



Weymouth & Portland Strategic Flood Risk Assessment Level 1 Update

Weymouth & Portland Borough Council

December 2009

Final Report

9T3285

All rights reserved. No part of this publication may be reproduced in any form, including photocopying or, transmitted by electronic means, or stored in an electronic retrieval system without express permission in writing from Haskoning UK Ltd.

This report has been prepared by Haskoning UK Ltd. solely for Weymouth and Portland Borough Council in accordance with the terms of appointment for the Weymouth and Portland Strategic Flood Risk Assessment dated January 2006 and should not be relied upon by third parties for any use whatsoever without express permission in writing from Haskoning UK Ltd.

Stratus Houses
Emperor Way
Exeter, Devon EX1 3QS
United Kingdom
+44 (0)1392 447999 Telephone
01392 446148 Fax
info@exeter.royalhaskoning.com E-mail
www.royalhaskoning.com Internet

Document title Weymouth & Portland
Strategic Flood Risk Assessment
Level 1 Update

Document short title

Status Final Report

Date December 2009

Project name Weymouth & Portland Strategic Flood Risk
Assessment

Project number 9T3285

Author(s) Mercedes Uden & Rachel Bird

Client Weymouth & Portland Borough Council

Reference 9T3285/Deliverables/Level 1 update

Drafted by Mercedes Uden & Rachel Bird

Checked by Ian Haken / Julie Davies

Date/initials check

Approved by Steve Edwards

Date/initials approval

SUMMARY

This Strategic Flood Risk Assessment (SFRA) was originally produced by Royal Haskoning in July 2006 for Weymouth and Portland Borough Council (W&PBC). It represents the views of Royal Haskoning which have been guided by a steering group of Weymouth and Portland Borough Council Planners, Engineers and Technical Specialists and Environment Agency (EA) staff from South Wessex Area. In 2009 the SFRA Level 1 was updated to include all additional information from the Historic Flood Mapping, Flood Reconnaissance Information System, Flood Zone updates, any changes made to the Flood Warning Dataset, and updated climate change assessments.

The content of the SFRA has been presented as a series of A1 maps outlining historic, current and future flood risk, electronic data to be used in a Geographical Information System (GIS) and a report providing background information and technical guidance for managing flood risk. Combined use of these deliverables will enable consistent and sustainable decisions to be made with respect to both current and future flood risk.

A SFRA is an overview of Flood Risk within a specific area and aims to provide general guidance to local authority planners, developers and other interested people, including the general public about locations where flood risk is an issue. Information regarding flood risk is important because flooding may result in loss of life and can cause distress, harm, destruction and large and expensive damage to properties. The information in a SFRA helps to guide the local planning authority in making judgements on allocating land through the planning process.

It is a Government requirement that flood risk is considered in the process of allocating land for development and recommends that sites should be allocated starting from those of lowest flood risk. This sequential process is documented in Planning Policy Statement 25 (PPS25) which replaced the Planning Policy Guidance Note 25 (PPG25) for Development and Flood Risk in August 2006. The Government aims to reduce the risks from flooding to people and the developed and natural environment by discouraging further built development within floodplain areas and promoting best practice for the control of surface water runoff.

Flooding is an issue with varying levels of severity across most of the study area with 5% of properties within the borough located in areas at risk of flooding. Significant flooding in the area is mainly caused by the overtopping of river banks, whilst less severe flooding generally in Weymouth itself, is predominantly from surface water runoff and the blockages of drains and culverts. Tidal flooding and associated rapid inundation is mainly concentrated at Chiswell on the Isle of Portland where the shingle spit of Chesil Beach can be overtopped and/or breached, although looking into the future with sea level rise tidal flooding will become more significant, particularly to Weymouth Town Centre.

Extensive records of historical flood events exist across the area with flooding at Chiswell documented as early as November 1824. These records have been sourced from Weymouth and Portland Borough Council and also from the Environment Agency and are used in conjunction with other data such as flood maps detailing extents of flood risk and information about the location of defences.

As well as current flood risk, the potential effects of climate change on flooding caused by fluvial and tidal influences have also been investigated. This involves the use of increased flow rates (by 20%) and the effect of sea level rise on coastal areas. Modelling was carried out in specific locations to accurately determine the extent of future flood extents based on the topography of the land surface. The effects of increased wave height and wind speed may also be an issue for coastal areas. The modelling of these effects is outside of the scope of this study. Detailed Flood Risk Assessments and further studies should encompass this information.

Information about the management of flooding has been provided with a particular focus on surface water flooding as this is a major cause of flooding incidents in the Weymouth and Portland Borough. Where appropriate and relevant, developments should use Sustainable Drainage Systems (SUDS) to control surface water before it enters the watercourse. Within a large urban area such as Weymouth the combined effect of water discharge from SUDS must also be addressed to prevent further flooding issues downstream.

A SFRA does not provide definitive conclusions regarding the flood risk to an individual property. If the SFRA indicates that a property or possible area for development is within or adjacent to a flood risk area, then a detailed Flood Risk Assessment (FRA) will be required to assess the site before any decisions can be made. The effect of large development sites on the drainage of adjacent land also needs to be considered as part of an FRA. This is achieved through the identification of Vulnerability Classifications for categories of development and the application of the relevant PPS25 Decision Flow Chart which guides the user through the process step by step to arrive at a valid recommendation. It is designed to be used in conjunction with land allocations identified as part of the Local Development Frameworks.

Flooding is an important issue which must not be ignored. In the future it is likely that flooding could occur more frequently and with more severity due to climate change. By using this SFRA, in combination with site specific Flood Risk Assessments submitted with planning applications for development or change of use, it is possible to allocate land for development in a sustainable way.

