Rother District Council

# Rother District Council

## Level 2 Strategic Flood Risk Assessment

June 2008

Prepared for:

Rother District Council

## Revision Schedule

### Rother District Council Level 2 Strategic Flood Risk Assessment

| Rev | Date | Details | Prepared by | Reviewed by | Approved by |
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| 01 | 14/05/08 | First Draft for RDC comment | **Helen Judd** Assistant Hydrologist | **Jon Robinson** Associate Director | **Jon Robinson** Associate Director |
| 02 | 27/06/08 | Second Draft | **Helen Judd** Assistant Hydrologist | **Jon Robinson** Associate Director | **Damon O'Brien** Technical Director |
| 03 | 21/08/08 | Final Draft | **Helen Judd** Assistant Hydrologist | **Jon Robinson** Associate Director | **Jon Robinson** Associate Director |

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# Glossary

| TERM | DEFINITION |
|---|---|
| Aquifer | A source of groundwater comprising water-bearing rock, sand or gravel capable of yielding significant quantities of water. |
| Catchment Flood Management Plan | A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk. |
| Culvert | A channel or pipe that carries water below the level of the ground. |
| Flood defence | Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard). |
| Flood plain | Area adjacent to river, coast or estuary that is naturally susceptible to flooding. |
| Flood storage | A temporary area that stores excess runoff or river flow often ponds or reservoirs. |
| Fluvial flooding | Flooding by a river or a watercourse. |
| Freeboard | Height of flood defence crest level (or building level) above designed water level |
| Groundwater | Water that is in the ground, this is usually referring to water in the saturated zone below the water table. |
| Inundation | Flooding |
| Local Development Framework (LDF) | The core of the updated planning system (introduced by the Planning and Compulsory Purchase Act 2004). The LDF comprises the Local Development Documents, including the development plan documents that expand on policies and provide greater detail. The development plan includes a core strategy, site allocations and a proposals map. |
| Local Planning Authority | Body that is responsible for controlling planning and development through the planning system. |
| Mitigation measure | An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere. |
| Overland Flow | Flooding caused when intense rainfall exceeds the capacity of the drainage systems or when, during prolonged periods of wet weather, the soil is so saturated such that it cannot accept any more water. |
| Residual Risk | The flood risk that remains after applying the Sequential Test and taking mitigation action. For example flood risk as a result of a breach in defences. |
| Risk | The probability or likelihood of an event occurring. |
| Sewer flooding | Flooding caused by a blockage or overflowing in a sewer or urban drainage system. |
| Sustainable drainage system | Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques. |
| Sustainable development | Development that meets the needs of the present without compromising the ability of future generations meeting their own needs. |
| 1 in 200 year event | Event that on average will occur once every 200 years. Also expressed as an event, which has a 0.5% probability of occurring in any one year. |
| 1 in 200 year | Flood defence that is designed for an event, which has an annual probability of |

| TERM | DEFINITION |
| --- | --- |
| design standard | 0.5%. In events more severe than this the defence would be expected to fail or to allow flooding. |

# 1 Introduction

## 1.1 Overview

Planning Policy Statement 25: Development and Flood Risk (PPS25)[1] published in December 2006 emphasises the active role Local Planning Authorities (LPAs) should have in ensuring flood risk is considered in strategic land use planning. PPS25[1] encourages LPAs to undertake a Strategic Flood Risk Assessment (SFRA) as part of their evidence base for the Local Development Framework (LDF) process and to use their findings to inform strategic land use planning.

Rother District Council have previously undertaken a Level 1 SFRA[2] for the District, following which the PPS25[1] Sequential Test has been applied at the strategic scale to potential, and probable, development areas across the District. The Sequential Test process has confirmed the need for a Level 2 SFRA to analyse specific strategic locations where development is or may be proposed in areas at risk of flooding.

This report presents the findings of the Level 2 SFRA. Specifically, it details the methodology and results of an extensive tidal flooding modelling and mapping exercise, which has looked at residual flood risk from breach or overtopping of existing defences. This is the principal strategic flood risk within Rother District. The Level 2 mapping compliments that produced by Rother District Council's Level 1 SFRA, to provide a complete suite of flood mapping from all sources, based on available data. The Level 1 and 2 reports should be used in conjunction with each other for both forward strategic planning and to inform ongoing development control decisions.

A close dialogue has been maintained with the Environment Agency throughout the preparation of the Level 2 report.

## 1.2 Study Area

The District of Rother is located in East Sussex and surrounds (but excludes) the town of Hastings. The majority of the District is rural, however the main settlements include Bexhill, Battle, Rye.

The landscape of the High Weald covers much of the inland areas of the District and comprises steep escarpments on beds of sands and clays. The Romney and Pevensey Marshes consist of extensive areas of flat marshland and are located in the east and west (coastal) areas of the District.

For the purposes of Sequential Testing (see Level 1 SFRA report), Rother District Council has identified potential development areas, with flood risk issues, within the District to be:

- North Bexhill
- Normans Bay
- Cooden Beach
- Pett Level
- Winchelsea Beach
- Rye Harbour and Harbour Road Employment Area
- Rye (West of the River Rother)
- Rye (East of the River Rother) or East Rye
- Camber (East)
- Camber (West and Central)
- Robertsbridge
- Etchingham

- Crowhurst
- Sedlescombe
- Bodium
- Winchelsea

The predominant key flood risk to these areas (with the exception of North Bexhill, Robertsbridge, Etchingham and Crowhurst) is tidal flooding due to the proximity to the coast and the defended nature of the coastal perimeter which, though generally maintained at a good standard, could locally fail under extreme circumstances, giving rise to residual flood risk.

## 1.3 Tidal Flooding

Flooding to low lying land from the sea and tidal estuaries is caused by storm surges and high tides. Where tidal defences exist, they can be breached or overtopped during severe storms. An event which may become more likely with the effects climate change on sea levels.

The Rother District has a substantial sea defence frontage to the English Channel and these defences are critical to the continued reduction in flood risk throughout the coastal zone. Without these defences, maintained to current defence standard, substantial areas of Rother District would be at actual direct flood risk.

Rother District has experienced tidal flooding in the past. In order to appraise the consequences of failure of flood defence infrastructure, breach modelling has been undertaken. **It is important to note when reviewing the flood mapping derived from this appraisal that the probability of failure (breach) of a given defence has not been assessed.**

The aim of the flood modelling is to simulate flood events to determine and illustrate the potential flood extents, depth and the areas at high, medium and low flood hazard. As well as informing forward planning, this information can also enable a sequential approach to site allocation and/or development within a flood zone.

## 1.4 Aim of Level 2 SFRA

The aim of this study is to provide supplementary information to the Level 1 SFRA, to inform on specific tidal flood risk issues and suitability for development of key development areas and known flooding hotspots identified by Rother District Council in preparation of their LDF.

The report introduces the tidal modelling and mapping studies undertaken and then discusses the key results, in terms of flood depth and hazard; at each breach/overtopping location.

The report concludes with guidance on use of the Level 2 outputs, application of the Exception Test and suggested flooding-based policies for Rother District.

## 1.5 Level 2 SFRA Objectives

The aims of Rother District Council's Level 2 SFRA have been met through the following objectives:

- Carry out 2-D hydrodynamic modelling of agreed breach locations in the Rother District for 0.1% and 0.5% annual probability tides under current and predicted future climate change scenarios;

- Provide mapping to illustrate the flood risk and flood hazard to potential development areas from a breach or overtopping of the existing defences;
- Provide guidance on application of the Exception Test in the potential development areas; and,
- Provide guidance to developers and SFRA users on the application of the Level 2 report.

# 2 Flood Modelling Methodology

The Level 2 SFRA requires detailed plans to show flood depth and hazard that potential development sites may experience. All of the potential development locations are at residual flooding from tidal sources that include the River Rother, River Brede, River Tillingham and the English Channel, and as such modelling results and figures form the bulk of this report.

Breaching or overtopping of flood defences has the potential to generate significant flood hazard and damage to homes and infrastructure. The aim of all flood modelling is to simulate flood events to determine the areas at highest risk; which can then assist in the development of future strategies such as development and flood prevention. This chapter presents the methodologies used in determining the maximum flood depth and extent, and hazard zone maps for the Rother District Council Level 2 SFRA.

The recent improvements in the defences within the vicinity of Rye were taken into consideration in the modelling. The Environment Agency confirmed the location of the improvements and that the height of the defences has been improved to 5.8 mAOD.

## 2.1 Model Topography

A key component in the modelling process for the SFRA is the representation of topography throughout flood prone regions of the study area. For this purpose, a Digital Terrain Model (DTM) was derived for the area to be modelled. A DTM is a three-dimensional grid of elevation information upon which the model simulations are run.

The DTM is based on filtered LiDAR (Light Detection and Ranging) data provided by the Environment Agency. This is processed in a GIS package (MapInfo with Vertical Mapper) prior to being incorporated into the hydraulic modelling software. LiDAR is a method of optical remote sensing which uses light reflections to determine vertical heights. The LiDAR data available for this project was produced with a horizontal resolution of approximately 2m and typically has a vertical accuracy of +/- 0.25m. LiDAR records the vertical heights of an area as the eye would see it from above, and therefore includes all buildings, structures and vegetation; this is known as the Digital Surface Model (DSM). Algorithms which detect the presence of buildings filter the LiDAR data to produce a Digital Terrain Model (DTM) where the majority of buildings, structures, and vegetation are removed.

For SFRA modelling the Digital Terrain Model is used as this provides a good representation of the surface over which floodwaters would flow. Within the model's flood cell the DTM is required to have full coverage. Whilst LiDAR data for this project was extensive there were some areas where it was necessary to either in-fill with NEXTMap Britain Data or manually using MapInfo with Vertical Mapper.

NEXTMap Britain Data was used in the first instance and is produced using Synthetic Aperture Radar (SAR) technology. The NEXTMap Britain Data used in this project was produced with a horizontal resolution of approximately 5m and a vertical accuracy of +/- 1 m. In some areas it was necessary to infill the LiDAR manually through an inspection of the surrounding area in agreement with the Environment Agency. As a consequence, in some mapping outputs a disparity in ground contouring (or flood depth contouring) can be seen. This however is localised and does not occur in any locations of particular interest to Rother District Council's planning concerns at this time.

## 2.2 Breach Details

The breach locations were specified in mutual agreement between the Environment Agency, Rother District Council and Scott Wilson based on local knowledge of the condition of the defences, the location of future development sites, historical flooding events and the vulnerability of local communities.

Breaches are modelled individually, however in some instances some breaches were modelled within the same flood cell extent due to their relatively close proximity to one another. A site walkover was undertaken by Scott Wilson on 26th February 2008. It was noted that it was not possible to breach the defences at Cooden Beach and therefore an overtopping model has been developed. Table 1 presents the breach references and a description of the breach location.

*Table 2-1: Breach References*

| Breach Number | Location of Breach | Description |
|---|---|---|
| 1 | X 568550 Y 105550 | Normans Bay |
| 2 | - | A breach was not appropriate at Cooden Beach therefore an overtopping model was developed. |
| 3 | X 588850, Y 113150 | Pett Level |
| 4 | X 591829, Y 116082 | Winchlesea Beach |
| 5 | X 594249, Y 119009 | Rye Harbour |
| 6 | X 591819, Y 120187 | Rye West (West bank of River Tillingham) |
| 7 | X 592158, Y 120002 | Rye South (Tony Maynard's Garden) |
| 8 | X 592395, Y 121079 | Rye North Salts |
| 9 | X 592511, Y 120622 | Rye East (South of Monkbretton Bridge) |
| 10 | X 596581, Y 118571 | Camber West (At Central car park) |
| 11 | X 597237, Y 118416 | Camber East (The Suttons) |
| 12 | X 598814, Y 118089 | Jury's Gap |

The rate of inundation, depth and extent of flooding that may be experienced if a defence were to breach are dependant on the breach dimensions, the time required to repair the breach (exposure duration) and tidal conditions. Breach dimensions have been provided by the Environment Agency and are defined based on its location and structure type as tabulated in Table 2.

*Table 2-2: Breach Width Categories*

| Location | Defence Type | Breach Width (m) |
|---|---|---|
| Open Coast | Earth bank | 200 |
| | Dunes | 100 |
| | Hard | 50 |
| | Sluice | Sluice Width |
| Estuary/Tidal River | Earth bank | 50 |
| | Hard | 20 |

A description of the type of defence is contained within the Level 1 SFRA. At each breach location the DTM has been used to assess what invert level a breach of the defences could achieve. In each simulation this assessed level is used to override the DTM at the breach location to ensure that water can flow into the model to approximate the breach event.

It should be noted that the current condition of the defences has not been used as a criterion on which to base breach dimensions and no assessment has been made of the probability of failure.

## 2.3 Flood Cell Definition

Once the DTM grids and breach locations have been obtained, the flood cell can be defined. The flood cell is the geographical extent of the model and defines the area over which flow calculations are performed - it provides the absolute limit of the flood results. The limit of the flood cell is determined by visually assessing the DTM against the peak tidal level and examining the possible flow paths of flood water based on the topography. It is important that the flood cell is large enough so that it does not restrict any flood flows but has to be within the extent of available topographic data and balanced against the length of time to perform the model simulations.

In the case of the Rother District there are extensive flat areas of relatively low elevations, which led to a requirement for a number of large flood cells.

The flood cell that incorporated a breach at Normans Bay and overtopping at Cooden Beach was limited in the west by the A259 and in all other directions by the higher topography to the north of the Pevensey Levels.

The flood cell that incorporated the breaches at Pett Level, Winchelsea Beach, Rye Harbour and Rye West was limited in the east and north by the River Rother and the higher topography to the northwest of the Brede and Pett Levels.

The flood cell that incorporated the breach at Rye South and North Salts is limited by the Royal Military Canal, the River Tillingham in the south and the higher elevations surrounding the River Tillingham in the west.

The flood cell that incorporated a breach at Rye East, both breaches at Camber and one at Jury's Gap is limited in the west by the River Rother and the Royal Military Canal and in the east by the B2080. It was deemed that it was not necessary to include the full extent of the Romney Marsh as it is significantly outside the study area.

## 2.4 Extreme Water Level Derivation

The base tidal levels used in the modelling were taken from the 2000 and 2060 levels that are presented in Peter Brett Associates (2004) 'English Channel and Extreme Tidal Level Review', ABP MER: Southampton. This report was provided by the Environment Agency.

One of the objectives of this Level 2 report was to carry out modelling under current day (2008) and predicted future climate change scenarios (2115). To derive the extreme tidal level for the required years it was therefore necessary to adjust the base levels by a magnitude (contingency) following the guidelines in PPS25[1]; this was agreed with the Environment Agency. Table 2-3 summarises the recommended contingency allowances.

*Table 2-3: Summary of the Recommended contingency allowances for net sea level rise (taken from Table B.1 in PPS25[1])*

| Administrative Area | Net Sea Level Rise (mm/yr) Relative to 1990 | | | |
|---|---|---|---|---|
| | 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 |

To achieve the 2008 levels 4 mm/year was added to the 2000 year base level (0.032 m). To achieve the 2115 levels 12 mm/year up to 2085 and 15 mm/year from 2085 to 2115 was added to the 2060 year base level (0.75 m)

The extreme water levels for each breach location simulated in this assessment are presented in Table Table 2-4.

*Table 2-4: Extreme Water Levels*

| Location | Scenario | Tidal Level (mAOD) |
|---|---|---|
| Pevensey | 0.5% 2008 | 4.97 |
| | 0.5% 2115 | 6.10 |
| | 0.1% 2008 | 5.12 |
| | 0.1% 2115 | 6.20 |
| | | |
| Rye | 0.5% 2008 | 5.23 |
| | 0.5% 2115 | 6.25 |
| | 0.1% 2008 | 5.33 |

| LOCATION | SCENARIO | TIDAL LEVEL (MAOD) |
|---|---|---|
| | 0.1% 2115 | 6.45 |

### Modelled Tidal Curve

Water levels have been agreed with the Environment Agency which have been incorporated with tidal cycles based on information from the UK Admiralty Tide Tables for tidal levels at Rye Harbour. Figure 1 shows an example tidal sequence which has been used for the boundary condition for the breach models.

