The specific policy recommendations that are made by this SFRA to enable the Council to deliver these objectives are as follows:

- To ensure that, in general, new residential development does not take place in areas identified as 'extreme' flood hazard risk by the SFRA climate change hazard maps. Notwithstanding this, the Council will need to ensure that specific provisions are made for residential development to cater for sustainable development at the coast and within Canterbury city centre and for the redevelopment of Herne Bay town centre. Sites will only be allocated for residential development within Flood Zone 3a where it can be shown that they meet the requirements of the Sequential Test and if necessary, all stages of the Exception Test.

- To ensure that replacement dwellings located within Flood Zones 2 and 3 reduce risk to life to residents through the appropriate design.

- To ensure that flood risk is not increased within the District, any new development will need to be designed such that the peak rate and volume of surface water runoff from the site is not increased above the existing surface water runoff rate. The proposals will also need to meet the requirements of the Council's Drainage Impact Assessment Guidance Note and the surface water management strategy recommendations of PPS25.

- To help reduce the rate and volume of surface water runoff and to improve the quality of the water passed on to watercourses, new development should incorporate the principles of SuDS in its drainage design wherever practically achievable.

- Development in some of the District's seafront areas may be located very close to the shoreline and will therefore be subjected to an increasing risk of flooding and damage from severe wave overtopping, even if located outside of Flood Zones 2 and 3. Consequently, any development that is proposed to take place within 30m of the crest of the seawall will require a site specific Flood Risk Assessment to be submitted. This should be compliant with PPS25 and also address the specific issues of wave overtopping.

- To ensure that all development in Flood Zones 2 and 3 incorporates flood resilient construction techniques. This will reduce the time and cost to recover the building to a habitable standard following a flood event. Specific details are set out in Section 10 of the SFRA.

- To ensure that any new development does not have an adverse impact on drinking water resources. This can be achieved through the reference to the Groundwater Source Protection Zone maps published by the Environment Agency and by encouraging the use of rainwater harvesting and grey water recycling systems.

14 Conclusions

Although the Canterbury District is very varied, from the historic city of Canterbury itself to the coastal towns of Whitstable and Herne Bay, together with the contrasting countryside and villages in the rural area, there is some degree of flood risk throughout most of the developed areas. The risk of coastal flooding to the low-lying parts of the District does, however, dominate much of this SFRA, even though there is a history of fluvial and surface water flooding that should not be overlooked, particularly in view of the events of winter 2000/2001.

Through the full and proper implementation of PPS25, the Local Plan and LDF procedures and site-specific FRAs, it will be possible to manage flood risk in a sustainable manner. The re-development of brownfield sites should provide opportunities to reduce overall flood risk, principally through the use of sustainable drainage systems. However, a planning solution to flood risk management should be sought wherever possible, steering vulnerable development away from areas affected by flooding in accordance with the PPS25 Sequential Test.

The District benefits from a comprehensive and well maintained sea defence system, which has been comprehensively upgraded over the last 25 years. There is an adopted Shoreline Management Plan in place as well as Coastal Flood and Erosion Flood Risk Management Strategies, both of which promote and support the long-term investment and, where necessary, improvement in the flood defences in this area to keep pace with climate change and sea level rise. Inland there is an adopted Catchment Flood Management Plan with recommendations to, at minimum, maintain the current standard of flood defence allowing for climate change.

Notwithstanding this, PPS25 requires the SFRA to adopt a precautionary approach to the appraisal of risk and this has meant that the impacts of residual risk events have been examined in great detail. This process has resulted in the analysis of breach and overtopping scenarios and the production of comprehensive flood extent and hazard maps for both current day and for the year 2110 taking into account future climate change.

In addition, detailed information on flood depth and velocity is now readily available for the densely urbanised coastal towns of Herne Bay and Whitstable. In these areas it is not always possible to locate new development away from the town centre for economic regeneration and other sustainability reasons. The availability of detailed and site-specific flood data therefore enables these risks to be better understood and through the use of appropriate design, the potential impacts of flooding can be mitigated.