CONTENTS

	Page
1 INTRODUCTION	1
1.1 What is a SFRA?	1
1.2 Aims and Objectives	2
1.3 Deliverables	2
2 STUDY AREA INFORMATION	3
2.1 Description of physical characteristics	3
2.2 Demographics, land use and economic features	6
3 TYPES OF FLOODING	7
3.1 General information	7
3.2 Current flood risk	10
3.3 Historic Flooding	12
3.4 Climate change	14
3.5 Tidal and Coastal Risk	15
3.6 Rapid inundation zones	17
3.7 Ground water	19
3.8 Sewage Treatment Works outflows and sewer flooding	20
4 MANAGING FLOODING	21
4.1 General information	21
4.2 Defences	21
4.3 Surface Water and Sustainable Drainage Systems (SUDS)	23
4.4 Managed retreat and river erosion	25
4.5 Flood warning	27
5 AREAS AT RISK OF FLOODING	29
5.1 Vulnerable areas	29
5.2 Current levels of flood risk	30
5.3 Climate change results	32
6 DATA AND MAPPING	36
6.1 Data collection	36
6.2 Data quality	36
6.3 Mapping	37
6.3.1 Existing Flood Risk and Climate Change	37
6.3.2 Historic flood events and defences	38
6.3.3 Geographical Information System (GIS)	38
7 SFRA USER GUIDANCE	40
7.1 Planning Policy Statement 25	40
7.2 Flood Zone Classification	41
7.3 The Sequential Test	41
7.4 Flood Risk Vulnerability Classification	43
7.5 The Exception Test	45
7.6 Additional guidance	45
7.7 Sustainability drivers	46

8	RECOMMENDATIONS AND CONCLUSIONS	47
9	REFERENCES	49
10	GLOSSARY OF TERMS	51

APPENDICES

Appendix A - Data Sources & Data Quality

Appendix B - Methodology for mapping potential flood risk areas

Appendix C - Methodology for mapping climate change

Appendix D - PPS25 Decision Flow Charts

Appendix E - Guidance for developing housing in a flood resistant manner

1 INTRODUCTION

Weymouth & Portland Borough Council (W&PBC) originally commissioned Royal Haskoning in January 2006 to undertake a Strategic Flood Risk Assessment (SFRA) for the areas within the boundary of Weymouth and Portland. The SFRA informs and provides evidence for part of the process W&PBC are undertaking to prepare their Local Development Framework.

The original SFRA was produced in July 2006 and represents the views of Royal Haskoning, which have been guided by a steering group comprising of Weymouth & Portland Borough Council planners and engineers and the Environment Agency (EA). In 2009 the SFRA Level 1 was updated to include additional information from the Historic Flood Mapping, Flood Reconnaissance Information System, Flood Zone updates, any changes made to the Flood Warning Dataset and updated climate change assessments.

This updated report also considers the update of the government guidance from Planning Policy Guidance Note 25 (PPG25) to Planning Policy Statement 25 (PPS25) in August 2006.

1.1 What is a SFRA?

A SFRA is an overview of current and future flood risk to a particular area. This predominantly desk-based study provides details of where flooding has occurred, where there is existing risk and where there could be risk in the future. It also provides details of the defences and structures in place to reduce that risk. Using all the information provided within the SFRA, Local Authorities can make informed judgements regarding the effects potential developments could have on the existing and future flood risk in the surrounding area.

Flooding is a serious environmental hazard and is caused by an often complex interaction of rainfall and associated runoff, tidal water, climatic conditions and the potential obstruction to flows from structures. The level of flood risk in Weymouth and Portland is the product of the frequency or likelihood of flood events and their consequences. Flooding of properties causes disruption, damages, distress, harm and can result in loss of life. It is therefore very important to try and prevent any inappropriate new development taking place in an area that is at a high risk of flooding, or will increase the risk of flooding elsewhere.

Reducing the vulnerability of the Weymouth and Portland Borough to the dangers and damage caused by unmanaged floods contributes to promoting a better quality of life, which helps in achieving some of the objectives of sustainable development and maintaining existing communities. Local planning authorities have to address the problems which flooding can cause when determining planning applications both now and in the future.

The information in a SFRA helps to guide the local planning authority in making judgements on allocating land through the planning process. It also informs the preparation of strategic policy and development control policy towards flooding and flood risk to include in the Local Development Framework. The information can be used as evidence for planning policy-making and to inform development control decisions.

The government recommends (through Planning Policy Statement 25: Development and Flood Risk (PPS25)) that, when drawing up or revising development plans, sites should be allocated for development starting from those of lowest flood risk. This is because the government aims to reduce the risks to people and the environment from flooding, by discouraging further built development within floodplain areas and promoting best practice for the control of surface water runoff.

1.2 Aims and Objectives

The objectives of the SFRA for Weymouth and Portland are:

- To provide a reference and policy document that will be part of the evidence base to inform the Local Development Framework and any subsequent plans.
- To ensure that W&PBC meet their obligations under the latest planning guidance (Planning Policy Statement 25: Development and Flood Risk (PPS25)).
- To provide a reference and policy document for use by the general public and developers to advise and provide information on their obligations under PPS25.
- To use as a tool to inform the development control process about the potential risk of flooding associated with future planning applications and the basis for requesting specific Flood Risk Assessments, if necessary.
- To promote working partnerships between W&PBC and the EA to develop best practice and data sharing with regard to flood risk information and its application.

1.3 Deliverables

The content of the SFRA is presented in a series of A1 maps, this report and a group of Geographical Information System (GIS) data files (shapefiles) for use electronically by Weymouth and Portland Council Officers. The information shown on the A1 maps has been grouped into two categories:

- a) Historic flood events and flood defences
- b) The effects of climate change

These maps highlight areas where flooding is an issue, or could be an issue in the future, and therefore where development should be avoided.

The report provides background information on the details shown in the maps and highlights areas particularly at risk of flooding. It also provides technical information regarding the production of the SFRA and recommendations and guidance for managing future flood risk.

The shapefiles provided show the information presented on the maps in an electronic format. These can be updated when new information becomes available therefore ensuring that any decisions being made by planning officers are based on the most up-to-date information available. The maps, shapefiles and report combined will enable consistent and sustainable decisions to be made with respect to both current flood risk and into the future.

2 STUDY AREA INFORMATION

This SFRA covers an area of approximately 42km², with 74% of this covering Weymouth and 26% the Isle of Portland. Weymouth is situated in the centre of the Dorset Coastline, approximately seven miles south of Dorchester on the A354. Portland is situated south of Weymouth. They are joined by the narrow isthmus of Chesil Beach along which the A354 runs.