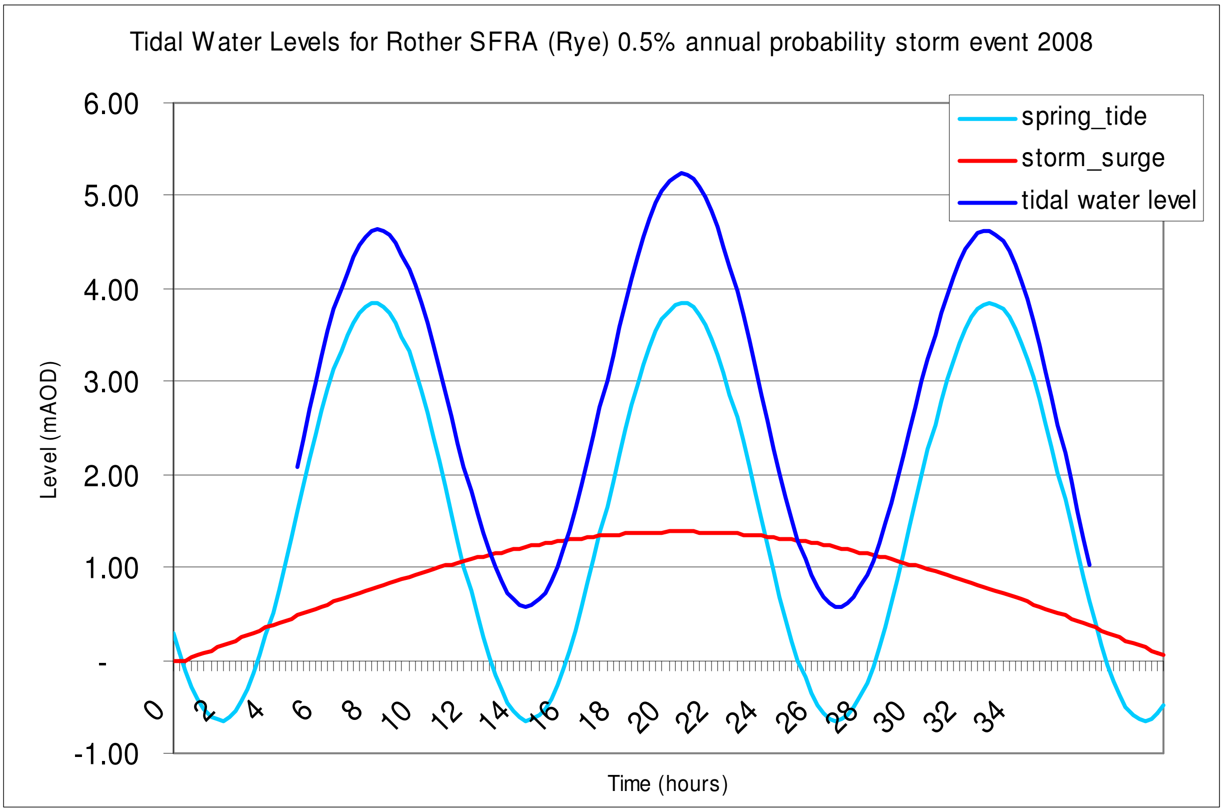



*Figure 1: Example Extreme Tide Profile*

## 2.5 Breach Modelling

To assess the extent, propagation, and hazard of a flood event where defences are breached, Scott Wilson undertook two-dimensional hydraulic modelling using the MIKE21 Hydrodynamic Module (M21-HD). The M21-HD software was developed by the Danish Hydraulic Institute (DHI), and is specifically oriented towards establishing flow patterns in complex water systems, such as coastal waters, estuaries and floodplains, using two-dimensional shallow water equations. M21-HD uses the latest 'flexible mesh' (FM) approach which uses a mesh consisting of triangular elements rather than traditional rectangular grids. The flexible mesh has the advantage that the model resolution can be varied across the model domain to focus computational effort at complex locations (e.g. at breaches).

### Model Extent and Resolution

For each flood cell, a MIKE21 flexible mesh was developed using MIKE21 program Mesh Generator. The element size can be manually controlled across the model domain by defining the maximum area covered by a single element. Small element sizes lead to increased resolution in the mesh and are used to define areas that are hydraulically important, such as the breach location and topographic features where water flows need to be accurately described. Lower resolution areas (large elements) are used in areas that have a lower priority reducing demands on computational resources.

In generating the model mesh, care is taken to identify features which may be important to the propagation of the simulated flood. These features include, but are not limited to, embankments, flood defences, and significant watercourses. Identification of these features ensures:

- The correct definition of features which may limit the flood extent but cause increase flood depths
- That flood flow paths are adequately defined to permit flow, such as where roads pass through embankments, allowing flood waters to propagate over much wider areas.

The identification of topographic features were schematised by reference to the DTM, 1:10 000 OS maps. The crest levels of linear features, such as secondary flood embankments, road embankments and railway embankments, have been established by interrogation of the DTM. It should be noted that the majority of the features described above have been identified through a desktop analysis only, and have not been verified on the ground. Results from the breach modelling which show strong dependence on barriers should therefore be used with caution.

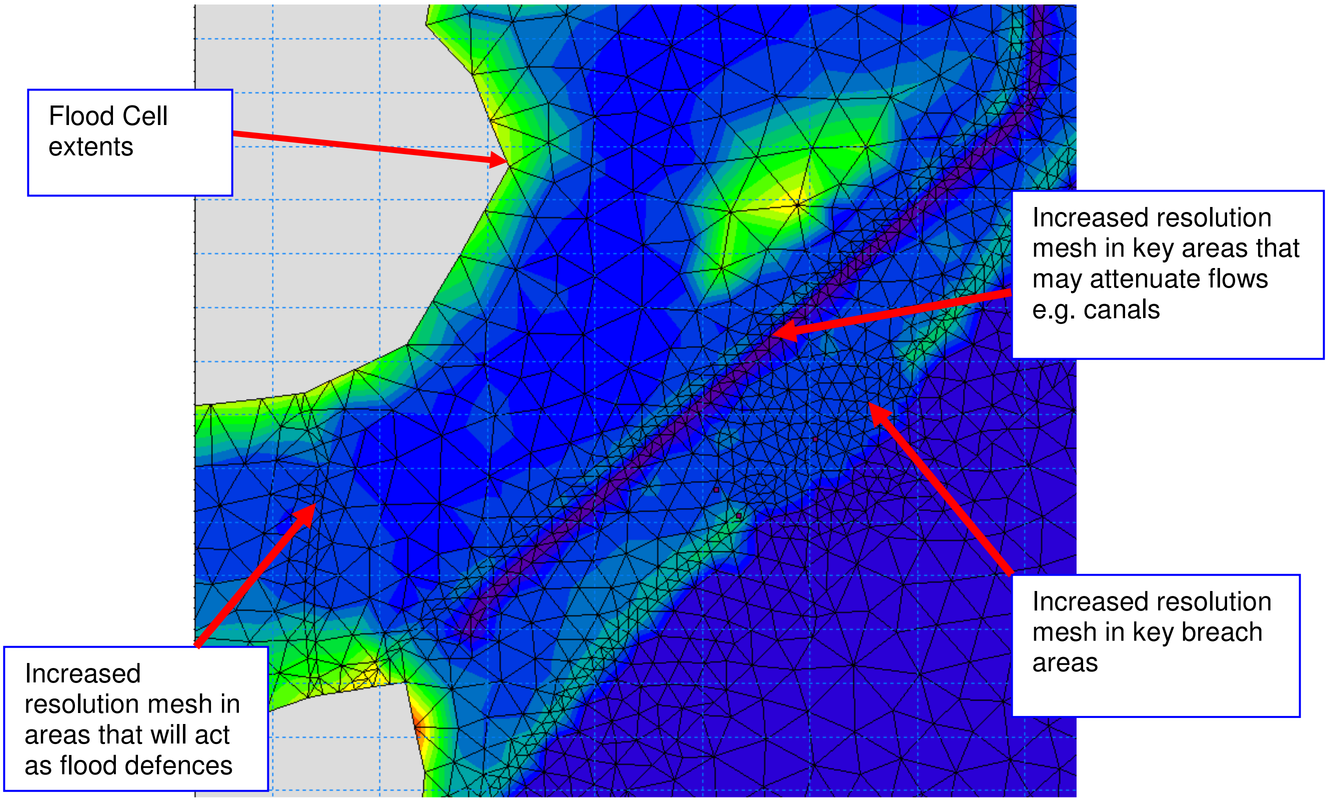



*Figure 2: Example of Mike 21 HD Flexible Mesh (Pett Level Breach)*

## Breach Specifications

In the hydraulic modelling undertaken for this study, the breach in the flood defence was present during the whole flood event (i.e. it is deemed to have occurred prior to the onset of the extreme tidal event), as it is not possible to vary the DTM during the simulation period. This is a conservative assumption.

## Boundary Conditions

The MIKE21 breach models require one boundary condition to be defined. This is a time dependent water level boundary, applied to the tidal water side of the breach location, which replicates the extreme tide levels/cycle during a tidal flood event.

Four tidal flood events were analysed for each breach/overtopping location. The tidal flood events analysed were:

- 0.5% (1 in 200 year) annual probability tidal flood event in the present day (2008);
- 0.5% (1 in 200 year) annual probability tidal flood event including the effects of climate change to 2115;
- 0.1% (1 in 1000 year) annual probability tidal flood event in the present day (2008); and,

- 0.1% (1 in 1000 year) annual probability tidal flood event including the effects of climate change to 2115.

### Hydraulic Roughness

Hydraulic roughness represents the conveyance capacity of the vegetative growth, bed and bank material, channel, sinuosity and structures of the floodplain. Within the MIKE21 model, hydraulic roughness is defined by inverse (1/n = N) of the dimensionless Manning Number 'n'.

The assigned hydraulic roughness coefficient is based on engineering judgement and available literature (e.g. Chow, 1979).

The applied inverse Manning Number, N, for the study area was set at 25. This represents a roughness coefficient suitable for detailed models covering rural areas. It was necessary to reduce the roughness values for the model areas that cover the river to ensure the model effectively propagates water along the waterways.

No data was available with which to calibrate the SFRA models. Previous sensitivity analysis on SFRA models has investigated the effect of hydraulic roughness. This analysis has demonstrated that whilst the roughness has a limited affect on the speed of propagation the overall depth and extent of flood waters is not significantly affected. Therefore, a conservative Manning number has been applied to ensure velocities are not significantly impeded. While it is possible to define individual roughness coefficients to various areas within a MIKE21 model, in this case it was deemed appropriate to apply a single roughness to the entire study area.

### Model Simulations Undertaken

A total of 48 model simulations were undertaken, 4 simulations for tidal events of at each of the 12 breach / overtopping locations. Results were recorded at five minute intervals in model time and output parameters cover surface elevation, water depth and direction and magnitude of flows.

The model results of the individual model simulations were then post processed using MapInfo to produce detailed flood depth and flood hazard maps based on the original DTM. These maps are presented as Appendix A of this report.

## 2.6 Definition of Hazard Categories

Flood hazard is a function of the instantaneous flood depth and velocity. Therefore, the maximum flood hazard for a given location could be experienced at any stage of the flood. Near the breach where velocities are high the highest hazard is likely to be achieved at the time of peak velocity. Further from the breach the maximum hazard will depend on local factors affecting both the depth of floodwaters and velocities at each instant. At the very fringes of the flood extent the maximum hazard occurs nearer the peak water depth towards the end of the simulation.

As the flood hazard is time and location dependant a hazard calculation is performed on every output timestep for every element in the model domain. The maximum hazard attained is then recorded for each element.

The flood hazard for each element is categorized as either low, medium or high. The assigned category is determined by a relationship between water velocity and depth as illustrated below in Figure 3. This methodology is similar to that advised in DEFRA FD2320 (hazard is a function of depth*(velocity+0.5) + debris factor).

http://www.defra.gov.uk/science/project_data/DocumentLibrary/FD2321/FD2321_3436_TRP.pdf

However, for the purposes of a strategic level study, the debris factor has been set to 0 on the basis that a constant factor is not reasonable to apply over a wide scale. Site specific FRA's should determine a suitable debris factor of their own. This issue will be highlighted in the SFRA reporting. This methodology has been agreed with the EA for SFRA in both the Thames and Anglian Regions.

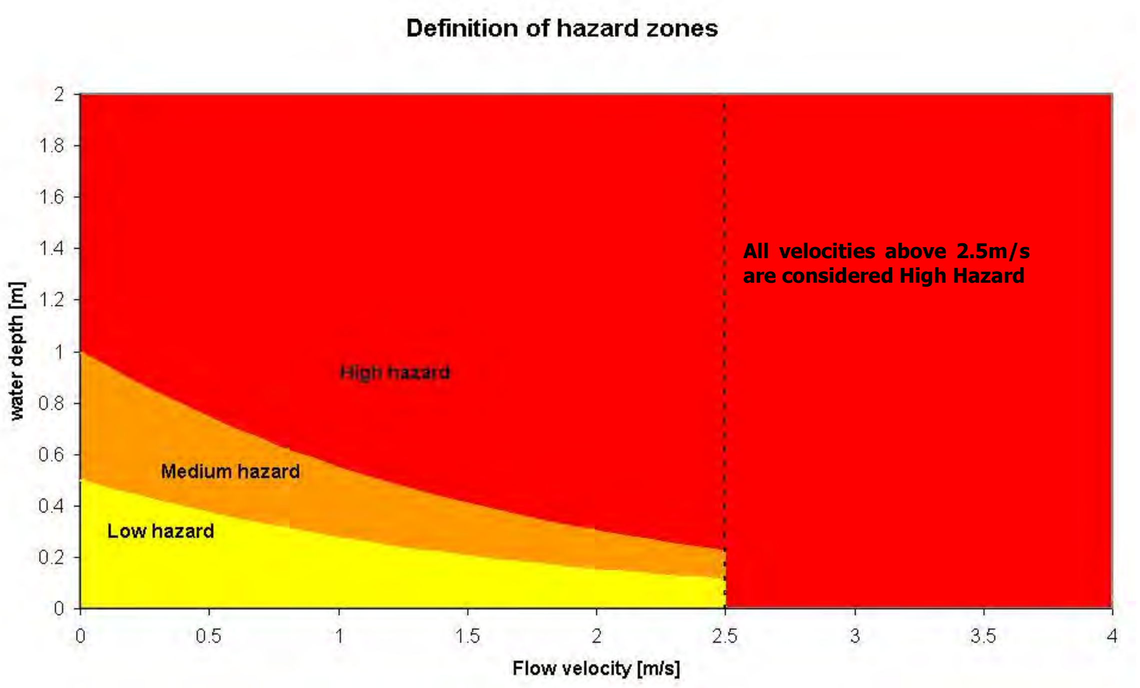



*Figure 3: Definition of Hazard Zones*

i.e. a flood event with a velocity of 1 m3/s and depth of 0.2m would be classed as low hazard, while a flood with flow velocity of 2m/s and water depth of 1.2m would be classed as high hazard.

*High risk*

A location is categorised as “High Risk” if during the simulation one of the following criteria is met:

$u > 2.5m/s$ [Local flow velocity exceeds 2.5 m/s]

$(1-e^{-0.60u}) + d \geq 1.0$

*Medium risk*

A location is categorised as “Medium Risk” if during the simulation both following criteria are met:

$(1-e^{-0.60u})+d<1.0$ [Flow regime below the blue line]

$(1-e^{-0.60u})\cdot 0.50+d\geq 0.50$

*Low risk*

A location is categorised as "low Risk" if during the simulation the following criterion is met:

$0.50\cdot(1-e^{-0.60u})+d<0.50$

## 2.7 Limitations of Breach modelling approach

The hazard zone maps indicate the product of depth and velocity from a particular breach event, or combined breach event within the flood cell. These hazard classifications do not indicate a change in flood probability.

It is essential to remember, when using the hazard zone maps, that **they represent hazard arising from one or more *specific* breach locations, and that hazard will almost certainly vary spatially if the breach locations are in different local areas**. This is also the case for the flood depth maps.

Further issues in this respect should also be considered:

- Not all possible breach locations have been considered. Necessarily, the modelling study had to be limited to those locations thought most likely to lead to flood risk for specific development areas;
- Breach width and depth, though based on Environment Agency guidance, are arbitrary and do not necessarily represent the actual dimensions of a breach in a given location; and,
- Changes in inundation extent or hazard zone are non-linear to changes in breach location.

# 3 Flood Modelling Results

## 3.1 Normans Bay

The small settlement of Normans Bay is located on the coastline approximately 2.5 km west of Bexhill. A railway line runs parallel to the coastline behind which the area is predominantly marshland known as the Hooe Level. On the Hooe Level there are some isolated farms, a dense network of smaller drainage ditches and a few larger drainage ditches; one in particular that drains from Normans Bay to the northwest (Waller's Haven).