The SFRA has analysed the risk of flooding at proposed Local Plan and SHLAA sites that have been identified for further testing and through this process has enabled the Sequential Test to be applied. For these sites the SFRA has also considered parts a and b of the Exception Test. For sites that are not identified through the Local Plan process and for windfall sites, the SFRA provides guidance for the completion of site-specific FRAs as well as setting out policy recommendations to help manage the risk of flooding within the District.

The risk of flooding to the coastal towns along the northern coastline of the District has been recognised by Canterbury City Council for many years. In response to coastal flooding and erosion risk management strategies produced and adopted by the Council there is a long term commitment to sustaining the high standard of protection provided by the District's coastal defences.

This SFRA has also provided specific policy recommendations for areas that are not included within the Environment Agency's Flood Zones, such as areas known to have flood or drainage problems and locations that could potentially be at risk from wave overtopping.

Alongside the development control role of the SFRA, it should be recognised that emergency planning is imperative to minimise the risk to life posed by flooding within the District. The Council is fully cognisant of this and has recently totally reviewed its civil contingency and emergency response plans as well as drafting a new Local Multi Agency Flood Plan for the District and annually updating its in-house Flood Emergency Plan.

It is recommended that the Canterbury District SFRA is reviewed regularly and the review should address the following key questions:

- Has any major flooding been observed within the District since the previous review?
- Have any amendments to PPS25 or the Practice Companion Guide been released since the previous review and will these impact upon the SFRA?
- Has the Environment Agency issued any amendments to their flood risk mapping and/or standing guidance since the previous policy review?
- Have any updates been made to the studies that underpin strategic flood risk management within the District, including the Catchment Flood Management Plan, the Shoreline Management Plan, and the Flood and Coastal Erosion Flood Risk Management Strategies?
- Have there been any changes to Planning Policy that could affect the way in which flood risk is managed through the planning process?
- Has Government issued new guidance on climate change predictions?

15 Appendices

Appendix 1 - Flood Zone Map (current climate conditions)

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CANTERBURY CITY COUNCIL

DRAINAGE IMPACT ASSESSMENT FOR DEVELOPMENT PROPOSALS

GUIDANCE NOTE – Revised March 2003

Background

In view of repeated experiences from all types of flooding in recent years, Canterbury City Council will now require a drainage impact assessment to be submitted as part of the consideration for new development in areas where flooding has been a known problem in the past or where there is a risk of flooding. Although levels of information will vary depending on the type of application, the relevant issues identified below need to be addressed. The list is not intended to be exhaustive, and there may well be other issues that arise depending on individual circumstances.

Where drainage or flooding issues are considered to be central to the acceptability or otherwise of a proposal, such information will be required as part of the application registration process, i.e., the application will not be registered until it is submitted.

Depending on the complexity of issues involved, surface water drainage design calculations will be expected to have been independently checked and certified by a chartered civil engineer.

General

- In appraising disposal of surface water, developers should pay particular attention to means of providing Sustainable Urban Drainage Systems (SUDS) or explain why this is not practicable for the particular site.
- Ground floor levels of all developments within the marine or fluvial flood plains, shall be set at such minimum level as determined by the City Council in conjunction with the Environment Agency, having regard to risk from flooding, and visual implications arising.
- Any development proposed within river flood plains shall not reduce the existing extent of storage capacity of flood plains.

Foul Water Disposal

The following issues need to be addressed and the relevant information provided:-
- Is connection to a public sewer proposed – if so where?
- Will any upsizing of existing pipes be required or other capacity improvements proposed?
- Will any third party land be involved in respect of requisition of sewers?
- Have Southern Water Services been contacted to determine any capacity issues – please provide written evidence of discussions?
- What time scale is envisaged for sewer connections?