Figure 2.1
Location Plan



2.1 Description of physical characteristics

The majority of significant watercourses are defined as either Main Rivers or Critical Ordinary Watercourses (COWs). Main Rivers are watercourses defined on a 'Main River Map' designated by DEFRA. The EA has permissive powers to carry out flood

defence works, maintenance and operational activities for Main Rivers, whilst the maintenance of ordinary watercourses is the responsibility of the Local Authority.

There are a number of Main Rivers within the study area; the River Wey, Pucksey Brook and Preston Brook.

The **River Wey** extends approximately 21km within the boundary of W&PBC and has a catchment area of roughly 37.4km² in total (although not all of this lies within the study area). The source of the River Wey is a chalk spring at Upwey, south of Dorchester. The spring is the discharge point from a confined aquifer consisting of Portland Stone and Portland Sand. The Wey Valley is a region of chalk waters. To the north of the valley, above Upwey, is the Ridge. The Ridge is a long stretch of hills with calcareous and neutral grassland. Between Broadwey and Weymouth the River Wey catchment is comprised of Kimmeridge and Oxford Clays and Forest Marble, making it impermeable to rain water. There is therefore a rapid response to rainfall in this area. In addition, this problem is increased when the upper chalk catchment is also saturated.

Pucksey Brook joins the River Wey from the west before it passes through Broadwey and Nottingham. Pucksey Brook has a length of approximately 2.2km inside the study area and a total catchment size of 12.11km². The source of the brook is by Clover Farm, south of Portesham.

The **Preston Brook** is approximately 4km east of Weymouth, is 5.3km in length and has a catchment area of 4.0km². Its source is just north of Preston, and it drains to Lodmoor Nature Reserve. It has a relatively small, steep catchment which is predominantly made up of chalk. Groundwater issues from Boiling Rock, near the top of the catchment, providing the baseflow to the watercourse. Upstream of Coombe Valley Road the catchment is predominantly rural, whilst downstream the catchment becomes more urbanised and is largely canalised and culverted. Balancing ponds have also been installed. Approximately 20% of the Preston Brook catchment is classified as urban. Littlemoor and Wyke Oliver tributaries join the Preston Brook through the predominantly residential area of Preston.

The **River Jordan** is another influential watercourse within the study area. It is 4.7km in length and has a catchment area of 7.9km². The source of the River Jordan is at Spring Bottom, just inside the study area, and it drains into the sea at Bowleaze Cove, to the east of Weymouth. The Jordan catchment can be thought of as three separate areas; the upper reach is rural with the river contained within a steep sided, but broad floodplain; the middle reach is largely urban, with the watercourse well confined into a close steep sided valley; and the largely rural lower reach down to the sea has some significant areas of floodplain.

Smaller watercourses within the study area include Broadwey Stream, Lanehouse Stream and Chafey's Stream. These are between 0.7km and 1.7km in length within the study area and have a combined catchment size of approximately 10km².

Weymouth is situated on an anticline of Jurassic Beds comprising distinct layers of hard and soft rocks. The more resistant chalks and Portland limestones are interspersed with the softer more eroded Oxford Clay. Portland is made up of layers of Kimmeridge Clay, Portland Sand, Portland Stone and Purbeck.

The south limb of the Weymouth Anticline is formed from the strata at Portland. This strata dips southward at an angle of approximately one and a half degrees. The Portland Stone forms a prominent hill in the north overlooking Portland Harbour and Chesil Beach, whilst in the south it descends to just above sea level at Portland Bill. Underneath the Portland Sand and Chesil Beach is a thick layer of Kimmeridge Clay. It is this layer which is the main cause of all the landslides around the northern part of Portland.

Chesil Beach (sometimes known as Chesil Bank) is a natural phenomenon which stretches 29km from Bridport Harbour (West Bay) to Chiswell in the Isle of Portland, connecting the island to the mainland, as shown in photo 2.1. It is a pebble storm beach which faces waves produced by south-westerly winds up the English Channel from the Atlantic Ocean. The beach backs onto Chiswell in Portland, then parts of Portland Harbour until it is separated from the land by the 13km of the Fleet Lagoon. At Abbotsbury the beach is approximately 155m wide, whilst at Portland it is 182m wide. There is a generally increasing ridge height from northwest to southeast, rising to a maximum of 14m above mean sea level at Portland. This ridge acts as a natural sea defence, although it only provides approximately a 1 in 5 year standard of defence.

At present the beach is practically stationary although there is a slight retreat towards the northeast, particularly at the Portland end of the beach.

Photo 2.1
Chesil Beach



The entire Weymouth and Portland coastline is designated as World Heritage Coast due to its geology, geomorphology and fossils which document 185 million years of earth history, along with its potential for ongoing research and its natural beauty.

The climate of Weymouth is generally mild due to the sheltered position of the town. The prevailing wind is from the south west so winters are relatively warm, with snow rarely falling. In the winter the temperature is usually around 6⁰C, whilst in the summer it settles just above 20⁰C. Weymouth and Portland receive less rain than most parts of the UK, with an average annual rainfall of 752mm. Weymouth and Portland receive on average 1768 hours of sunshine a year, making it one of the sunniest spots in England.

2.2 Demographics, land use and economic features

Weymouth and Portland has the highest population density in Dorset with 1154 people per square kilometre. It is split into fifteen wards; twelve in Weymouth and three in Portland, and the total population is approximately 64,400 (Weymouth ~ 51,800, Portland ~ 12,600) living in approximately 30,000 properties.

Weymouth is mainly a residential area with some large areas of agricultural land whilst Portland is a combination of residential and rural areas with small areas of, predominantly quarrying, industry. The designated Area of Natural Beauty, known as the Dorset Downs Heath and Coast covers 7.5km² of the study area, encompassing the settlements of Upwey and Sutton Poyntz and the upper reaches of the Wey Valley. There are also seven Sites of Special Scientific Interest (SSSI) and three Nature Reserves within the study area. These SSSI's are the Isle of Portland, Radipole Lake, Lodmoor, the South Dorset Coast, Portland Harbour Shore, Chesil Beach and the Fleet, and Studland Cliffs. The Nature Reserves are Fleet Nature Reserve close to Wyke Regis, Radipole Nature Reserve at Radipole and Southill, and Lodmoor Nature Reserve at Overcombe, as shown in photo 2.2.