The main flood risk to Normans Bay is from tidal flooding from the English Channel. However, this risk is residual due to the presence of flood management measures on the shingle beaches which protect Normans Bay from flood events, under normal circumstances.

The Environment Agency Flood Zones applicable to Normans Bay show the effect of extreme tidal flooding should there be no flood risk management measures in place. However it is noted within the South Foreland to Beachy Head Shoreline Management Plan (2006) that this area benefits from flood defences, and that the policy is 'Hold the Line'.

### Breach modelling results

In order to better understand the risk of flooding posed by the English Channel, breach modelling has been carried out at Normans Bay close to the entrance to the static caravan park.

A breach location was chosen opposite the entrance to the static caravan park. This location was chosen as flooding has occurred at this location in the past. A photograph of this breach location is presented in Appendix B-1. The defences in this location are maintained shingle beaches, parts of which have additional concrete revetments. To provide the most conservative modelling result the breach width was set at 200m.

Overtopping was permitted in the model from Bexhill to Pevensey. Due to the standard of the defences only a limited amount of overtopping occurred in the current day scenarios, more significant overtopping occurred in the climate change scenarios.

### Flood Propagation and Depth

The flood depth maps for all the scenarios run are presented in Appendix A and are A 1.1.1, A 1.2.1, A 1.3.1 and A 1.4.1. Under all scenarios flood waters generally move in a north and westerly direction from the breach firstly propagating into the area south of the railway line. The Tower Ditch acts as a conduit for flood water whereas the railway embankment restricts flood waters from propagating to the Hooe Level, for a short time. Flood waters overtop the railway embankment directly north of the breach location and are directed onto the Hooe Level. They are restricted in an easterly direction by the embankments along Reynold's Gut although these are eventually overtopped.

The flood waters do not fully retreat before the onset of the second tidal cycle. Flood waters are not directed to Normans Bay due to the topography. Flood waters on the Hooe Level are restricted from flowing back into Normans Bay by the railway line, although this becomes overtopped in climate change scenarios.

The floodwaters are restricted from flowing onto the Pevensey Levels in the present day scenarios by the A259, although this is overtopped in the climate change scenarios.

Approximate flood depths are presented below. It is important to note that these were extracted over large areas and for more detailed flood depths please refer to the figures in Appendix A. The depths presented here are applicable only to the breach location specified and therefore may not be the worst-case scenario for site-specific flood risk assessments and should be used with caution.

**0.5% annual probability tidal event**

- The area between the railway line and the caravan park experiences flood depths of 1.1 m;
- The area between the railway line and Coast Road experiences depths of 1 m;
- The area near Normans Bay station experiences depths of 1.5 m;
- No flooding occurs east of Normans Bay, south of the railway line;
- East of Reynolds Gut sluice and north of the railway line experiences flood depths of approximately 1 m; and,
- The A259 prevents flooding to the northwest onto Pevensey Levels.

**0.5% annual probability tidal event including the effects of climate change**

- The area between the railway line and the caravan park experiences flood depths of up to 1.7 m;
- The area between the railway line and Coast Road experiences depths of approximately 1.6 m;
- The area near Normans Bay station experiences depths of 1.9 m;
- East of Normans Bay, south of the railway line experiences flood depths of approximately 2.6 m; and
- East of Reynolds Gut sluice and north of the railway line experiences flood depths of approximately 1.5 m.

**0.1% annual probability tidal event**

- The area between the railway line and the caravan park experiences flood depths of up to 1.3 m;
- The area between the railway line and Coast Road experiences depths of 1.2 m;
- The area near Normans Bay station experiences depths of 1.6 m;
- No flooding occurs east of Normans Bay, south of the railway line;
- East of Reynolds Gut sluice and north of the railway line experiences flood depths of approximately 1.25 m; and,
- The A259 prevents flooding to the northwest onto Pevensey Levels.

**0.1% annual probability tidal event including the effects of climate change**

- The area between the railway line and the caravan park experiences flood depths of up to 1.9 m;
- The area between the railway line and Coast Road experiences depths of 1.2 m;
- The area near Normans Bay station experiences depths of 1.75m;
- East of Normans Bay, south of the railway line experiences depths of up to 2.75 m; and,
- East of Reynolds Gut sluice and north of the railway line experiences flood depths of approximately 1.8 m.

### Flood Hazard

To provide an assessment of the danger to people posed by flood waters, hazard mapping was completed as part of the breach assessment. The flood hazard maps for all the scenarios run are presented in Appendix A and are A 1.1.2, A 1.2.2, A 1.3.2 and A 1.4.2.

Flood hazard can be expressed as a combination of flood depth and velocity. Therefore, the maximum flood hazard for a given location could be experienced at any stage of the flood. Near the breach where velocities are high the highest hazard is likely to be achieved at the time of peak velocity. Further from the breach the maximum hazard will depend on local factors affecting both the depth of floodwaters and velocities at each instant. At the very fringes of the flood extent the maximum hazard occurs nearer the peak water depth towards the end of the simulation.

Generally, there is a greater flood hazard closer to the breach location. In the present day scenarios high hazard has been classified in the majority of the area that is to the west of Normans Bay, south of the railway line. An extensive area north of the railway has also been classified as having a high flood hazard.

In the climate change scenarios a high flood hazard has been classified over an extensive area that has been flooded. This is primarily due to the depths of flooding that have been simulated.

## 3.2 Cooden Beach

The settlement of Cooden Beach is located adjacent to the southern coastline between Bexhill and Normans Bay. To the east of Cooden Beach is the settlement of Cooden itself that resides on higher ground. To the northwest of Cooden Beach is the Hooe Level. An embanked railway runs parallel to the coastline but is bridged over the B2182 in the centre of Cooden Beach.

The defences in this location are maintained shingle beaches; photographs are presented in Appendix B-2 and B-3. After a site visit and interrogation of the Digital Terrain Model (DTM) it was apparent that a breach was not a possible at this location, as the ground level behind the defences is at approximately the same height as the crest of the defence. Therefore only defence overtopping can potentially occur.

For this area (1km$^2$) only NEXTMap Britain Data was available and therefore the modelling in this area is based on 5m resolution topographic data. The change in the topographic data can be seen in the flood depth map. In the simulation, the railway embankment is not well defined in the immediate vicinity of Cooden Beach.

The main flood risk to Cooden Beach is from tidal flooding from the English Channel and overtopping of the defences has been known to occur.

The Environment Agency Flood Zones are based on no flood risk management measures in place. They show that part of Cooden Beach lies within Flood Zone 3a and that it does benefit from defences.

### Overtopping modelling results

In order to better understand the risk of flooding posed by the English Channel, An overtopping model was developed that allows for overtopping from Bexhill to Pevensey. However, due to the standard of the defences only a small amount of overtopping occurred under the present climate.

### Flood Propagation and Depth

The flood depth maps for all the scenarios run are presented in Appendix A and are A 2.1.1, A 2.2.1, A 2.3.1 and A 2.4.1 In the climate change scenarios very little overtopping in Cooden actually occurs. The only place that overtops is near the roundabout on the B2182. The propagation of this overtopping may be limited by the low resolution of the DTM in this area. More extensive overtopping occurs near Culver Croft bank. This allows flood waters to inundate Cooden Beach Golf Course.

Approximate flood depths are presented below but is should be clarified these were extracted over large areas and for more detailed flood depths please refer to the figures in Appendix A. The depths presented here are applicable to the breach locations specified and therefore may not be the worst-case scenario for site-specific flood risk assessments.

**0.5% annual probability tidal event**

- No overtopping occurs

**0.5% annual probability tidal event including the effects of climate change**

- The roundabout on the B2182 south of Cooden Beach station experiences depths of up to 1.0 m; and,
- Hooe Level experiences depths of up to 1.75 m.

**0.1% annual probability tidal event**

- No overtopping occurs

**0.1% annual probability tidal event including the effects of climate change**

- The roundabout on the B2182 south of Cooden Beach station experiences depths of up to 1.1 m; and,
- Hooe Level experiences depths of up to 2.0 m.

## Flood Hazard

To provide an assessment of the danger to people posed by flood waters, hazard mapping was completed as part of the breach assessment. The flood hazard maps for all the scenarios run are presented in Appendix A and are A 2.1.2, A 2.2.2, A 2.3.2 and A 2.4.2.

Flood hazard can be expressed as a combination of flood depth and velocity. Therefore, the maximum flood hazard for a given location could be experienced at any stage of the flood. Near the breach where velocities are high the highest hazard is likely to be achieved at the time of peak velocity. Further from the breach the maximum hazard will depend on local factors affecting both the depth of floodwaters and velocities at each instant. At the very fringes of the flood extent the maximum hazard occurs nearer the peak water depth towards the end of the simulation.

Hazard mapping shows that where Cooden floods from overtopping of the defences in the climate change scenarios, the hazard has been classified as low. Where the defences have been overtopped near Culver Croft and the Cooden Beach Golf Course, high hazard is observed.

# 3.3 Pett Level

The settlement of Pett Level is located adjacent to the southern coastline. To the west are steep cliffs and to the east are the extensive flat marsh area of the Pett Levels. The Royal Military Canal begins here opposite 'The Smugglers' public house and runs in a north easterly direction.

The main flood risk to Pett Level is from tidal flooding from the English Channel. However, this risk is residual due to the presence of flood management measures in the form of raised embankments and hard defences.

The Environment Agency Flood Zones are based on no flood risk management measures in place. They show that Pett Level is located in Flood Zone 3a, and the area south and east of the Royal Military Canal is benefits from defences.

## Breach/overtopping modelling results

In order to better understand the risk of flooding posed by the English Channel, breach modelling has been carried out at Pett Level near 'The Smugglers' where a gate is located in the defences. This location was agreed for modelling purposes as it was deemed to be the most vulnerable section of the defence. In the Inception Meeting (20th December) it was noted that a breach width of 200m should be modelled as it has been known for the earth embankments such as these to collapse underneath the hard defence.

Overtopping was permitted in the model from Pett Level to the River Rother. However, due to the standard of the defences a limited amount of overtopping occurs only in climate change scenarios, near the mouth of the River Rother.

## Flood Propagation and Depth

The flood depth maps for all the scenarios run are presented in Appendix A and are A 3.1.1, A 3.2.1, A 3.3.1 and A 3.4.1. Under all scenarios flood waters generally move in a northerly direction from the breach. They are temporarily limited by the Royal Military Canal which directs flood waters to propagate onto Pett Level. The Royal Military Canal eventually overtops and flood waters continue to fill north and west, although flood water is restricted temporarily by Pett Road. The greatest depths are found immediately east of Pett Road where flood waters accumulate.

Approximate flood depths are presented below but is should be clarified that these were extracted over large areas and for more detailed flood depths please refer to the figures in Appendix A. The depths presented here are applicable to the breach location specified and therefore may not be the worst-case scenario for site-specific flood risk assessments.

**0.5% annual probability tidal event**

- The area between the Royal Military Canal and the breach location experiences depths of up to 1.75 m;
- The area directly north of the Royal Military Canal and the breach location experiences depths of up to 1.7 m;
- The area immediately east of Pett Level road near Chickhill Bridge experiences depths of up to 1.85 m; and,
- Pett Level directly east of the Royal Military canal experiences depths of approximately 1.1 m.

**0.5% annual probability tidal event including the effects of climate change**

- The area between the Royal Military Canal and the breach location experiences depths of up to 2.75 m;
- The area directly north of the Royal Military Canal and the breach location experiences depths of up to 2.8 m;
- The area immediately east of Pett Level road near Chickhill Bridge experiences depths of up to 3.0 m and,
- Pett Level directly east of the Royal Military canal experiences depths of approximately 2.2 m.

**0.1% annual probability tidal event**

- The area between the Royal Military Canal and the breach location experiences depths of up to 2 m;
- The area directly north of the Royal Military Canal and the breach location experiences depths of up to 1.8 m;
- The area immediately east of Pett Level road near Chickhill Bridge experiences depths of up to 2 m and,
- Pett Level directly east of the Royal Military canal experiences depths of approximately 1.3 m.

**0.1% annual probability tidal event including the effects of climate change**

- The area between the Royal Military Canal and the breach location experiences depths of up to 2.4 m;
- The area directly north of the Royal Military Canal and the breach location experiences depths of up to 3.0 m;
- The area immediately east of Pett Level road near Chickhill Bridge experiences depths of up to 3.1 m and,
- Pett Level directly east of the Royal Military canal experiences depths of approximately 2.3 m.

## Flood Hazard

To provide an assessment of the danger to people posed by flood waters, hazard mapping was completed as part of the breach assessment. The flood hazard maps for all the scenarios run are presented in Appendix A and are A 3.1.2, A 3.2.2, A 3.3.2 and A 3.4.2 that illustrate flood hazards that may be experienced should a breach occur in the tidal defences during all of the scenarios run.

Flood hazard can be expressed as a combination of flood depth and velocity. Therefore, the maximum flood hazard for a given location could be experienced at any stage of the flood. Near the breach where velocities are high the highest hazard is likely to be achieved at the time of peak velocity. Further from the breach the maximum hazard will depend on local factors affecting both the depth of floodwaters and velocities at each instant. At the very fringes of the flood extent the maximum hazard occurs nearer the peak water depth towards the end of the simulation.

Hazard mapping shows that area of maximum hazard is nearest the breach. However, due to flood depths that have been simulated around Pett Level the majority of the area has been classified as having a high hazard.

## 3.4 Winchelsea Beach

The settlement of Winchelsea Beach is located on the coast surrounded by the Pett Levels. The embanked River Brede flows from the River Tillingham to Winchelsea Beach.

The main flood risk to Winchelsea Beach is from the English Channel. However, this risk is residual due to the presence of flood management measures in the form of raised embankments and hard defences which protect Winchelsea Beach from tidal flood events.

The Environment Agency Flood Zone Maps illustrate the extent of flooding should no flood management measures be in place. These show that Winchelsea Beach entirely resides within Flood Zone 3a.

### Breach/overtopping modelling results

In order to better understand the risk of flooding posed by the English Channel, breach modelling was undertaken at Winchelsea Beach. The breach was located at the mouth of the dried watercourse as this was deemed to be the most vulnerable location. As the defences are hard, the breach width modelled was 50 m.

Overtopping was permitted in the model from Pett Level to the River Rother. However, due to the standard of the defences a limited amount of overtopping occurred only in climate change scenarios, near the mouth of the River Rother.

### Flood Propagation and Depth

The flood depth maps for all the scenarios run are presented in Appendix A and are A 4.1.1, A 4.2.1, A 4.3.1 and A 4.4.1.

Flooding through the breach leads to flooding in a northerly direction towards the River Brede. Flood waters are retained initially within the embankments of the River Brede although these are eventually overtopped to the west and east which allows floodwaters to flood propagate toward Pett Level. Morlais Ridge acts as a secondary flood defence in Winchelsea Beach and shallower flood depths are experienced to the south of Morlais Ridge. The greatest flood depths occur along the route of the old river that includes Old River Way and Willow Lane. Pett Level Road also acts as a flood defence and the flood depths to the south of this road are less than those to the north.

Approximate flood depths are presented below but is should be clarified that these were extracted over large areas and for more detailed flood depth please refer to the figures in Appendix A. The depths presented here are applicable to the breach location specified and therefore may not be the worst-case scenario for site-specific flood risk assessments.

**0.5% annual probability tidal event**

- The area between Dogs Hill Road and Smeatons Lane experiences depths of up to 2.5 m;
- The area west of Dogs Hill Road in the caravan park experiences depths of up to 1.1 m;
- The area east of the breach location experiences depths of up to 1.5 m;
- The area immediately east of Morlais Ridge experiences flood depths of up to 0.7 m; and,
- The area west of Pett Level Road experiences flood depths up to 0.7 m.

**0.5% annual probability tidal event including the effects of climate change**

- The area between Dogs Hill Road and Smeatons Lane experiences depths of up to 3.0 m;

- The area west of Dogs Hill Road in the caravan park experiences depths of up to 1.5 m;
- The area east of the breach location experiences depths of up to 2 m;
- The area immediately east of Morlais Ridge experiences flood depths of up to 1.7 m; and,
- The area west of Pett Level Road experiences flood depths up to 1.2 m.