Surface Water Disposal

The following issues need to be addressed and the relevant information provided:-

- How will surface water be disposed of for all buildings, roads and hard surfaced areas?
- If soakaways are proposed, independently-certified percolation tests shall be required in order to demonstrate adequate soakage rates in the local soil conditions.
- If disposal is to a Main River, has the Environment Agency been contacted and has agreement been secured? Please provide written evidence if this is the case.
- If disposal is to an Ordinary Watercourse, has the riparian owner been contacted and has agreement been secured – please provide written evidence if this is the case. Notwithstanding any approval by the riparian owner please note that approval by the City Council, as the Land Drainage Authority, will also be required. What routing arrangements and ownerships are involved to ensure that free flowing water can be maintained down stream of the application site? Should the down stream area have a known incidence of flooding, the developer shall need to take all necessary measures to demonstrate that the development does not increase the extent of frequency of flooding. In some instances this may need measures being taken beyond the immediate development site.
- Have calculations been carried out to determine surface water run-off for the existing undeveloped site, taking account of specific local ground conditions?
- In general, on-site storage must be provided to retain surface water flows generated by a 1- in-100-year storm *(duration up to 24 hours)*. Outflow to land drainage systems (whether rivers, watercourses or pipe systems) and existing surface water sewers is to be restricted to a maximum of 4 litres per second per hectare. In the case of discharge to land drainage it might be necessary to observe lower limits subject to specific calculations referred to above.
- Where the on-site surface water drainage system is to be adopted by Southern Water and that company's stipulation is that it shall be designed to protect against flooding from a 1-in-30-year storm (60-minute event), then the system shall also be checked to ensure that no properties on or adjacent to the site will be flooded by a 1-in-100-year storm (duration up to 24 hours). Suitable on-site attenuation systems shall also be provided if required to cater for the storage of the additional flows between the 1 in 30 and 1 in 100 year storm events.
- Where surface water flows from the development will ultimately discharge to land drainage systems (either directly or via existing public sewers), the developer must demonstrate the ability of the land drainage to cope with the additional flows under 1-in-100-year storm conditions (duration up to 24 hours).
- If the surface water run-off for the proposed development is in excess of the run-off for the undeveloped site, what water attenuation methods are to be proposed (e.g., oversized pipes, underwater tanks, or surface water ponds)? What calculations have been used to determine this? As above, such calculations should be carried out on the basis of 1-in-100-year storm conditions (duration up to 24 hours).
- Provision is to be made for dealing with surface water run off generated during construction such that the risk of flooding to surrounding property is no greater than that which existed prior to the development. Specific calculations will be required to demonstrate this.
- If surface water lagoons are to be used, will there be residual water in the lagoons at all times and if so have risk assessments been carried out to deal with safety, landscaping and future maintenance regimes?
- If surface water disposal is to be to an adopted sewer, where will the connection be made and have Southern Water Services been contacted to determine any capacity issues? If so, please provide written evidence of this.
- An arrangement is to be put in place for the long-term maintenance of all drainage systems relating to the development, including maintenance of pumps, keeping ditches clear where these are fundamental to the effective drainage of the site, cleaning out of soakaways, gully traps and their associated pipework, etc.

Contributions to Flood Defence & Alleviations Works

Depending on the location and circumstances of the development the City Council may require the developer to make a contribution to future flood defence or alleviation works within the drainage catchment area or flood plain for the purposes of both the protection of the new development and existing development that may be affected. The requirement for a contribution will be generally in accordance with the guidelines set out in PPG 25 but local circumstances may also be taken taken into consideration. The amount of the contribution will be determined by the City Council, in consultation with the developer, depending upon local circumstances.

Implementation

Where drainage systems are approved as part of the consideration of a planning application, conditions may well be imposed on the permission relating to dates for implementation or other detailed technical requirements. In order to discharge conditions, and particularly for unadoptable surface water drainage systems, the developer will be required to submit a statement from a chartered engineer that the measures have been adequately and satisfactorily implemented.

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