Photo 2.2
Lodmoor Nature Reserve & SSSI



Portland harbour covers an area of approximately 16km². The harbour shore is a SSSI and in addition the northern shore is an intertidal zone. The whole harbour area is sheltered to the north by the mainland, to the south by Portland, to the west by Chesil Beach and to the east by four large stone breakwaters separated by the South, East and North ship channels. The Inner Breakwater is the smallest and is attached at Balaclava Bay. The Outer Breakwater is an island which has a fort at the northern end. The North-eastern Breakwater is also an island and has a warning light at the south-eastern end, and the Bingleaves Groyne is attached to the land south of Weymouth.

3 TYPES OF FLOODING

3.1 General information

A floodplain is an area that would naturally be affected by flooding if a river rises above its banks, or where high tides and stormy seas cause flooding in coastal areas. Over hundreds of years, natural floodplains have been built on and today many towns and cities exist on floodplains. Some settlements and areas of agricultural land have flood defences in place to reduce the risk of flooding. It should be noted however that in these areas there will always be some risk (however low) of flooding.

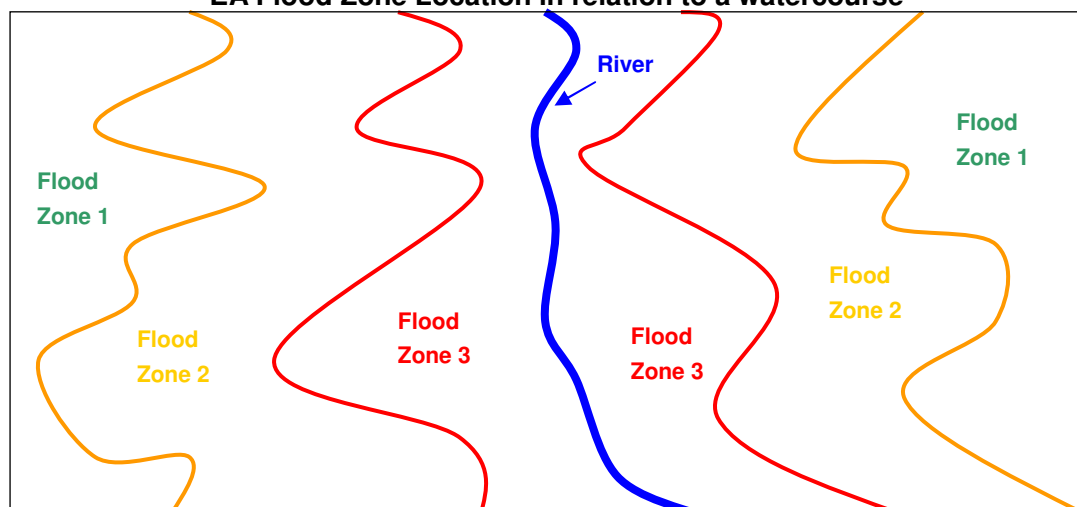
Environment Agency Flood Zones

The EA produce a Flood Map depicting areas where there is a high risk (Flood Zone 3) or a low-to-medium risk (Flood Zone 2) of flooding from rivers and the sea. These zones do not take into account any flood defences that could reduce the impact of flooding if there was a flood event, because the defences can be breached, overtopped and may not be in existence for the lifetime of any development. The Flood Zones cover the watercourses in the study area which have a catchment area of greater than 3km² and indicate where flooding can occur at postcode level. This Flood Map can be viewed on the EA website at www.environment-agency.gov.uk.

The Flood Map is split into three areas (as indicated in figure 3.1):

- EA Flood Zone 3 is the area that could be affected by fluvial or tidal flooding if there were no flood defences. The probability of tidal flooding in this area is at or greater than 0.5% (1 in 200 years) and the probability of fluvial flooding is at or greater than 1% (1 in 100 years). This is described as a high risk area.
- EA Flood Zone 2 shows the additional extent of an extreme fluvial or tidal flood with no defences in place. These areas are likely to be affected by a major flood with up to a 0.1% (1 in 1000) chance of occurring each year. This is described as a low to medium risk area.
- All land not in EA Flood Zones 2 or 3 are in Flood Zone 1 which has little to no risk of flooding and the probability of flooding is less than 0.1%.
(See www.environment-agency.gov.uk for more details)

Figure 3.1
EA Flood Zone Location in relation to a watercourse



In April 2009 Royal Haskoning obtained the most up to date Flood Zones 2 and 3 from the Environment Agency. Figures and tables using the Flood Zones have been revised using the new boundaries throughout this report.