**0.1% annual probability tidal event**

- The area between Dogs Hill Road and Smeatons Lane experiences depths of up to 2.5 m;
- The area west of Dogs Hill Road in the caravan park experiences depths of up to 1.3 m;
- The area east of the breach location experiences depths of up to 1.5 m;
- The area immediately east of Morlais Ridge experiences flood depths of up to 0.7 m; and,
- The area west of Pett Level Road experiences flood depths up to 0.8 m.

**0.1% annual probability tidal event including the effects of climate change**

- The area between Dogs Hill Road and Smeatons Lane experiences depths of up to 3.1 m;
- The area west of Dogs Hill Road in the caravan park experiences depths of up to 1.5 m;
- The area east of the breach location experiences depths of up to 2.0 m;
- The area immediately east of Morlais Ridge experiences flood depths of up to 2.0 m; and,
- The area west of Pett Level Road experiences flood depths up to 1.3m.

## Flood Hazard

To provide an assessment of the danger to people posed by flood waters, hazard mapping was completed as part of the breach assessment. The flood hazard maps for all the scenarios run are presented in Appendix A and are A 4.1.2, A 4.2.2, A 4.3.2 and A 4.4.2 that illustrate flood hazards that may be experienced should a breach occur in the tidal defences during all of the scenarios run.

Flood hazard can be expressed as a combination of flood depth and velocity. Therefore, the maximum flood hazard for a given location could be experienced at any stage of the flood. Near the breach where velocities are high the highest hazard is likely to be achieved at the time of peak velocity. Further from the breach the maximum hazard will depend on local factors affecting both the depth of floodwaters and velocities at each instant. At the very fringes of the flood extent the maximum hazard occurs nearer the peak water depth towards the end of the simulation.

Hazard mapping shows that areas of maximum hazard from this breach are in the channel of the old river that includes Old River Way and Willow Lane. Large areas to the east and west of Winchelsea Beach have been classified as a high hazard under climate change scenarios.

## 3.5 Rye Harbour

The settlement of Rye Harbour is located on the western bank of the tidal River Rother approximately 1km from the English Channel. The west, north and south of Rye Harbour is predominantly marshland.

The main flood risk to Rye Harbour is from the tidal River Rother. However, this risk is residual due to the presence of flood management measures in the form of earth embankments which protect Rye Harbour from tidal flood events. These have recently been improved in this location and have a crest height of 5.8 mAOD, confirmed in correspondence with the Environment Agency.

The Environment Agency Flood Zone Maps illustrate the extent of flooding should no flood management measures be in place. These show that Rye Harbour entirely resides within Flood Zone 3a.

### Breach modelling results

In order to better understand the risk of flooding posed by the River Rother, breach modelling was undertaken at Rye Harbour. The modelling also allowed for the defences to be overtopped from the mouth of the River Rother to more accurately represent a flooding situation.

The modelled breach was located adjacent to Harbour Point. At this location the defences are earth embankments and therefore a breach width of 50 m was defined.

### Flood Propagation and Depth

The flood depth maps for all the scenarios run are presented in Appendix A and are A 5.1.1, A 5.2.1, A 5.3.1 and A 5.4.1.

The simulated flood from the River Rother demonstrated that the defences south of Rye Harbour would be overtopped before flood waters penetrate through a breach in the defences at Rye Harbour. The floodwaters are limited by an embankment from Rye Harbour to Winchelsea Beach although this is eventually overtopped near the Mortello Tower. Flood waters were simulated to flow through the breach in the second tidal cycle. The effect of a breach at Rye Harbour is only noticeable under climate change scenarios due to the extensive overtopping of the defences to the south of Rye Harbour.

The deepest floodwaters occur west of Tram Road and east of Rye Harbour Wharf.

Approximate flood depths are presented below but is should be clarified these were extracted over large areas and for more detailed flood depths please refer to the figures in Appendix A. The depths presented here are applicable to the breach location specified and therefore may not be the worst-case scenario for site-specific flood risk assessments.

**0.5% annual probability tidal event**

- The area west of Lime Kiln cottage experiences depths of approximately 1.2 m;
- The area northwest of Tram Road experiences depths of up to 1.3 m;
- The area east of the “Depot” experiences depths of up to 1.8 m;
- East of Tram Road experiences minimal flooding; and,
- Oyster Creek experiences depths of up to 0.6 m.

**0.5% annual probability tidal event including the effects of climate change**

- The area west of Lime Kiln Cottage experiences depths of approximately 2.2 m;
- The area northwest of Tram Road experiences depths of up to 1.9 m;

- The area east of the “Depot” experiences depths of up to 1.8 m;
- East of Tram Road experiences depths up to 1.5 m; and,
- Oyster Creek experiences depths of up to 1.3 m.

**0.1% annual probability tidal event**

- The area west of Lime Kiln Cottage experiences depths of approximately 1.3 m;
- The area northwest of Tram Road experiences depths of up to 1.3 m;
- The area east of the “Depot” experiences some flooding up to 0.8 m;
- East of tram Road experiences depths up to 0.9 m; and,
- Oyster Creek experiences depths of up to 0.7 m.

**0.1% annual probability tidal event including the effects of climate change**

- The area west of Lime Kiln Cottage experiences depths of approximately 2.3 m;
- The area northwest of Tram Road experiences depths of up to 2.3 m;
- The area east of the “Depot” experiences some flooding up to 2.0 m;
- East of Tram Road experiences depths of up to 1.7 m; and,
- Oyster Creek experiences depths of up to 1.4 m.

## Flood Hazard

To provide an assessment of the danger to people posed by flood waters, hazard mapping was completed as part of the breach assessment. The flood hazard maps for all the scenarios run are presented in Appendix A and are A 5.1.2, A 5.2.2, A 5.3.2 and A 5.4.2 that illustrate flood hazards that may be experienced should a breach occur in the tidal defences during all of the scenarios run.

Flood hazard can be expressed as a combination of flood depth and velocity. Therefore, the maximum flood hazard for a given location could be experienced at any stage of the flood. Near the breach where velocities are high the highest hazard is likely to be achieved at the time of peak velocity. Further from the breach the maximum hazard will depend on local factors affecting both the depth of floodwaters and velocities at each instant. At the very fringes of the flood extent the maximum hazard occurs nearer the peak water depth towards the end of the simulation.

Hazard mapping shows that areas of maximum hazard from this breach/overtopping are immediately adjacent to the breach, east of Rye Harbour Wharf and south of Harbour Road.

## 3.6 Rye West

The area that has been named Rye West is located on the south side of the tidal River Brede, surrounding Winchelsea Road. The area is predominantly developed in the immediate vicinity of the breach location but further to the west extends on to the Brede Level.

The main flood risk to Rye West is from the tidal River Tillingham. However, this risk is residual due to the presence of flood management measures in the form of hard defences which protect Rye West from tidal flood events. These have recently been improved in this location and have a crest height of 5.8 mAOD that has been confirmed in correspondence with the Environment Agency.

The Environment Agency Flood Zone Maps illustrate the extent of flooding should no flood management measures be in place. These show that Rye West entirely resides within Flood Zone 3a. It does however also show that the area benefits from flood defences.

### Breach modelling results

In order to better understand the risk of flooding posed by the River Tillingham, breach modelling was undertaken in the Rye West area. The modelling also allowed for the defences to be overtopped along the River Brede and Tillingham from the confluence with the River Rother to more accurately represent a flooding situation. The model has assumed that the sluice under the A268 and Brede Sluice are not working; this is a conservative approach. A breach width of 50 m was defined.

### Flood Propagation and Depth

The simulated flood along the Rivers Brede and Tillingham demonstrated that under present day scenarios flood water penetrates the breach during the first tidal cycle. Flood water is directed in a southwesterly direction, according to topography. Flood water propagates onto Brede Level but is restricted from flowing north by the railway embankment and flowing east by the embankment along the River Brede. Flooding however is experienced to the north of the railway line as a result of overtopping along the River Tillingham where the defences have not been recently improved.

In climate change scenarios flood waters propagate in the same manner as above. However, the railway embankment is overtopped.

Approximate flood depths are presented below but is should be clarified these were extracted over large areas and for more detailed flood depths please refer to the figures in Appendix A. The depths presented here are applicable to the breach location specified and therefore may not be the worst-case scenario for site-specific flood risk assessments.

**0.5% annual probability tidal event**

- The factory opposite the breach experiences depths up to 1.2 m;
- Brede Level approximately 400 m from the breach experiences (west of Martello Tower) depths up to 1.3 m;
- Immediately north of the railway line on Gibbets Marsh (near Ashden Avenue) experiences depths up to 1.5 m; and,
- Rye Paddock experiences no flooding.

**0.5% annual probability tidal event including the effects of climate change**

- The factory opposite the breach experiences depths up to 1.6 m;

- Brede Level approximately 400 m from the breach (west of Martello Tower) experiences depths up to 1.7 m;
- Immediately north of the railway line on Gibbets Marsh (near Ashden Avenue) experiences depths up to 1.9 m; and,
- Rye Paddock experiences no flooding.

**0.1% annual probability tidal event**

- The factory opposite the breach experiences depths up to 1.3 m;
- Brede Level approximately 400 m from the breach (west of Martello Tower) experiences depths up to 1.4 m;
- Immediately north of the railway line on Gibbets Marsh (near Ashden Avenue) experiences depths up to 1.6 m; and,
- Rye Paddock experiences no flooding.

**0.1% annual probability tidal event including the effects of climate change**

- The factory opposite the breach experiences depths up to 1.7 m;
- Brede Level approximately 400 m from the breach (west of Martello Tower) experiences depths up to 1.8 m;
- Immediately north of the railway line on Gibbets Marsh (near Ashden Avenue) experiences depths up to 2.0 m; and,
- Rye Paddock experiences no flooding.

## Flood Hazard

To provide an assessment of the danger to people posed by flood waters, hazard mapping was completed as part of the breach assessment. The flood hazard maps for all the scenarios run are presented in Appendix A and are A 6.1.2, A 6.2.2, A 6.3.2 and A 6.4.2 that illustrate flood hazards that may be experienced should a breach occur in the tidal defences during all of the scenarios run.

Flood hazard can be expressed as a combination of flood depth and velocity. Therefore, the maximum flood hazard for a given location could be experienced at any stage of the flood. Near the breach where velocities are high the highest hazard is likely to be achieved at the time of peak velocity. Further from the breach the maximum hazard will depend on local factors affecting both the depth of floodwaters and velocities at each instant. At the very fringes of the flood extent the maximum hazard occurs nearer the peak water depth towards the end of the simulation.

Hazard mapping shows that during the current day scenarios areas of maximum hazard from this breach/overtopping are immediately adjacent to the breach, as well as north of the railway line. The majority of the Brede Level is classified as having a low risk. In climate change scenarios the high hazard areas are in similar places but the majority of the Brede Level is classified as a medium hazard.

# 3.7 Rye South

The area that has been named Rye South is located on the north side of the tidal River Brede near Shipyard Lane. The area is predominantly developed in the immediate vicinity and is directly south of the centre of Rye.

The main flood risk to Rye South is from the tidal River Brede. However, this risk is residual due to the presence of flood management measures in the form of soft defences which protect Rye South from tidal flood events. These have recently been improved in this location and have a crest height of 5.8 mAOD that has been confirmed in correspondence with the Environment Agency.

The Environment Agency Flood Zone Maps illustrate the extent of flooding should no flood management measures be in place. These show that Rye South (south of the A259) entirely resides within Flood Zone 3a. It does not show that the area benefits from defences.

## Breach modelling results

In order to better understand the risk of flooding posed by the River Brede, breach modelling was undertaken in the Rye South area. The modelling also allowed for the defences to be overtopped from the confluence with of the River Rother and along the River Brede, to more accurately represent a flooding situation.

It was agreed that a breach should be modelled in the earth embankments next to the industrial estate. The breach width modelled was 50m.

Breach modelling was undertaken for four scenarios; the 0.5% and 0.1% annual probability for 2008 and 2115. No overtopping occurs in the present day scenarios.

## Flood Propagation and Depth

The flood depth maps for all the scenarios run are presented in Appendix A and are A 7.1.1, A 7.2.1, A 7.3.1 and A 7.4.1.

For the present day scenarios the simulated flood from the River Brede demonstrate that the when the defences south of Rye South are breached flood water is directed in a northwest direction, up to the A259. It is temporarily restricted from flowing east by Shipyard Lane. Further east flood water is temporarily limited by Rock Channel but then propagates toward the recreation ground. The deepest water occurs immediately west of Shipyard Lane.

During the climate change scenarios flood water penetrates the breach and propagates toward the areas to the east and west of Shipyard Lane before extensive overtopping occurs during the second tidal cycle.

Approximate flood depths are presented below but is should be clarified these were extracted over large areas and for more detailed flood depths please refer to the figures in Appendix A. The depths presented here are applicable to the breach location specified and therefore may not be the worst-case scenario for site-specific flood risk assessments.

**0.5% annual probability tidal event**

- The area immediately adjacent to the breach (west of Shipyard Lane) experiences depths of up to 2.3 m;
- The area immediately east of Shipyard Lane experiences depths of up to 2.2 m; and,
- The area between Wish Ward Strand and the A259 experiences no flooding.

**0.5% annual probability tidal event including the effects of climate change**

- The area immediately adjacent to the breach (west of Shipyard Lane) experiences depths of up to 3.2 m;
- The area immediately east of Shipyard Lane experiences depths of up to 3.1 m; and,
- The area between Wish Ward Strand and the A259 experiences depths up to 1.25 m.

**0.1% annual probability tidal event**

- The area immediately adjacent to the breach (west of Shipyard Lane) experiences depths of up to 2.5 m;
- The area immediately east of Shipyard Lane experiences depths of up to 2.25 m; and,
- The area between Wish Ward Strand and the A259 experiences no flooding.

**0.1% annual probability tidal event including the effects of climate change**

- The area immediately adjacent to the breach (west of Shipyard Lane) experiences depths of up to 3.5 m;
- The area immediately east of Shipyard Lane experiences depths of up to 3.25 m; and,
- The area between Wish Ward Strand and the A259 experiences depths up to 1.25 m.

## Flood Hazard

To provide an assessment of the danger to people posed by flood waters, hazard mapping was completed as part of the breach assessment. The flood hazard maps for all the scenarios run are presented in Appendix A and are A 7.1.2, A 7.2.2, A 7.3.2 and A 7.4.2 that illustrate flood hazards that may be experienced should a breach occur in the tidal defences during all of the scenarios run.

Flood hazard can be expressed as a combination of flood depth and velocity. Therefore, the maximum flood hazard for a given location could be experienced at any stage of the flood. Near the breach where velocities are high the highest hazard is likely to be achieved at the time of peak velocity. Further from the breach the maximum hazard will depend on local factors affecting both the depth of floodwaters and velocities at each instant. At the very fringes of the flood extent the maximum hazard occurs nearer the peak water depth towards the end of the simulation.

Hazard mapping shows that areas of maximum hazard from this breach/overtopping is simulated to occur in the areas to the west and east of Shipyard Lane. Under climate change scenarios high flood hazard has also been calculated to occur over the majority of the flood cell due to the depths of flooding.

## 3.8 North Salts

The area that has been named North Salts is located to the north of Rye on the west side of the tidal River Rother. The area is predominantly developed in the immediate vicinity of the breach location.

The main flood risk to North Salts is from the tidal River Rother. However, this risk is residual due to the presence of flood management measures in the form of hard defences which protect the North Salts area from tidal flood events. These have recently been improved in this location and have a crest height of 5.8 mAOD that has been confirmed in correspondence with the Environment Agency.

The Environment Agency Flood Zone Maps illustrate the extent of flooding should no flood management measures be in place. These show that Rye Harbour entirely resides within Flood Zone 3a. It does however also show that the area benefits from flood defences.

### Breach/overtopping modelling results

In order to better understand the risk of flooding posed by the River Rother, breach modelling was undertaken in the North Salts area. The modelling also allowed for the defences to be overtopped along the River Brede and the River Rother up to Scott's Float Sluice where the tidal system becomes fluvial.

### Flood Propagation and Depth

The flood depth maps for all the scenarios run are presented in Appendix A and are A 8.1.1, A 8.2.1, A 8.3.1 and A 8.4.1.

For the present day scenarios the simulated flood from the River Rother demonstrated the current defences are not overtopped in the present day scenarios. Once the breach occurs in present day scenarios the flood water is generally directed in a southerly direction, according to the topography. The floodwaters are temporarily restricted by the embanked railway but this is eventually overtopped in the second tidal cycle. Further flooding to the south is restricted by the A268 but flood water reaches the west side of the A268 from the River Brede. Once the floodwaters overtop the railway embankment they rapidly inundate the cricket and recreation grounds.

Under climate change scenarios the cricket and recreation grounds are inundated with flood water. The flood waters directed from the recreation ground (as a result of the breach at North Salts) overtop Rock Channel before overtopping of the defences occurs.

Approximate flood depths are presented below but is should be clarified these were extracted over large areas and for more detailed flood depths please refer to the figures in Appendix A. The depths presented here are applicable to the breach location specified and therefore may not be the worst-case scenario for site-specific flood risk assessments.

**0.5% annual probability tidal event**

- The area immediately west of the breach location experiences flood depths up to 1.8 m;
- North Salts experiences flood depths up to 2.3 m; and,
- The cricket ground experiences depths up to 1.5 m.

**0.5% annual probability tidal event including the effects of climate change**

- The area immediately west of the breach location experiences flood depths up to 2.8 m;
- North Salts experiences flood depths up to 3.3 m; and,
- The cricket ground experiences depths up to 3.2 m.

**0.1% annual probability tidal event**

- The area immediately west of the breach location experiences flood depths up to 1.8 m;
- North Salts experiences flood depths up to 2.5 m; and,
- The cricket ground experiences depths up to 1.8 m.

**0.1% annual probability tidal event including the effects of climate change**

- The area immediately west of the breach location experiences flood depths up to 3.0 m;
- North Salts experiences flood depths up to 3.5 m; and,
- The cricket ground experiences depths up to 3.5 m.

### Flood Hazard

To provide an assessment of the danger to people posed by flood waters, hazard mapping was completed as part of the breach assessment. The flood hazard maps for all the scenarios run are presented in Appendix A and are A 8.1.2, A 8.2.2, A 8.3.2 and A 8.4.2 that illustrate flood hazards that may be experienced should a breach occur in the tidal defences during all of the scenarios run.

Flood hazard can be expressed as a combination of flood depth and velocity. Therefore, the maximum flood hazard for a given location could be experienced at any stage of the flood. Near the breach where velocities are high the highest hazard is likely to be achieved at the time of peak velocity. Further from the breach the maximum hazard will depend on local factors affecting both the depth of floodwaters and velocities at each instant. At the very fringes of the flood extent the maximum hazard occurs nearer the peak water depth towards the end of the simulation.

Hazard mapping shows that areas of maximum hazard from this breach/overtopping occur around North Salts, and in the present day scenarios these are classified as having a high flood hazard. In the present day scenarios most of the cricket and recreation ground is classified as having a high hazard, which is a result of the depths of flooding experienced.

## 3.9 Rye East

The area that has been named Rye East is located on the east side of the tidal River Rother. The area is predominantly marshland (Walland Marsh) although the area is slightly urbanised to the northeast. The DTM for the model was predominantly created using LiDAR data supplied by the Environment Agency. However, the coverage of the LiDAR data was not complete and it was necessary to manually fill in the LiDAR data. This was deemed appropriate in this case as the areas without LiDAR coverage are generally flat and a significant distance from the breach location and the Rye East area.

There are raised earth embankments that are located along the east bank of the River Rother. These are planned to be improved in 2020, but for the purposes of the modelling undertaken in this study the present day heights were used.

The main flood risk to Rye East is from the tidal River Rother. However, this risk is residual due to the presence of flood management measures in the form of earth embankments which protect Rye East from tidal flood events.

The Environment Agency Flood Zone Maps illustrate the extent of flooding should no flood management measures be in place. These show that Rye East entirely resides within Flood Zone 3a.

### Breach modelling results

In order to better understand the risk of flooding posed by the River Rother, breach modelling has been carried out in the Rye East area.

A breach was modelled in the earth embankments on the east side of the River Rother; just south of Monkbretton Bridge. A breach width of 50m was modelled. The modelling also allowed for the defences to be overtopped from the mouth of the River Rother up to Scott's Float Sluice, where the tidal River Rother becomes fluvial, to more accurately represent a flooding situation.

### Flood Propagation and Depth

The flood depth maps for all the scenarios run are presented in Appendix A and are A 9.1.1, A 9.2.1, A 9.3.1 and A 9.4.1.

The simulated flood from the River Rother demonstrated that the breach in the defences just south of Monkbretton Bridge is penetrated in the first tidal cycle. Flood water as directed in a south easterly direction and quickly propagates onto the extensive flat marsh area of Walland Marsh. The A259 does restrict the flow of floodwaters to the north, however this area is inundated from overtopping of the embankments along the east side of the River Rother. Propagation to the south is also temporarily restricted by Camber Road although this is eventually overtopped. In the present day scenarios the only defences that are overtopped are those located between the A259 and the railway line.

In the climate change scenarios the defences along the east bank of the River Rother are overtopped which allows floodwaters to inundate Walland Marsh extensively. This includes the area north of the Union Canal and Rye Golf Links.

Approximate flood depths are presented below but is should be clarified these were extracted over large areas and for more detailed flood depths please refer to the figures in Appendix A. The depths presented here are applicable to the breach location specified and therefore may not be the worst-case scenario for site-specific flood risk assessments.

**0.5% annual probability tidal event**

- The area directly opposite the breach near the school has been simulated to experience depths of up to 1.2 m;
- The area between the A259 and the railway line (around Kings Avenue) has been simulated to experience depths of up to 1.1 m; and,
- The area north of the railway line has been simulated to experience no flooding.

**0.5% annual probability tidal event including the effects of climate change**

- The area directly opposite the breach near the school has been simulated to experience depths of up to 1.9 m;
- The area between the A259 and the railway line (around Kings Avenue) has been simulated to experience depths of up to 1.5; and,
- The area north of the railway line has been simulated to experience flood depths up to 1m.

**0.1% annual probability tidal event**

- The area directly opposite the breach near the school has been simulated to experience depths of up to 1.5 m;
- The area between the A259 and the railway line (around Kings Avenue) has been simulated to experience depths of up to 1.5; and,
- The area north of the railway line has been simulated to experience no flooding.

**0.1% annual probability tidal event including the effects of climate change**

- The area directly opposite the breach near the school has been simulated to experience depths of up to 2.0 m;
- The area between the A259 and the railway line (around Kings Avenue) has been simulated to experience depths of up to 1.75 m and,
- The area north of the railway line has been simulated to experience flood depths up to 1.5 m.

### Flood Hazard

To provide an assessment of the danger to people posed by flood waters, hazard mapping was completed as part of the breach/overtopping assessment. The flood hazard maps for all the scenarios run are presented in Appendix A and are A 9.1.2, A 9.2.2, A 9.3.2 and A 9.4.2 that illustrate flood hazards that may be experienced should a breach occur in the tidal defences during all of the scenarios run.

Flood hazard can be expressed as a combination of flood depth and velocity. Therefore, the maximum flood hazard for a given location could be experienced at any stage of the flood. Near the breach where velocities are high the highest hazard is likely to be achieved at the time of peak velocity. Further from the breach the maximum hazard will depend on local factors affecting both the depth of floodwaters and velocities at each instant. At the very fringes of the flood extent the maximum hazard occurs nearer the peak water depth towards the end of the simulation.

Hazard mapping shows that areas of maximum hazard in the present day scenarios from this breach/overtopping are simulated to be immediately adjacent to the breach, in the small area that overtops the defences and in an extensive area to the east of Camber Road. In the climate change scenarios the majority of the Rye East area has been classified as having a high hazard with the exception of the area to the north of the railway embankment which has been classified as having a medium hazard.

## 3.10 Camber West

The small settlement of Camber is located on the coastline approximately 4.5 km southeast of Rye; the area that has been named Camber West surrounds the Central car park. The area is predominantly developed in the immediate vicinity of the breach location but further to the west extents on to the Walland Marsh.

The main flood risk to Camber West is from the English Channel. However, there are well developed sand dunes along this coastline that in some places have a crest height up to 20 mAOD.

The Environment Agency Flood Zone Maps illustrates that all of Camber West is located within Flood Zone 3a.

### Breach/overtopping modelling results

In order to better understand the risk of flooding posed by the English Channel, breach modelling has been carried out in the Rye West area. The modelling also allowed for the defences to be overtopped from the mouth of the River Rother to the edge of Rother District Council's boundary (just east of the Midrips) to more accurately represent a flooding situation.

The breach was located at the Central car park that is located along the same line as the dunes. The car park has an approximate level of 5.5 mAOD but for modelling purposed an invert level of 4.4 mAOD was used that is more representative of the ground levels further from the car park.

A secondary flood defence runs through the centre of Camber from the west end of The Suttons in a northeast direction, along the Guldeford Sewer, and has been included in the modelling of Camber. In discussions with the Environment Agency a slot board is located in this defence at the New Lydd Road. It is known that recently this has remained open and there are no plans for it to be closed, therefore the modelling has assumed it to be open.

## Flood Propagation and Depth

The flood depth maps for all the scenarios run are presented in Appendix A and are A 10.1.1, A 10.2.1, A 10.3.1 and A 10.4.1.

In the present day scenarios the simulated flooding from the English Channel through a breach at the Central car park is directed initially in a north westerly direction but then in a northeasterly direction, according to the topography. Flooding is restricted by drains and embankments that surround Camber and flood water does not penetrate past Guldeford Sewer.

In the climate change scenarios flood water propagates as in the present day scenarios although the Wainway Wall is overtopped which allows flood water to propagate onto the Walland Marsh. Floodwater also flows through the open slot board in the secondary defence.

Approximate flood depths are presented below but is should be clarified these were extracted over large areas and for more detailed flood depths please refer to the figures in Appendix A. The depths presented here are applicable to the breach location specified and therefore may not be the worst-case scenario for site-specific flood risk assessments.

**0.5% annual probability tidal event**

- Sea Road experiences flood depths of up to 0.5 m;
- The holiday centre experiences depths of up to 0.4 m; and,
- Yates Close experiences no flooding.

**0.5% annual probability tidal event including the effects of climate change**

- Sea Road experiences flood depths of up to 1.0 m;
- The holiday centre experiences depths of up to 1.0 m; and,
- Yates Close experiences depths up to 0.5 m.

**0.1% annual probability tidal event**

- Sea Road experiences flood depths of up to 0.6 m;
- The holiday centre experiences depths of up to 0.5 m; and,
- Yates Close experiences no flooding.

**0.1% annual probability tidal event including the effects of climate change**

- Sea Road experiences flood depths of up to 1.1 m;
- The holiday centre experiences depths of up to 1.1 m; and,
- Yates Close experiences depths up to 0.6 m.

## Flood Hazard

To provide an assessment of the danger to people posed by flood waters, hazard mapping was completed as part of the breach assessment. The flood hazard maps for all the scenarios run are presented in Appendix A and are A 10.1.2, A 10.2.2, A 10.3.2 and A 10.4.2 that illustrate flood hazards that may be experienced should a breach occur in the tidal defences during all of the scenarios run.

Flood hazard can be expressed as a combination of flood depth and velocity. Therefore, the maximum flood hazard for a given location could be experienced at any stage of the flood. Near the breach where velocities are high the highest hazard is likely to be achieved at the time of peak velocity. Further from the breach the maximum hazard will depend on local factors affecting both the depth of floodwaters and velocities at each instant. At the very fringes of the flood extent the maximum hazard occurs nearer the peak water depth towards the end of the simulation.

The hazard mapping shows that in the current day scenarios much of the flooded area is classified as having a low or medium hazard, with the exception of in the immediate vicinity of the breach. Under the climate change scenarios much of the flooded area is also classified as having a low to medium hazard. However, a larger area adjacent to the breach has been classified as having a high hazard.

## 3.11 Camber East

The small settlement of Camber is located on the coastline approximately 4.5 km southeast of Rye; the area that has been named Camber East surrounds the 'The Suttons' and a caravan park. The area is predominantly developed in the immediate vicinity to the west of the breach location. Towards the north and east the area is predominantly marshland with only a caravan park in the immediate vicinity.

The main flood risk to Camber East is from the English Channel, although a shingle embankment with a clay core protects the area from tidal flooding in normal circumstances. A breach location was located at the eastern end of 'The Suttons' as past flooding has been experienced in this area. The breach width modelled was 100m.

The Environment Agency Flood Zone Maps illustrates that all of Camber West is located within Flood Zone 3a.

### Breach/overtopping modelling results

In order to better understand the risk of flooding posed by the English Channel, breach modelling has been carried out in the Camber East area. The modelling also allowed for the defences to be overtopped from the mouth of the River Rother to the edge of Rother District Council's boundary that is just east of the Midrips, to more accurately represent a flooding situation.

A secondary flood defence runs through the centre of Camber from the west end of The Suttons in a northeast direction, along the Guldeford Sewer, and has been included in the modelling of Camber. In discussions with the Environment Agency a slot board is located in this defence at the New Lydd Road. It is known that recently this has remained open and there are no plans for it to be closed, therefore the modelling has assumed it to be open.

### Flood Propagation and Depth

The flood depth maps for all the scenarios run are presented in Appendix A and are A 11.1.1, A 11.2.1, A 11.3.1 and A 11.4.1.

Under the present day scenarios the simulated flood from the English Channel through a breach at the eastern end of The Suttons directed in a north easterly direction, according to the topography. It is restricted by the embankments of the Guldeford Sewer, although the section that runs from south to north is overtopped adjacent to the caravan park. Under climate change scenarios the embanked drain to the east and New Lydd Road are overtopped early in the first tidal cycle. This allows flood water to quickly propagate onto Broomhill Level. Flood water flows through the open slot board and propagates toward the caravan park to the north of Guldeford Sewer. The embankment along the drain to the north of this caravan park is not overtopped.

Approximate flood depths are presented below but is should be clarified these were extracted over large areas and for more detailed flood depths please refer to the figures in Appendix A. The depths presented here are applicable to the breach location specified and therefore may not be the worst-case scenario for site-specific flood risk assessments.

**0.5% annual probability tidal event**

- The campsite opposite the breach location experiences depths up to 0.4 m;
- Yates Close experiences no flooding; and,
- Broomhill Farm cottages experience no flooding.

**0.5% annual probability tidal event including the effects of climate change**

- The campsite opposite the breach location experiences depths up to 1.1 m;
- Yates Close experiences depths of 1.0 m; and
- Broomhill Farm cottages experience depths of 0.5 m.

**0.1% annual probability tidal event**

- The campsite opposite the breach location experiences depths up to 0.6 m;
- Yates Close experiences no flooding; and
- Broomhill Farm cottages experience no flooding.

**0.1% annual probability tidal event including the effects of climate change**

- The campsite opposite the breach location experiences depths up to 1.3 m;
- Yates Close experiences depths of 1.1 m; and,
- Broomhill Farm cottages experiences depths of 0.7 m.

## Flood Hazard

To provide an assessment of the danger to people posed by flood waters, hazard mapping was completed as part of the breach assessment. The flood hazard maps for all the scenarios run are presented in Appendix A and are A 11.1.2, A 11.2.2, A 11.3.2 and A 11.4.2 that illustrate flood hazards that may be experienced should a breach occur in the tidal defences during all of the scenarios run.

Flood hazard can be expressed as a combination of flood depth and velocity. Therefore, the maximum flood hazard for a given location could be experienced at any stage of the flood. Near the breach where velocities are high the highest hazard is likely to be achieved at the time of peak velocity. Further from the breach the maximum hazard will depend on local factors affecting both the depth of floodwaters and velocities at each instant. At the very fringes of the flood extent the maximum hazard occurs nearer the peak water depth towards the end of the simulation.

Hazard mapping shows that in the present day scenarios the majority of the flooded area has been classified as having a low hazard. In climate change scenarios the majority of the caravan park opposite the breach has been classified as having a high hazard.

# 3.12 Jury's Gap

Jury's Gap is located in the east of the Rother District approximately 1.3 km east of Camber. There is a line of development parallel to the coast beyond which is an extensive area of marshland (Walland Marsh).

The main flood risk to Jury's Gap is from the English Channel. However, this risk is residual due to the presence of managed shingle beaches with a hard revetment that protect Jury's Gap in normal circumstances.

The Environment Agency Flood Zone Maps illustrate the extent of flooding should no flood management measures be in place. These show that Jury's Gap entirely resides within Flood Zone 3a.