Figure 3.2
W&PBC - Flood Zone 2, 2006 and Flood Zone 2, 2009

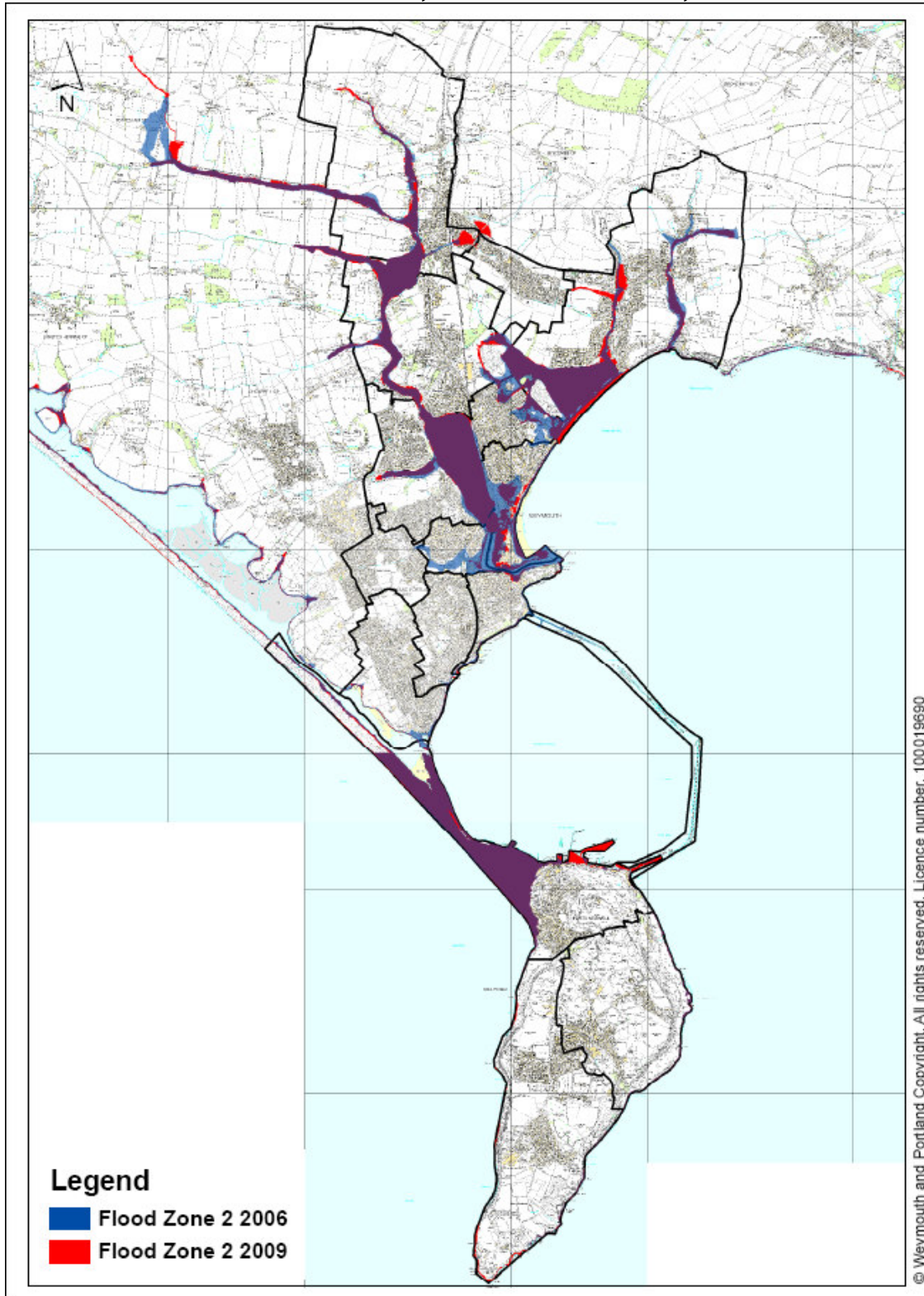
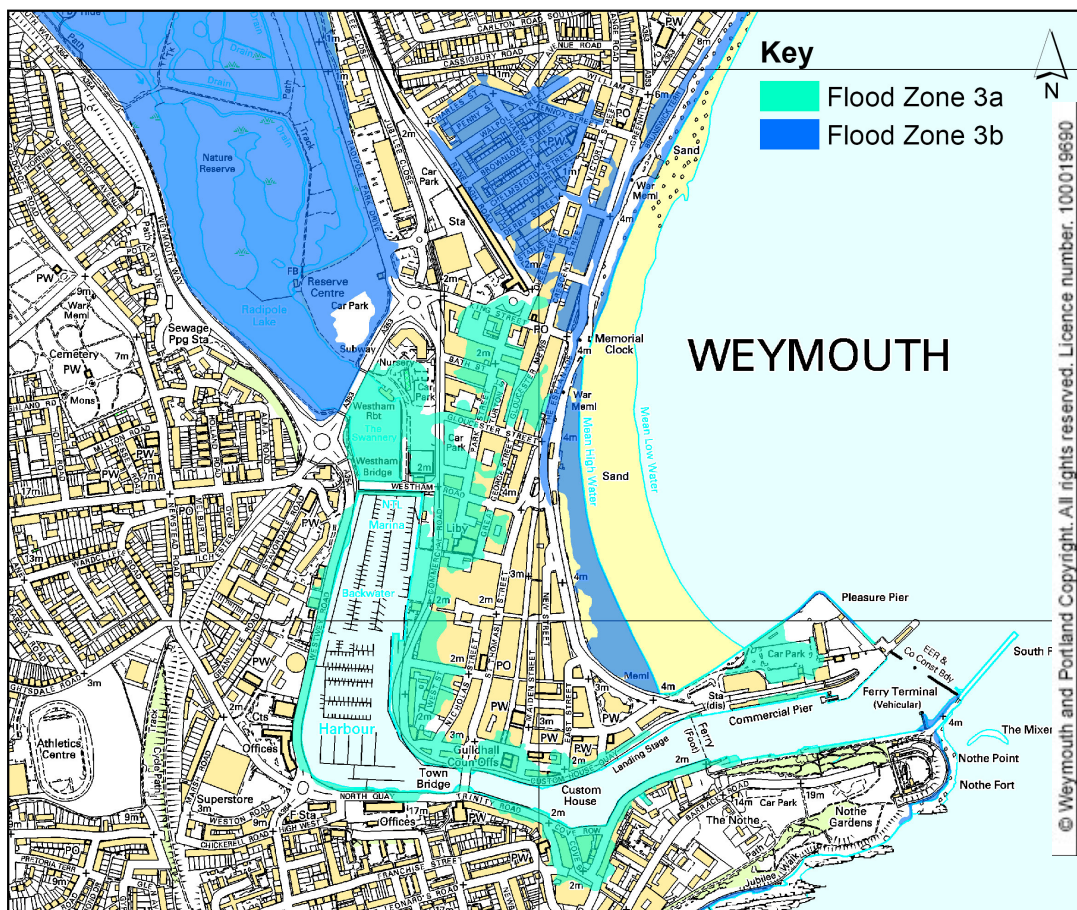


Figure 3.2 shows that the revised 2009 Flood Zone 2 has expanded and contracted in areas. Red shows the 2006 boundary, Blue the 2009 boundary and purple is where the 2006 and 2009 outline corresponds.

As the EA Flood Map does not take defences into account PPS25 further splits Flood Zone 3 into Flood Zones 3a and 3b. Flood Zone 3b is classed as functional floodplain which comprises of land where water has to flow or be stored in times of flood. Generally this is thought to be areas that would flood with an annual probability of 5% (1 in 20 year return period event). Flood Zone 3a is then the remaining areas of high probability of flooding. Modelling is required to show areas the Flood Zone 3a / 3b split and therefore at a planning stage it should be assumed that Flood Zone 3 is Flood Zone 3b until modelling can show otherwise.

As part of the Level 2 SFRA modelling was undertaken for Weymouth Town Centre. The resulting Flood Zone 3a / 3b split for this area is therefore shown in Figure 3.3.

Figure 3.3
Flood Zone 3a / 3b split for Weymouth Town Centre



Potential Flood Risk Areas (as defined by Royal Haskoning)

Where the EA has not given a flood zone for a watercourse in the study area, for the purposes of this SFRA, we have plotted an estimate of the 1% probability (or 1 in 100 years) flood extent for the watercourse. This has been done solely using engineering judgement, without the benefit of sophisticated modelling techniques. The Potential Flood Risk Areas therefore represent data of poorer quality than the EA Flood Zones

and should be treated as a guide to indicating flood risk only. Information on how the Potential Risk Areas were produced can be found in Appendix B.

The Potential Flood Risk area also contains polygons outlining area in close proximity to the Flood Zone that have been flooded in the past. There have been other areas where flooding has been reported the cause is predominantly due to surface water runoff and therefore not been digitised in the Potential Flood Risk shape file.

3.2 Current flood risk

Flooding is an issue with varying levels of severity across most of the study area. Significant flooding in the area is mainly caused by the overtopping of river banks and tidal flooding, whilst less severe flooding in Weymouth is predominantly from surface water runoff, and the blockage of drains and culverts.

There are a number of flooding issues along Lanehouse Stream, although the majority of flooding in the area does not seem to be as a result of the stream overtopping. Most of the problems tend to be as a result of blocked drains and gullies, surface water runoff, and tidal flap valve malfunctions. There are screens in place along the stream. It is known that these screens can become blocked and cause flooding during a high flow event. The screens are subject to high maintenance, as they must be visited when heavy rainfall is predicted to ensure they are not blocked, to enable the structures to operate efficiently.

On the River Jordan the Mill Lane Leat, Preston Road Bridge and Fisherbridge Road Bridge are all critical inspection sites. At these locations silt needs to be removed on a regular basis to ensure the flow of water is not restricted as this can cause flooding problems upstream of the site. There are minor localised drainage problems along the A353 Preston Road and at Puddledocks. Other problems in this area are caused by backflow through private surface water systems and overtopping of the River Jordan during times of heavy rainfall. Further work is being undertaken by the Environment Agency to assess the flooding in this area.

Also along the River Jordan, flooding has occurred at the Waterside Holiday Park, shown in photo 3.1, due to water backing up at the Bowleaze Coveway Road Bridge.

**Photo 3.1
Flooding at Waterside Holiday Park**



Flooding has occurred at Sutton Poyntz due to obstructions at the culvert and bridge. There is a screen in place and it is designated as a critical inspection site. There is also a groundwater seepage problem on Sutton Road.

There is knowledge of flooding events in Preston. Some events were caused by heavy rainfall affecting the Preston Brook, but there are also issues regarding inadequate culverts and bridges, blocked gullies, and surface water runoff. Channel improvements and defences as part of the Preston Brook Scheme (Section 5.1) have been put in place along Littlemoor Road to try to reduce flooding in the area, in addition to a flood relief culvert at Oakbury Drive.

Flooding occurs in Littlemoor, along the Broadway Stream. This flooding is sometimes a result of blocked screens. In addition a series of three balancing ponds have been put in place by W&PBC along Broadway Stream. These ponds have not worked effectively in the past; on occasions the bottom most pond has been full whilst the other two ponds have been empty. The Weymouth Relief Road is currently under construction in this area. As part of the road network there are a number of flood mitigation measures to take account of the additional highway drainage and run-off, and to try and improve the situation for the residents of Littlemoor. These mitigation measures include additional balancing ponds, namely 'Littlemoor East Pond', 'Bincombe Marsh Pond' and 'Chalbury detention basin'.

There is evidence of flooding incidents at Southhill in 1977, 1979, 1993 and more recently in 2008/9. In particular, in December 2008 and January 2009 there were a number of incidents of flooding of properties in Southhill due to heavy rainfall events and limited culvert capacity. The culvert is situated upstream of Radipole Lane in Southhill. Up to this point the watercourse is open. Following these flood events a feasibility study has been produced regarding this culvert and watercourse entitled *Feasibility Study Report for Southhill Watercourse, Weymouth, August 2009*. The results of this study indicate that the current maximum capacity of the culvert corresponds to a 1 in 50 year flood event and that during a 1 in 100 year event it would be expected to see flooding at least equivalent to that experienced by the Southhill area on 13th December 2008.

Problems in Broadway, Upwey and Nottingham result from water overtopping the banks of the River Wey during heavy rainfall, surface water runoff and overland flow from surrounding fields. In Weymouth and Wyke Regis inadequate culverts, drainage systems, sewer flooding and surface water runoff (primarily from roads) are the principle causes of flooding.