## Breach modelling results

In order to better understand the risk of flooding posed by the English Channel, breach modelling was undertaken in the Jury's Gap area. The modelling also allowed for the defences to be overtopped from the mouth of the River Rother to the edge of Rother District Council's boundary (just east of the Midrips) to more accurately represent a flooding situation.

A breach was located immediately adjacent to Jury's Gap Sluice on the eastern side. The breach width modelled was 50m as the defences are hard.

## Flood Propagation and Depth

The flood depth maps for all the scenarios run are presented in Appendix A and are A 12.1.1, A 12.2.1, A 12.3.1 and A 12.4.1.

The simulated flood from the English Channel demonstrated that shortly after the water penetrates the breach it flows into Jury's Gut Sewer that acts as a conduit for water to flow quickly away from Jury's Gap. However, this becomes overtopped which causes the areas north and south Jury's Gut Sewer to flood.

**0.5% annual probability tidal event**

- Immediately opposite the breach flood depths are experienced up to 1.3 m;
- Immediately adjacent to the north bank of the Jury's Gut Sluice flood depths are experienced up to 1.4 m; and
- South of Jury's Gut Sewer near the Kentpen Wall flood depths are experienced up to 0.9 m.

**0.5% annual probability tidal event including the effects of climate change**

- Immediately opposite the breach flood depths are experienced up to 2.1 m;
- Immediately adjacent to the north bank of the Jury's Gut Sluice flood depths are experienced up to 1.7 m; and
- South of Jury's Gut Sewer near the Kentpen Wall flood depths are experienced up to 1.1

**0.1% annual probability tidal event**

- Immediately opposite the breach flood depths are experienced up to 1.4 m;
- Immediately adjacent to the north bank of the Jury's Gut Sluice flood depths are experienced up to 1.4 m; and

- South of Jury's Gut Sewer near the Kentpen Wall flood depths are experienced up to 0.9 m.

**0.1% annual probability tidal event including the effects of climate change**

- Immediately opposite the breach flood depths are experienced up to 2.1 m;
- Immediately adjacent to the north bank of the Jury's Gut Sluice flood depths are experienced up to 1.8 m; and
- South of Jury's Gut Sewer near the Kentpen Wall flood depths are experienced up to 1.4 m.

## Flood Hazard

To provide an assessment of the danger to people posed by flood waters, hazard mapping was completed as part of the breach assessment. The flood hazard maps for all the scenarios run are presented in Appendix A and are A 12.1.2, A 12.2.2, A 12.3.2 and A 12.4.2 that illustrate flood hazards that may be experienced should a breach occur in the tidal defences during all of the scenarios run.

Flood hazard can be expressed as a combination of flood depth and velocity. Therefore, the maximum flood hazard for a given location could be experienced at any stage of the flood. Near the breach where velocities are high the highest hazard is likely to be achieved at the time of peak velocity. Further from the breach the maximum hazard will depend on local factors affecting both the depth of floodwaters and velocities at each instant. At the very fringes of the flood extent the maximum hazard occurs nearer the peak water depth towards the end of the simulation.

Hazard mapping shows that areas of maximum hazard from this breach/overtopping are immediately adjacent to the breach under present day scenarios. Under climate change scenarios a high flood hazard has been classified in the area around the breach as well as either side of the Jury's Gut Sewer.

# 4 The Sequential Approach

The Level 1[2] and Level 2 SFRAs have shown that much of Rother District resides within Flood Zone 2 and 3, having a medium to high probability of flooding. As previously discussed within this report, this flood risk generally concerns tidal sources and is in fact residual risk, being the risk arising from a failure of existing flood defence infrastructure. However, the risk is real and for Rother District Council to be conversant with the policy aims of PPS25[1], they must continue to use a sequential approach to the allocation of sites and the development control of infill/windfall sites which come forward as a matter of routine.

## 4.1 Site Allocation

The Level 1 SFRA includes a Sequential Test Appendix which relates to the Spatial Strategy for Rother District contained in the Preferred Options Core Strategy. The following text is reproduced from that Appendix:

*The Core Strategy gives broad locations for strategic development but it does not allocate specific sites. Separate sequential tests will be prepared for proposed allocated land during preparation of the Site Allocations DPD, which will also examine existing settlement development boundaries, with a view to making amendments where necessary.*

Table 4 summarises the Sequential Test undertaken by Rother District Council at the time of writing.

*Table 4: Summary of the Sequential Test for Rother District*

| Site ID | Location Name | Grid Reference | Tidal Flood Zone | | | | Fluvial Flood Zone | | Known area of poor drainage | Known sewerage flooding | Known highway flooding | Development Type and Vulnerability | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3a | 3b | 1 | 2/3 | (Y/N) | (Y/N) | (Y/N) | Essential Infrastructure / Water Compatible / Highly / More / Less | Exception Test Required in Future ? |
| 1 | North Bexhill | TQ 7351 05 | ✓ | ✓ | ✓ | - | ✓ | ✓* | N | N | N | Residential & Employment | N |
| 2 | Normans Bay | TQ 6870 57 | - | ✓ | ✓ | - | ✓ | ✓ | Y | N | Y | Residential & Coastal Uses | Y** |
| 3 | Cooden Beach | TQ 7100 66 | ✓ | ✓ | ✓ | - | ✓ | ✓* | N | N | Y | Residential & Coastal Uses | Y** |
| 4 | Pett Level | TQ 8881 35 | ✓ | ✓ | ✓ | - | ✓ | ✓ | Y | N | Y | Residential & Coastal Uses | Y** |
| 5 | Winchelsea Beach | TQ 9151 65 | - | ✓ | ✓ | - | ✓ | ✓ | Y | Y | N | Residential & Coastal Uses | Y** |
| 6 | Rye Harbour | TQ 9401 90 | - | ✓ | ✓ | - | ✓ | ✓ | N | N | N | Residential & Water Compatible | Y** |
| 7 | Harbour Road | TQ 9341 95 | - | ✓ | ✓ | - | ✓ | ✓ | N | N | N | Employment & Water Compatible | Y** |
| 8 | Rye West of R. Rother | TQ 9212 01 | ✓ | ✓ | ✓ | - | ✓ | ✓ | Y | Y | Y | Mixed use including Water Compatible | Y** |
| 9 | Rye East of R. Rother | TQ 9272 07 | - | ✓ | ✓ | - | - | ✓ | Y | N | N | Residential & Educational | Y** |
| 10 | Camber (East) | TQ 9731 85 | - | ✓ | ✓ | - | ✓ | - | Y | N | N | Residential & Coastal Uses | Y** |
| 11 | Camber (West) | TQ 9651 87 | - | ✓ | ✓ | - | ✓ | - | Y | N | Y | Residential & Coastal Uses | Y** |
| 12 | Robertsbridge | TQ 7352 35 | - | - | - | - | ✓ | ✓ | Y | Y | Y | Residential & Employment | Y |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | Etchingham | TQ 7132 63 | - | - | - | - | ✓ | ✓ | Y | N | Y | Residential & Employment | Y |
| 14 | Crowhurst | TQ 7601 23 | - | - | - | - | ✓ | ✓ | Y | N | Y | Residential | Y |
| 15 | Sedlescombe | TQ 7821 77 | - | - | - | - | ✓ | ✓* | N | Y | N | Residential | Y |
| 16 | Bodiam | TQ 7832 54 | - | ✓* | ✓* | - | ✓ | ✓* | N | N | Y | Residential & Tourist | Y |
| 17 | Winchelsea | TQ 9071 77 | ✓ | ✓* | ✓* | - | ✓ | ✓* | N | N | Y | Residential | Y** |

* Small part only
** Tidal flood risk for which Exception Test 'safe' standards can be broadly determined at the time of writing (based on Flood Hazard maps)

## 4.2 Development Control

Development is only permissible in areas at risk of flooding where it can be demonstrated that there are no reasonably available sites in areas of lower risk and that the benefits outweigh the risks from flooding i.e. the development must pass the Exception Test.

Where there are no reasonably available sites in Flood Zone 1, decision makers should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2, applying the Exception Test if required. Only where there are no reasonably available sites in Flood Zones 1 or 2 should decision makers consider sites in Flood Zone 3, taking into account flood risk vulnerability and applying the Exception Test where necessary.

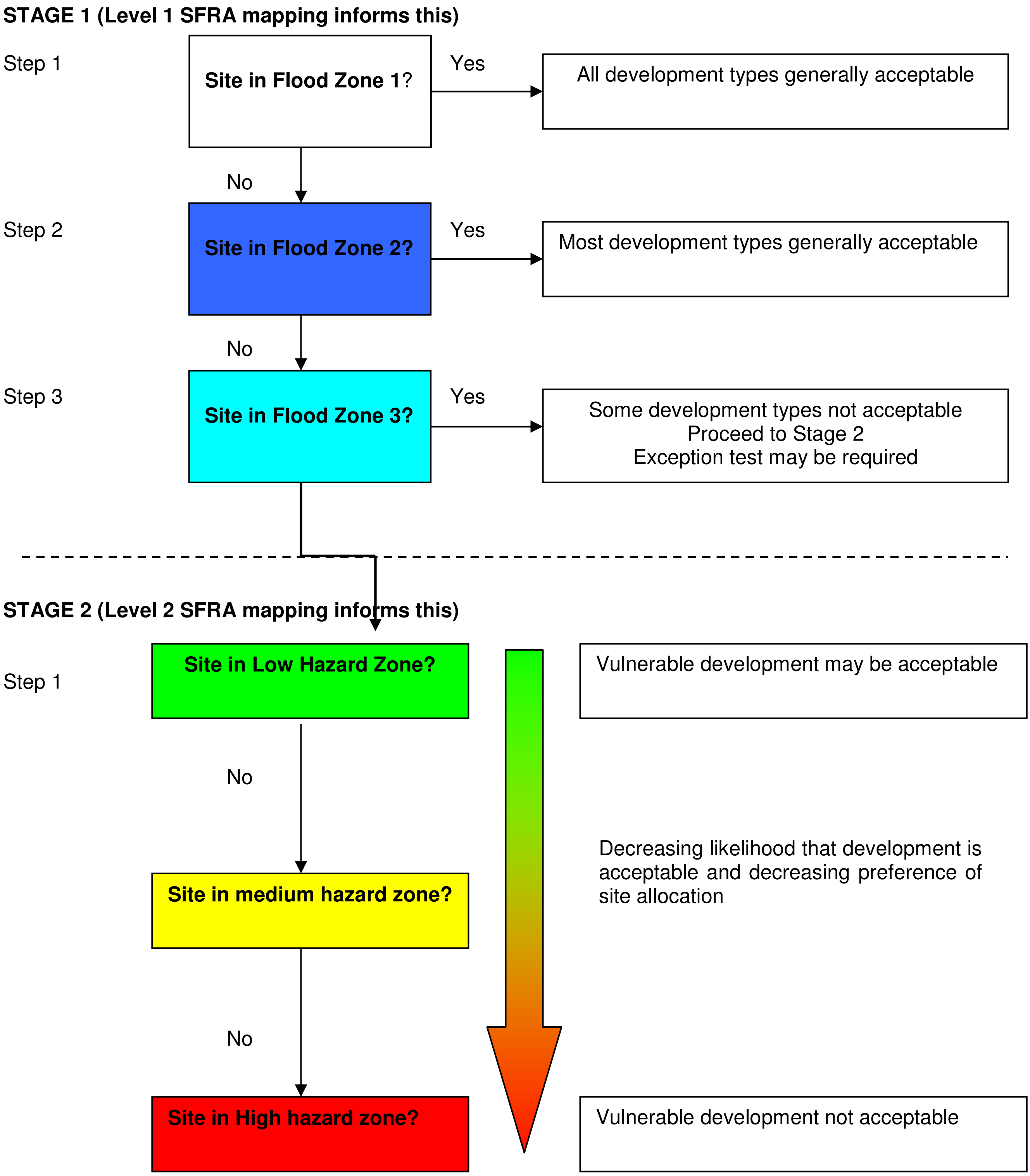
In the situation of Rother District, it is unlikely that development can always be sequentially steered away from high risk flood zones, due to the extensive spatial coverage of tidal floodplain. In this case new development should be directed to areas at lowest probability of flooding within the flood cell and the flood vulnerability should be matched to the flood risk of the site e.g. higher vulnerability uses should be located on parts of the site with the lowest probability of flooding.

The production of Flood Hazard maps has allowed an appreciation of differing levels of flood hazard within the flood zones, allowing an extended sequential approach to be taken as illustrated in Figure 4 below.

Stage 1 of Figure 4 represents the PPS25[1] Sequential Test. Steps 1 to 3 are to be followed, with each, from a flood risk point of view, being less desirable than the previous for a given development type (i.e. Flood Zone 2 is less desirable than Flood Zone 1). As the user progresses through the steps, they must be confident that a site of lesser flood risk is not appropriate for the specific development under consideration.

Stage 2 of Figure 4 represents the additional Hazard Zone test. To move to Stage 2 the user must again be confident that no site of a lesser flood risk is appropriate for the specific development under consideration. As with Stage 1, each step represents, from a flood risk point of view, a less desirable site than the previous step.

*Figure 4: Suggested Sequential Approach for development control in Rother District*



As can be seen from the above schematic, the interrogation of Hazard Zone information is a series of further steps beyond the usual procedure of applying the PPS25[1] Sequential Test. It is intended that the Hazard Zones classification of low-medium-high remains subjective and is inherently relative to a specific site.

A planning authority's decision to allocate development land within areas where Hazard Zone maps have been produced in this Strategic Flood Risk Assessment should examine all of the following:

- The vulnerability of the proposed development type to flooding;
- The residual risk to the development; and,
- The options for managing the residual risk.

## 4.3 Site Specific Flood Risk Assessment Guidance

The Rother District Council SFRA Levels 1[2] and 2 together provide a comprehensive collation of existing flood risk information in the District. The Level 2 goes further, deriving new information on the potential risks and hazards from tidal sources. However, the scope of these documents is strategic in nature and so it is imperative that site-specific flood risk assessments are produced by those proposing development.

It is probable that flood risk exists within the District that has not been highlighted in either the Level 1 or 2 SFRAs either because the information has not existed or due to other development factors (in particular the location of breaches relative to development areas). Therefore, site specific flood risk assessments are required to assess the flood risk posed to proposed developments and to ensure that where necessary and appropriate, suitable mitigation measures are included in the development. They should however use information from the SFRA, where this is helpful or strengthens the assessment.

A site-specific flood risk assessment forms the 3rd tier of the assessment approach advocated by PPS25[1] and its Practice Guide[3]. Rother District Council should require a flood risk assessment to inform both local sequential testing and site-specific exception tests, rather than relying solely on the information presented within the Level 1[2] and 2 SFRAs.

This section presents the recommendations for site specific flood risk assessments prepared for submission with planning applications in the Rother District Council administrative area.

The site specific flood risk assessment guidance presented in the following sections has been developed based on:

- the recommendations presented in Planning Policy Statement 25[1] and the PPS25 Practice Guide[3];
- a review of the policies contained within the existing Local Plan for Rother District Council; and,
- the information gathered through and findings of the Level 1 and 2 SFRA processes.

### Requirement for a Flood Risk Assessment

When informing developers of the requirements of a flood risk assessment for a development site, consideration should be given to the position of the development relative to flood sources, the vulnerability of the proposed development and its scale.

In any one of the following situations a Flood Risk Assessment would be required with a planning application:

- The development site is located in Flood Zone 2 or 3;
- The proposed development comprises 5 or more residential dwellings and/or the site area is greater than 0.5 hectares (even if the site is located in Flood Zone 1). This is to ensure storm water generated by the site is managed in a sustainable manner and does not increase the burden on existing infrastructure and/or flood risk to neighbouring property;
- The floor space of proposed non-residential development is greater than 1000m² or the site area is greater than 1 hectare;
- The development site is located in an area known to have experienced flooding problems from any flood source; and,
- The development is located within 20m of any watercourse regardless of Flood Zone classification, or within 200m of a coastal flood defence on either open coast or estuary.

## Flood Risk Assessment Content

Annex E of PPS25[1] presents the minimum requirements for flood risk assessment. These include:

- Considering the risk of flooding arising from the development in addition to the risk of flooding to the development;
- Identifying and quantifying the vulnerability of the development to flooding from different sources and identify potential flood risk reduction measures;
- Assessments of the remaining ‘residual’ risk after risk reduction measures have been taken into account and demonstrate that this is acceptable for the particular development;
- The vulnerability of those that could occupy and use the development, taking account of the Sequential and Exception Tests and the vulnerability classification, including arrangements for safe access;
- Considering how the ability of water to soak into the ground may change with development, along with how the proposed layout of development may affect drainage systems; and,
- Fully account for current climate change scenarios and their effect on flood zoning and risk.

## Access and Egress

Safe access and egress is required to enable the evacuation of people from the development, provide the emergency services with access to the development during times of flood and enable flood defence authorities to carry out any necessary duties during periods of flood.

‘Safe’ access/egress route is a route that is safe for use by occupiers without the intervention of the emergency services or others.

For developments located in areas at tidal risk the Environment Agency consider ‘safe’ access/egress to be in accordance with ‘FRA Guidance for new Developments FD 2320’ (Joint DEFRA and EA document) the requirements for safe access and egress from new developments are as follows in order of preference:

- Safe, dry route for people and vehicles;
- Safe, dry route for people;
- If a dry route for people is not possible, a route for people where the flood hazard in terms of depth and velocity of flooding) is low and should not cause risk to people. (Flood breach results should be used to determine this); and,
- If a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity of flooding) is low to permit access for emergency vehicles.

Details of how this will be achieved should be clearly described in site specific Flood Risk Assessments using depth and hazard mapping provided as part of this report.

## Finished Floor Levels

Where developing in flood risk areas is unavoidable as is the case in some areas of Rother District, the most accepted method of mitigating flood risk is to ensure habitable floor levels are raised above the maximum flood water level. This can substantially reduce the damage to property and significantly reduce the risk of injury and fatalities.

In areas of minimal floodwater depth, raising finished floor levels can usually be easily be accommodated in building design. In areas where a substantial depth of floodwater is expected properties can incorporate a garage, utility area or public space on the ground floor with habitable areas above.

The following requirements for finished floor levels in Rother District are suggested:

For ***residential*** developments***:***

- Where no breach analysis is undertaken by the applicant; finished floor levels should be set at or above the Environment Agency 0.1% annual probability (1 in 1000 year) flood level. If this is not possible, floor levels should be set at or above the Environment Agency 0.5% annual probability (1 in 200 year) flood level.
- If breach analysis has been undertaken by the applicant then levels derived from the breach modelling should be used in the same way (preferably at or above the 0.1% annual probability (1 in 1000 year) flood level or the 0.5% annual probability (1 in 200 year) if this is not practical).
- In some planning applications for residential development the use of the breach modelling undertaken as part of this Level 2 SFRA to set finished floor levels may be acceptable, depending on local topography and proximity to a modelled breach location.
- No freeboard is required as raising finished floor levels of defended properties is considered conservative enough.

For ***Less Vulnerable*** developments:

- Finished floor levels do not need to be raised. However, it is strongly recommended where possible that internal access is provided to upper floors to provide safe refuge during a flood event.

For ***More vulnerable*** developments:

- Finished floor levels do not need to be raised, however, internal access to higher floors must be provided to give safe refuge during times of flood.

## Flood Warning and Evacuation Plans

Flood Warning and Emergency Procedures tend to form part of a higher level emergency management plans for the wider area including information such as repair procedures, evacuation routes, refuge areas flood warning dissemination and responsibilities.

Rother District Council has emergency plans in place to respond to any incident that occurs within their administrative area. These documents should be updated to include the information generated by this SFRA. This will ensure that emergency plans are appropriate to the conditions expected during a flood event and that Rother District Council and the emergency services are fully aware of the likely conditions and how this may affect their ability to safeguard the local population.

When applying the Sequential Test to determine the type of development that may be appropriate in the District, the type of flood warning procedure that exists and the time between the flood warning and the flood peak should be analysed.

When submitting flood risk assessments for developments within flood risk areas, developers should make reference to local Flood Warning and Emergency Procedures to demonstrate their development will not impact on the ability of Rother District Council and the emergency services to safeguard the current population.

Flood Hazard in a particular area must be viewed in the context of the potential evacuation and rescue routes to and from that area and discussed as part of a site specific flood risk assessment.

# 5 The Exception Test

## 5.1 Background

After application of the sequential test, if it is found to be impossible for an allocation or development to be located in a lower flood risk zone, then it may be possible to apply the Exception Test at the site specific level, providing the development is consistent with the wider sustainability objectives of the area.

At the time of writing, Rother District Council have not identified individual sites for allocation, and thus, as their Sequential Test to date points out, testing is only possible at the strategic development area scale.

In the preparation of this report, the Environment Agency acknowledged this, but highlighted the need to demonstrate, via a partial Exception Test at this time, what information was available in the demonstration of Part C (see below), and how far it was expected that this information would support successful application of Part C in future.

## 5.2 Application

The Exception Test consists of three sections which are detailed below. All of these sections are required to be passed before it could be deemed that a development would be appropriate within the flood zone.

### Part A – Wider Sustainability to the Community

It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by the SFRA where one has been prepared. If the DPD has reached the 'submission' stage (Figure 4 of PPS12[4]; Local Development Frameworks) the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal.

- The site should be scored against the sustainability criteria of the Sustainability Appraisal.
- Where a development fails to score positively against the SA the Rother District Council could consider planning conditions or Section 106 Agreements.

Rother District Council's Sustainability Checklists are presented in Appendix C.

### Part B – Redevelopment of Previously Developed Land

The development must be on developable previously developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously developed land.

Planning Policy Statement 3[6]: Housing defines previously developed land as:

*'Previously-developed land is that which is or was occupied by a permanent structure, including the curtilage of the developed land and any associated fixed surface infrastructure.'*

The definition includes defence buildings, but excludes:

- Land that is or has been occupied by agricultural or forestry buildings.

- Land that has been developed for minerals extraction or waste disposal by landfill purposes where provision for restoration has been made through development control procedures.
- Land in built-up areas such as parks, recreation grounds and allotments, which, although it may feature paths, pavilions and other buildings, has not been previously developed.
- Land that was previously-developed but where the remains of the permanent structure or fixed surface structure have blended into the landscape in the process of time (to the extent that it can reasonably be considered as part of the natural surroundings).

There is no presumption that land that is previously-developed is necessarily suitable for housing development nor that the whole of the curtilage should be developed.

## Part C – Safe from Flood Risk

A FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall. The PPS25 Practice Guide[3] provides details on the definition of 'safe' in Chapter 5 – Risk Management by Design, and Chapter 6 – Residual Risk.

A suggested minimum requirement of the definition of 'safe' in Rother District could be:-

- Dry access for highly vulnerable uses should be up to the 0.5% annual probability (1 in 200 year) flood event taking into account climate change;
- Dry escape for residential dwellings should be up to the 0.5% annual probability (1 in 200 year) flood event taking into account climate change; and,
- Preferably dry for other uses such as educational establishments and less vulnerable land use classifications.

However the definition of safe should be clarified and agreed between Rother District Council and the Environment Agency at the site-specific scale and may require additional considerations depending on the precise nature of the proposed development and flood risk on a site by site basis.

It is recommended that Rother District Council complete Table 5 to assist in identification of possible development locations that may require Exception Testing either in development of the LDF or as they come forward under individual planning applications (e.g. those sites already allocated in the existing Local Plan).

This table has been partially completed based on the Sequential Test undertaken by Rother District Council to date and cross reference to information available at this time for those areas with broad scale flood risk issues (i.e. using flood depth and hazard maps in tidal flood risk areas). It should be continually reviewed and updated in the light of new flood risk information that becomes available, and with regard to Parts A and B, as the information in support of these becomes available,

*Table 5: Sites for Application of the Exception Test* ***(copy as necessary in future iterations)***

| AREA | Flood Zoning | | Development Vulnerability | Exception Test | | |
|---|---|---|---|---|---|---|
| | | | | Part A | Part B | Part C |
| | Level 1 SFRA | Level 2 SFRA | Essential Infrastructure / Water Compatible / Highly / More / Less | Wider Sustainability | Brownfield Land (Y/N) | Safe ? |
| Normans Bay | 3 | 3 | | | | The average hazard index for this area is medium.<br><br>Soft defence at point of breach<br><br>Dry access to outside of Normans Bay is likely to be not possible as the main access roads are cut off. |
| Cooden Beach | 1 | 1 | | | | The average hazard index for this area is low.<br><br>Soft defence at point of breach<br><br>Dry access is likely to be possible from Cooden Beach to the east. |
| Pett Level | 3 | 3 | | | | The average hazard index for this area is high.<br><br>Hard defence at point of breach<br><br>Flood depths are very deep therefore it is difficult to see how dry |

| AREA | FLOOD ZONING | | DEVELOPMENT VULNERABILITY | EXCEPTION TEST | | |
|---|---|---|---|---|---|---|
| | | | | PART A | PART B | PART C |
| | Level 1 SFRA | Level 2 SFRA | Essential Infrastructure / Water Compatible / Highly / More / Less | Wider Sustainability | Brownfield Land (Y/N) | Safe ? |
| | | | | | | access is possible. |
| Winchelsea Beach | 3 | 3 | | | | The average hazard index for this area is high.<br><br>Hard defence at point of breach<br><br>Completely dry access would be difficult to achieve at least part if not all of the access roads are likely to become inundated. |
| Winchelsea | 3 | 3 | | | | The average hazard index for this area is high.<br><br>Hard defence at point of breach<br><br>Dry access would be available to the north. |
| Rye Harbour | 3 | 2 | | | | The average hazard index for this area is medium.<br><br>Soft defence. at point of breach<br><br>Completely dry access would be difficult to achieve. |

| AREA | FLOOD ZONING | | DEVELOPMENT VULNERABILITY | EXCEPTION TEST | | |
|---|---|---|---|---|---|---|
| | | | | PART A | PART B | PART C |
| | Level 1 SFRA | Level 2 SFRA | Essential Infrastructure / Water Compatible / Highly / More / Less | Wider Sustainability | Brownfield Land (Y/N) | Safe ? |
| Harbour Road | 3 | 2 | | | | The average hazard index for this area (as a result of a breach at Rye Harbour) is medium.<br><br>Soft defence at point of breach<br><br>Dry access along harbour is likely not to be possible. |
| Rye West of River Tillingham | 3 | 3 | | | | The average hazard index for this area is high.<br><br>Hard defence at point of breach<br><br>Flood depths are deep therefore it is difficult to see how dry access would be achieved. |
| Rye South (North of River Tillingham) | 3 | 3 | | | | The average hazard index in this area is high.<br><br>Soft defence at point of breach<br><br>Flood depths are deep therefore it is difficult to see how dry access would be achieved. |
| Rye East (East of | 3 | 3 | | | | The average hazard index in this area is high. |

| AREA | FLOOD ZONING | | DEVELOPMENT VULNERABILITY | EXCEPTION TEST | | |
|---|---|---|---|---|---|---|
| | | | | PART A | PART B | PART C |
| | Level 1 SFRA | Level 2 SFRA | Essential Infrastructure / Water Compatible / Highly / More / Less | Wider Sustainability | Brownfield Land (Y/N) | Safe ? |
| River Rother) | | | | | | Soft defence at point of breach<br><br>Flood depths are deep therefore it is difficult to see how dry access would be achieved. |
| Camber (West) | 3 | 3 | | | | The average hazard index in this area is medium.<br><br>Soft defence at point of breach<br><br>Dry access is likely to be possible out and into Camber from the west along New Lydd Road. |
| Camber (East) | 3 | 3 | | | | The average hazard index in this area is medium.<br><br>Soft defence at point of breach<br><br>Dry access may be possible in parts to the west of Camber. |
| Jury's Gap | 3 | 3 | | | | The average hazard index in this area is medium. |

| AREA | FLOOD ZONING | | DEVELOPMENT VULNERABILITY | EXCEPTION TEST | | |
|---|---|---|---|---|---|---|
| | | | | PART A | PART B | PART C |
| | Level 1 SFRA | Level 2 SFRA | Essential Infrastructure / Water Compatible / Highly / More / Less | Wider Sustainability | Brownfield Land (Y/N) | Safe ? |
| | | | | | | Hard defence at point of breach<br><br>Dry access is likely to be possible to the east of Jury's Gap. |

# 6 Policy Recommendations

National and local policies have been reviewed against the local flood risk issues.

The Cuckmere and Sussex Havens CFMP[7] and Draft Rother and Romney CFMP[8] provide a summary of the flood risk management policies that have been set out by the Environment Agency. The strategies suggested below meet with these aspirations and if integrated will aid to strengthen the position of Rother District Council.

From these policies the following recommendations are made around which Rother District Council may wish to form specific policies within their LDF. Integration of these suggested policy considerations into LDF / LDDs should ensure that the objectives and aspirations of the Environment Agency and national policy are met whilst strengthening the position of Rother District Council with regard to Flood Risk.

## 6.1 Development Control

- The Environment Agency set out the framework under which an applicant or the Council can decide whether a Flood Risk Assessment is required in support of an individual planning application. This should be used to guide all development applications and is held online at:

  http://www.pipernetworking.com/floodrisk/matrix.html

- If development is to be constructed with less vulnerable uses on the ground level, agreements need to be in place to prevent future alteration of these areas to 'more vulnerable' uses without further study into flood risk.

- Single storey residential development should not normally be considered in flood risk areas as they offer no opportunity for safe refuge areas on upper floors.

- Where a development is applying for a change of use, flood evacuation plans should be developed through liaison with the emergency services. This accounts for changes from lower to higher vulnerability class, and should be delivered as part of the site-specific flood risk assessment.

- The Council should ensure new development in an area known to suffer stormwater flooding does not increase the discharge to the existing drainage system either though restricting site discharge rates and/or through capital contributions to improvements works of the existing drainage infrastructure.

- The Council ensure that proposed developments can be accommodated by the existing drainage infrastructure provision. Where a development cannot be met by current resources, ensure that the phasing of development is in tandem with infrastructure investment.

## 6.2 Flood Defence

- The SFRA process has highlighted the importance of flood defences throughout Rother District. Future policy should seek to address how these defences are to be maintained to ensure that they are maintained to the current high level of protection.
- Review the condition of existing local defences, the dependence of additional local development on them for flood mitigation and where necessary the Council should seek to maintain and or improve defences if necessary.
- Where necessary and achievable, and through liaison with the Environment Agency and local Internal Drainage Boards, adopt a policy for the routine maintenance of all watercourses ensuring they are clear of debris that could affect flood flow conveyance.

## 6.3 Flood Mitigation

- Where possible, mitigate flood risk from developments through development of flood storage schemes which will also provide amenity benefit.
- Within flood risk assessments, groundwater flooding should be investigated in detail and the Council should ensure that new developments in known groundwater flood risk areas undertake a site investigation to determine the risks from groundwater flooding and incorporate mitigation measures into the design of any buildings to prevent flood damage from this source.
- Within flood risk assessments, surface water flooding should be investigated in detail, and comprehensive surface water runoff calculations undertaken.
- Require all flood risk assessment and sustainable drainage design to consider the impacts of climate change for the lifetime of the development at the site and downstream.
- Ensure discharge rates from new developments do not increase following redevelopment, including an allowance for climate change and preferably restrict discharge rates to greenfield runoff rates in areas known to have a history of sewer flooding.

## 6.4 Environmental

- Consider the potential benefits an appropriately designed Sustainable Drainage System could have for the biodiversity, amenity value, water quality and resource value of a development and/or surrounding area.
- Consider the vulnerability and importance of local ecological resources when determining the suitability of drainage strategies/SuDS.

# References

1. Communities and Local Government (2006) *'Planning Policy Statement 25: Development and Flood Risk',* TSO: London.
2. Rother District Council (2008) *'Strategic Flood Risk Assessment – Level 1 (Draft – 18th April 2008)',* Rother District Council: Bexhill.
3. Communities and Local Government (2008) *'Planning Policy Statement 25: Development and Flood Risk: Practise Guide',* Department for Communities and Local Government: London.
4. Communities and Local Government (2004) *'Planning Policy Statement 12: Local Development Frameworks',* Department of Communities and Local Government: London.
5. Rother District Council (2006) *'Rother District Local Plan: Adopted July 2006',* Rother District Council: Bexhill.
6. Communities and Local Government (2006) '*Planning Policy Statement 3: Housing',* DCLG: London.
7. Environment Agency (2007) *'Cuckmere and Sussex Havens Catchment Flood Management Plan',* Environment Agency: Worthing.
8. Environment Agency (2007) *'Rother and Romney Catchment Flood Management Plan: Draft Report December 2007',* Environment Agency: Worthing.