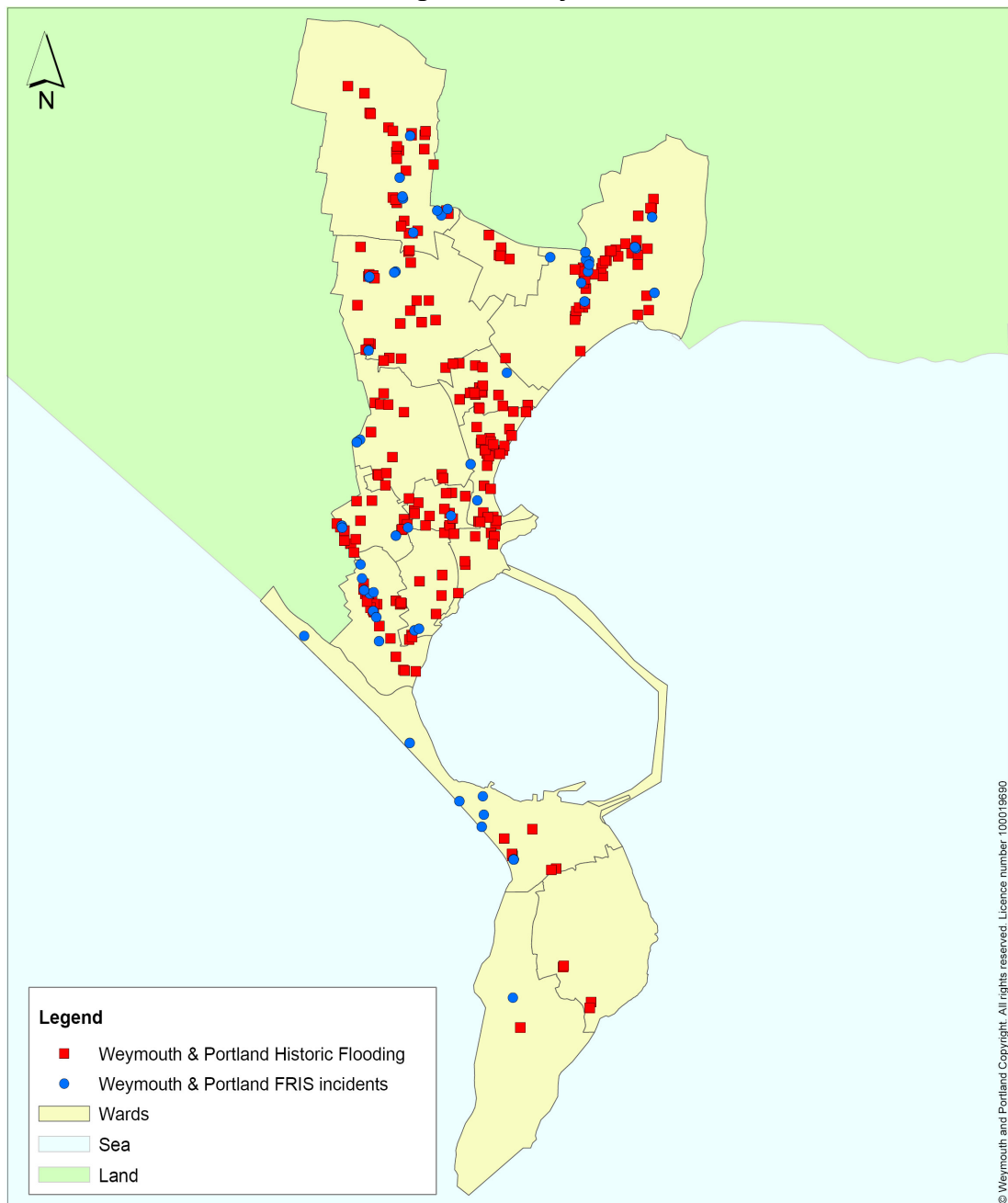
Coastal flooding is becoming a major issue along the Dorset coastline. Due to predicted increases in sea level rise from climate change, the importance of protection from the sea will need to be realised. Flood mitigation can be achieved through coastal protection schemes or through managed retreat programmes. In this study area, projects have already been carried out at Weymouth Harbour and Preston Beach. As the majority of Portland coastline is cliff, coastal flooding is not widespread, however it does occur at certain locations within the study area. Currently, the main location of tidal flooding in Portland is at Chiswell, where the pebble bank can fail through overtopping, breaching or by changes to its density, although Weymouth Town Centre is known to also be at risk of tidal flooding.

Further investigation of the tidal flood risk to the Weymouth Town Centre both now and in the future has been investigated during the Level 2 SFRA for Weymouth & Portland Borough Council.

3.3 Historic Flooding

Looking at historic flooding can highlight areas that are currently at risk to flooding. Historic information, as shown in figure 3.4, has been obtained from newspaper reports, W&PBC Engineers and the EA Flood Reconnaissance Information System (FRIS). This system is a collection of geo-referenced events collated by the EA, which also highlights the source of the flooding and other key information about the event.

Figure 3.4
Historic Flooding within Weymouth & Portland



Particularly large events are described below:

22nd & 23rd November 1824

Chiswell and Chesil Beach is an area that is particularly susceptible to flooding. Occasionally, exceptionally large wave systems develop in the Atlantic and cause large, long period waves to hit the beach. This can result in overtopping or breaching of the ridge, sending enormous volumes of flood water into urban areas behind the ridge, particularly Chiswell. This rapid inundation can have disastrous effects on the people living in Chiswell. The worst recorded overtopping of the beach occurred on the 22nd and 23rd November 1824 when a hurricane caused a storm surge. Many fishermen's cottages were destroyed, killing up to sixty people.

Other extreme tidal events which have affected Chiswell include:

- February 1904,
- February 1910,
- January 1924,
- June 1938,
- December 1942,
- November 1954,
- January 1962,
- October 1976,
- December 1978
- 2nd December 2005.

24th October 1908

A very sudden, severe storm followed a summer of drought. The rain started just after 9am and rained solidly for three hours. The drainage system in Weymouth was unable to cope with the volume of water and torrents rushed through the Dorchester Road district. Streets were flooded to depths of 0.30 – 0.75m and many properties were flooded internally. The worst hit areas were Hardwicke Street, Upper and Lower Chelmsford Street, Brownlow Street, Charles Street, Walpole Street and Penny Street. In total 100mm of rain fell in approximately five hours, although the effects would have been much worse if the rain had coincided with a high tide.

18th & 19th July 1955

This event produced the highest rainfall ever recorded in the UK at Martinstown Dorset, approximately 8km away. The unprecedented intensity started after 5pm on the 18th July 1955, following weeks of very little rain. The high tide was at 19:30; therefore the release of water from Radipole Lake was reduced. In addition gullies were choked. The water level rose in parts of Weymouth to several feet, entered many properties and caused damage to Westham Bridge and other structures in the area. In total approximately 180mm of rain fell in 21 hours.

Other major rainfall events include:

- *11th and 12th July 1977* when 78mm rain fell in 12 hours. Weymouth, Westham and Wyke Regis were particularly affected by this event.
- *24th August 1977* when 54mm rain fell in 12 hours. This event is estimated to have a return period of 25 years and mainly affected areas of Weymouth and Westham.
- *30th May 1979* when 35mm rain fell in 12 hours. This event affected all parts of Weymouth and the north of Portland.
- *5th June 1983* when 53.8mm rain fell in 6 hours

- 30th December 1993 when 35mm rain fell in 24 hours but was concentrated in approximately 5 hours. This was estimated to be a 1 in 10 year event and mainly affected the River Jordan and Preston Brook, although Broadway and Upwey were also affected.
- 10th May 2004 when a heavy, localised storm caused overland flows from the Littlesea Industrial Estate to the west.
- December 2008. Exceptional rainfall caused internal and external flooding to properties and businesses in Southill.