# Appendix A: Drawings

| | |
|---|---|
| A 1.1.1 | Normans Bay 1 in 200 year 2008 Flood Depth Map |
| A 1.1.2 | Normans Bay 1 in 200 year 2008 Flood Hazard Map |
| A 1.2.1 | Normans Bay 1 in 200 year 2115 Flood Depth Map |
| A 1.2.2 | Normans Bay 1 in 200 year 2115 Flood Hazard Map |
| A 1.3.1 | Normans Bay 1 in 1000 year 2008 Flood Depth Map |
| A 1.3.2 | Normans Bay 1 in 1000 year 2008 Flood Hazard Map |
| A 1.4.1 | Normans Bay 1 in 1000 year 2115 Flood Depth Map |
| A 1.4.2 | Normans Bay 1 in 1000 year 2115 Flood Hazard Map |
| A 2.1.1 | Cooden Beach 1 in 200 year 2008 Flood Depth Map |
| A 2.1.2 | Cooden Beach 1 in 200 year 2008 Flood Hazard Map |
| A 2.2.1 | Cooden Beach 1 in 200 year 2115 Flood Depth Map |
| A 2.2.2 | Cooden Beach 1 in 200 year 2115 Flood Hazard Map |
| A 2.3.1 | Cooden Beach 1 in 1000 year 2008 Flood Depth Map |
| A 2.3.2 | Cooden Beach 1 in 1000 year 2008 Flood Hazard Map |
| A 2.4.1 | Cooden Beach 1 in 1000 year 2115 Flood Depth Map |
| A 2.4.2 | Cooden Beach 1 in 1000 year 2115 Flood Hazard Map |
| A 3.1.1 | Pett Level 1 in 200 year 2008 Flood Depth Map |
| A 3.1.2 | Pett Level 1 in 200 year 2008 Flood Hazard Map |
| A 3.2.1 | Pett Level 1 in 200 year 2115 Flood Depth Map |
| A 3.2.2 | Pett Level 1 in 200 year 2115 Flood Hazard Map |
| A 3.3.1 | Pett Level 1 in 1000 year 2008 Flood Depth Map |
| A 3.3.2 | Pett Level 1 in 1000 year 2008 Flood Hazard Map |
| A 3.4.1 | Pett Level 1 in 1000 year 2115 Flood Depth Map |
| A 3.4.2 | Pett Level 1 in 1000 year 2115 Flood Hazard Map |
| A 4.1.1 | Winchelsea Beach 1 in 200 year 2008 Flood Depth Map |
| A 4.1.2 | Winchelsea Beach 1 in 200 year 2008 Flood Hazard Map |
| A 4.2.1 | Winchelsea Beach 1 in 200 year 2115 Flood Depth Map |
| A 4.2.2 | Winchelsea Beach 1 in 200 year 2115 Flood Hazard Map |
| A 4.3.1 | Winchelsea Beach 1 in 1000 year 2008 Flood Depth Map |
| A 4.3.2 | Winchelsea Beach 1 in 1000 year 2008 Flood Hazard Map |
| A 4.4.1 | Winchelsea Beach 1 in 1000 year 2115 Flood Depth Map |
| A 4.4.2 | Winchelsea Beach 1 in 1000 year 2115 Flood Hazard Map |
| A 5.1.1 | Rye Harbour 1 in 200 year 2008 Flood Depth Map |
| A 5.1.2 | Rye Harbour 1 in 200 year 2008 Flood Hazard Map |
| A 5.2.1 | Rye Harbour 1 in 200 year 2115 Flood Depth Map |
| A 5.2.2 | Rye Harbour 1 in 200 year 2115 Flood Hazard Map |
| A 5.3.1 | Rye Harbour 1 in 1000 year 2008 Flood Depth Map |
| A 5.3.2 | Rye Harbour 1 in 1000 year 2008 Flood Hazard Map |
| A 5.4.1 | Rye Harbour 1 in 1000 year 2115 Flood Depth Map |
| A 5.4.2 | Rye Harbour 1 in 1000 year 2115 Flood Hazard Map |
| A 6.1.1 | Rye West 1 in 200 year 2008 Flood Depth Map |
| A 6.1.2 | Rye West 1 in 200 year 2008 Flood Hazard Map |
| A 6.2.1 | Rye West 1 in 200 year 2115 Flood Depth Map |
| A 6.2.2 | Rye West 1 in 200 year 2115 Flood Hazard Map |
| A 6.3.1 | Rye West 1 in 1000 year 2008 Flood Depth Map |
| A 6.3.2 | Rye West 1 in 1000 year 2008 Flood Hazard Map |
| A 6.4.1 | Rye West 1 in 1000 year 2115 Flood Depth Map |
| A 6.4.2 | Rye West 1 in 1000 year 2115 Flood Hazard Map |
| A 7.1.1 | Rye South 1 in 200 year 2008 Flood Depth Map |

# Appendix B: Site Photographs

**Plate B-1 Normans Bay:** Breach location

**Plate B-2 Cooden Beach:** Original breach location

**Plate B-3 Cooden Beach**: View from original breach location facing north

**Plate B-4 Pett Level:** Breach Location

**Plate B-5 Pett Level:** View from breach location facing north

**Plate B-6 Winchelsea Beach:** Breach location

**Plate B-7 Winchelsea Beach:** View from breach location facing north

**Plate B-8 Rye Harbour:** Breach location

**Plate B-9 Rye Harbour:** View from near breach location facing south towards the mouth of the River Rother

**Plate B-10 Rye Harbour**: View from breach location facing south along defences

**Plate B-11 Rye West:** Breach location

**Plate B-12 Rye South:** Breach location facing north

**Plate B-13 Rye East:** Breach location facing south

**Plate B-14 Rye East:** View from breach location facing south

**Plate B-15 Rye East:** View from breach location facing northeast

**Plate B-16 North Salts:** Breach location facing north

**Plate B-17 North Salts:** Breach location facing south

**Plate B-18 Camber West:** Breach location facing north

**Plate B-19 Camber West:** View from breach location facing east

**Plate B-20 Camber West:** View from breach location facing west

**Plate B-21 Camber West:** View of breach location across Central car park facing north

**Plate B-22 Camber East:** Breach location

**Plate B-23 Camber East:** View of defences at The Suttons

**Plate B-24 Camber East:** View from breach location facing northeast

**Plate B-25 Camber East:** View of breach location from the north

**Plate B-26 Jury's Gap:** View behind breach from the north

**Plate B-27 Jury's Gap:** View on breach location facing west

# Appendix C: Sustainability Appraisal Framework

**Sustainability Appraisal Framework for the Assessment of the Rother Core Strategy**

This Sustainability Appraisal Framework was taken from the Sustainability Appraisal developed as part of Rother District Council's Core Strategy Preferred Options (2008) (yet to be released for consultation. The SA Framework (the SA Objectives collectively) seeks to progress the development of vibrant sustainable communities and therefore there is no single objective to "create and sustain vibrant communities", it is considered that all the objectives work together to deliver this vision.)

| | SA Objective<br>To: | Decision-Aiding Questions | Indictors | Data source |
|---|---|---|---|---|
| SEA Directive topics: Population, Human Health | | | | |
| **1** | Ensure that everyone has the opportunity to live in a decent, sustainably constructed and affordable home | Does the option/policy<br>• Deliver affordable, sustainable housing in both urban and rural, in keeping with local character<br>• Support sympathetic accommodation of housing growth in sustainable locations<br>• Balance housing delivery with community facilities and environmental capacity<br>• Provide for an appropriate mix and range of housing | • Average property price : earnings ratio<br>• Number of affordable units annually<br>• Number of completions<br>• Number households on housing register<br>• Total homeless in priority need | • APP & AMR<br>• APP & AMR<br>• AMR<br>• Housing Services<br>• ES in Figures |
| SEA Directive topics: Human Health | | | | |
| **2** | Improve the health and well-being of the population and reduce inequalities in health | Does the option/policy:<br>• Increase accessibility to health facilities<br>• Protect & increase provision of and access to leisure including open space and cultural activities<br>• Increase or improve PRoW network | • Death rates<br>• Life expectancy<br>• Percentage of people with limiting long term illness<br>• % new development within 30 minutes public transport of a GP and Hospital | • ES in Figures<br>• ES in Figures<br>• ES in Figures<br>• AMR |

| | SA Objective<br>To: | Decision-Aiding Questions | Indictors | Data source |
|---|---|---|---|---|
| **3** | Reduce crime and the fear of crime | Does the option/policy:<br>• Reduce actual levels of crime<br>• Reduce fear of crime | • Recorded crime rates(by type) in Rother<br>• % residents that feel fairly or very safe | • APP/AMR<br>• Community Strategy |
| SEA Directive topics: Population, Human Health | | | | |
| **4** | Reduce deprivation and social exclusion | Does the option/policy:<br>• Reduce poverty and social exclusion in those areas most affected<br>• Reduce the number of children living in poverty<br>• Reduce the number of households in fuel poverty | • % households in fuel poverty<br>• % working population claiming benefits<br>• Indices of multiple deprivation<br>• % population in deprived areas<br>• average gross annual earnings | • SEERA<br>• ES in Figures<br>• ES in Figures<br>• ES in Figures<br>• ES in Figures |
| **5** | Raise educational achievement levels and develop the opportunities for lifelong learning | Does the option/policy:<br>• Increase the numbers of school-leavers achieving GCSE passes<br>• Increase numbers undertaking further and higher education<br>• Enhance opportunities for adult education | • Levels of educational attainment (achievements key stage 2 level 4 or above)<br>• Number of students 16+ in full time education<br>• Levels of educational attainment % attaining 5 Grade A-C | • ES in Figures<br>• ES in Figures<br>• ES In Figures |
| **6** | Sustain economic growth and competitiveness and encourage innovation in higher value, lower impact activities | Does the option/policy:<br>• Stimulate economic revival in priority regeneration areas<br>• Provide a diverse range of jobs that meets local needs<br>• Support the rural economy<br>• Ensure the correct mix of skills to meet the current and future needs of local employers | • % unemployed for more than 1yr<br>• unemployment as % of population<br>• GVA per person<br>• Number of VAT registered business<br>• Amount of land for employment<br>• Loss of employment land to retail<br>• Permissions for B class uses<br>• Tourist accommodation rates | • APP<br>• APP<br>• ES in Figures<br>• Community Plan<br>• AMR<br>• AMR<br>• AMR<br>• Tourism SE Survey |

| | SA Objective<br>To: | Decision-Aiding Questions | Indictors | Data source |
|---|---|---|---|---|
| | | • Encourage the development of a buoyant, sustainable tourism sector<br>• Increase provision of better quality jobs / skilled employment? | | |
| SEA Directive Topics: Population, Material Assets, Air, Climate Factors | | | | |
| **7** | Improve accessibility to services and facilities for all ages across the District | Does the option/policy:<br>• improve accessibility in the rural areas of the District<br>• Support delivery of quality public transport<br>• Enhance the PRoW and cycle network<br>• Support the timely delivery of infrastructure needs associated with new development<br>• Encourage the provision of services and facilities in accessible locations | • % new development within 30 minutes public transport of:<br>○ GP<br>○ Hospital<br>○ Primary & secondary school<br>○ Employment<br>○ Major retail centre<br>• % completed retail, office & leisure development in town centres<br>• Access to open space | • AMR<br><br>• AMR<br><br>• Open space assessment / Future AMR |
| SEA Directive topics: Human Health, Cultural Heritage | | | | |
| **8** | Encourage and facilitate increased engagement in cultural and leisure activities | Does the option/policy:<br>• Improve accessibility to cultural and leisure activities<br>• Increase the number of cultural enterprises / organisations in the District | • Satisfaction with sport & leisure facilities?<br>• Satisfaction with theatres & galleries<br>• Visits to museums in Rother per 1000 population | • APP<br>• APP<br>• APP |
| SEA Directive topics: Material Assets, Air, Climatic Factors, Biodiversity, Soil | | | | |

| | SA Objective<br>To: | Decision-Aiding Questions | Indictors | Data source |
|---|---|---|---|---|
| 9 | Improve efficiency in land use and encourage the prudent use of natural resources | Does the option policy:<br>• Use land that has been previously developed in preference to Greenfield<br>• Re-use buildings and materials<br>• Protect and enhance the best and most versatile agricultural land | • % development on previously developed land<br>• vacant private sector dwellings returned to occupancy | • APP<br>• APP |
| SEA Directive Topics: Air, Climatic Factors, Material Assets, Human Health | | | | |
| 10 | Reduce road congestion and pollution levels and ensure air quality continues to improve by increasing travel choice and reducing car usage | Does the option/policy:<br>• Improve air quality<br>• Improve travel choice<br>• Reduce the need for travel by car / lorry<br>• Reduce the need to travel for commuting | • Background levels of air pollutants<br>• Number of AQMAs<br>• Commuting patterns in/out District<br>• Mode of travel to work<br>• % PRoW signposted & easy to use | • ES in Figures<br>• Environmental Health<br>• ES in Figures<br>• ES in Figures<br>• ES Council Plan |
| SEA Directive Topics: Climatic Factors, Material Assets | | | | |
| 11 | Reduce emissions of Greenhouse gases | Does the option/policy:<br>• Reduce emissions through reduced travel, energy consumption<br>• Promote renewable energy generation<br>• Promote community involvement, understanding & action on climate change | • Emissions of greenhouse gases<br>• % new development with renewable energy generation<br>• Renewable Energy capacity installed by type | • ES in Figures<br>• Future AMR<br>• AMR |
| SEA Directive Topics: Climatic Factors, Material Assets, Water, Human Health | | | | |
| **12** | **Minimise the risk of flooding and resulting detriment to people and property** | **Does the option/policy:**<br>• **Reduce the proportion of properties at risk of flooding in the District**<br>• **Promote adoption and use of SuDS** | • **Properties at risk from flooding**<br>• **Planning permissions granted contrary to EA advice on flood defence grounds** | • **SFRA / EA**<br>• **AMR** |

| | SA Objective<br>To: | Decision-Aiding Questions | Indictors | Data source |
|---|---|---|---|---|
| SEA Directive Topics: Water, Human Health, Material Assets | | | | |
| **13** | **Maintain, improve and manage water resources in a sustainable way** | **Does the option/policy:**<br>• **Protect & improve water quality**<br>• **Require the use of water efficiency measures**<br>• **Minimise the risk of pollution to water sources** | • **Water consumption per household**<br>• **Quality of river water**<br>• **Rivers of Good or Fair chemical and biological water quality**<br>• **Bathing quality at beaches** | • **Future AMR**<br>• **ES in Figures**<br>• **EA website**<br>• **ES in Figures** |
| SEA Directive topics: Biodiversity, Flora, Fauna | | | | |
| **14** | Conserve and enhance biodiversity | Does the option/policy:<br>• Protect and enhance designated and locally valued habitats and species<br>• Prevent and reverse habitat fragmentation<br>• Provide opportunities for provision & enhancement of green space | • Number & area designated sites<br>• Condition of designated sites including SSSI in favourable or unfavourable recovering<br>• Number of SNCIs<br>• Area of ancient semi-natural woodland | • AMR<br>• AMR<br>• AMR<br>• Natural England |
| SEA Directive Topics: Landscape, Cultural Heritage, Soils | | | | |

| | SA Objective<br>To: | Decision-Aiding Questions | Indictors | Data source |
|---|---|---|---|---|
| **15** | Protect and enhance the high quality natural and built environment | Does the option/policy:<br>• Ensure protection and enhancement of the AONB<br>• Protect or enhance sites & features of historical, archaeological, or cultural interest (including conservation areas, listed buildings, registered parks and gardens and scheduled monuments)<br>• Minimise adverse impact on landscape setting of towns and rural settlements | • Number of Conservation Areas<br>• Buildings of Grade I and II* at risk<br>• Number of listed buildings<br>• Landscape character assessment (qualitative, contextual) | • AMR<br>• EH Register<br>• AMR<br>• ESCC LCA |
| SEA Directive Topics: Material Assets | | | | |
| **16** | Reduce waste generation and disposal, and achieve the sustainable management of waste | Does the option/policy:<br>• Help reduce waste and facilitate recycling in construction and operation<br>• Encourage composting<br>• Encourage development self-sufficient in waste management<br>• Support recovery of energy from waste | • Tonnage & % of recycled household waste<br>• Waste collected per person (kg)<br>• % change in household waste collected per year<br>• % household waste composted<br>• % household waste landfilled | • APP<br>• APP<br>• APP<br>• ESCC Waste BVPI Report<br>• ESCC Waste BVPI Report |