The EA map historic flood events across England and Wales as part of their Historic Flood Mapping (HFM). The area the HFM highlighted in Weymouth and Portland is Chesil Beach at Chiswell. More details can be found regarding this area in Section 3.6.

All incidents of fluvial and coastal flooding recorded in the HFM and FRIS databases are contained by the Environment Agency's Flood Zone 2. There are other incidents outside of this boundary; however flooding is caused by surface water.

3.4 Climate change

This SFRA is intended to be used as a long-term planning document. PPS25 states that climate change needs to be considered in terms of both fluvial and tidal flooding.

At present it is difficult to quantify how the changing climate will affect the areas currently at risk of flooding. The limits of floodplains cannot be defined precisely because floods with similar probability can arise from different combinations of event that will have different impacts. However government guidance suggests possible increases due to climate change. Using this guidance various modelling / calculation techniques have shown that fluvial flooding is not expected to increase significantly in this area but sea level rise may result in major changes to the areas at risk of tidal flooding in the future.

Government guidance regarding future flood risk and development is detailed in Planning Policy Statement 25 (PPS25). Further information and predictions regarding climate change has been investigated and presented by UKCP09 but currently no guidance is available on how to use these predictions and therefore PPS25 should still be used.

Global sea level are expected to continue to rise and PPS25 recommends regional contingency allowance for net sea level rise in the South West.

Table 3.1
Recommended contingency allowance for net sea level rise

Administrative Region	Net Sea Level Rise (mm/yr) Relative to 1990			
	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
South West	3.5	8.0	11.5	14.5

Source: Table B.1 Planning Policy Statement 25: Development and Flood Risk

Mapping of the possible tidal flood risk into the future has been undertaken as part of this study. This includes detailed modelling of Weymouth Town Centre undertaken as part of the Level 2 SFRA. Results of this can be seen in Section 5.3 and on the A1 maps.

Annual rainfall is expected to increase by 5-30% from 1990 to 2115 resulting in potential increases in peak flow of up to 5% for a given return period by 2025 and 20% by 2115. To ensure PPS25 requirements are met 20% increase in fluvial flows have been assessed in this SFRA.

Table 3.2
Recommended National precautionary sensitivity ranges for peak rainfall intensities, peak river flow, offshore winds and wave heights

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

Source: Table B.2 Planning Policy Statement 25: Development and Flood Risk

The effects of increased wave height and wind speed may also be an issue for coastal areas. The modelling of these effects is outside of the scope of this study. Guidance indicates a 10% sensitivity allowance needs to be applied up to 2115. Detailed Flood Risk Assessments and further studies should encompass this information.

As a result of climate change, new fluvial flood extents based on the existing Flood Zone 3 data have been created in certain key areas based on the LiDAR Digital Terrain Model (DTM) data. LiDAR DTM captures height information based on a 2 metre grid and was provided by the EA for the purpose of this study. The specific methodology using software tools such as ArcView GIS, Spatial Analyst and Profile Extractor is detailed in Appendix C. The locations chosen for these detailed studies were identified by locating FRIS hotspots and other known locations of high frequency flooding, the availability of suitable LiDAR DTM data and the presence of existing Flood Zone 3 data. Therefore the locations where this methodology has been applied are Nottingham, Preston, Radipole and the River Jordan, the results can be seen in Section 5.3.

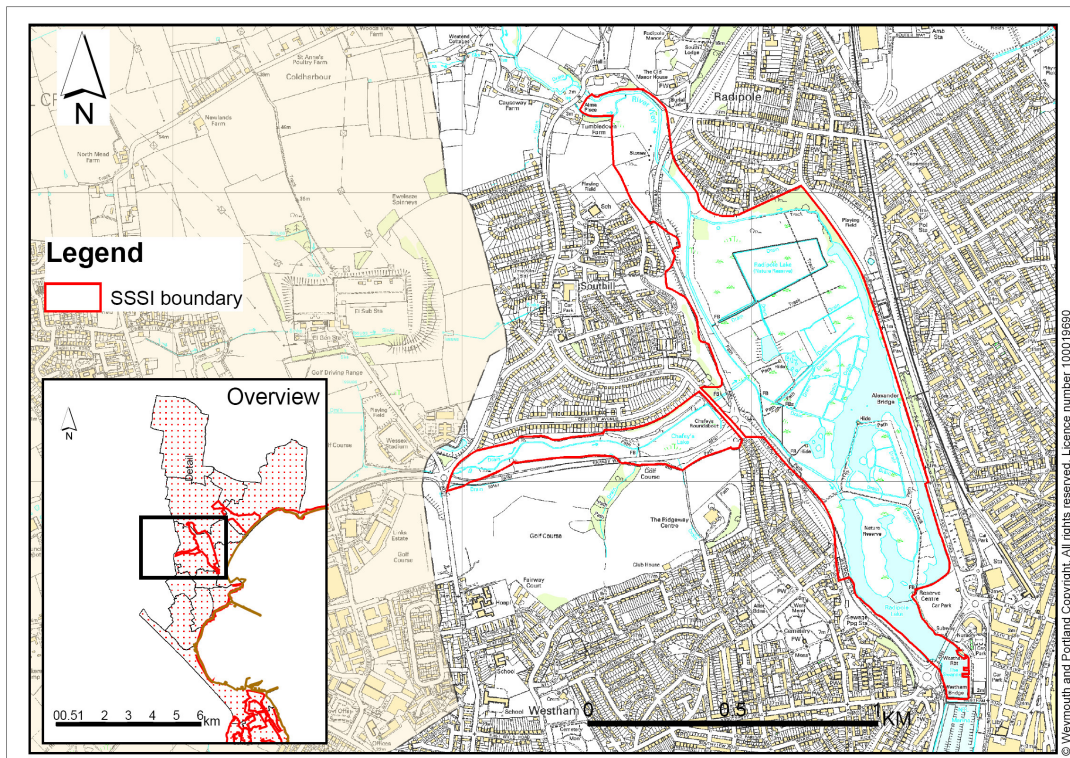
It is beyond the scope of this SFRA to apply this climate change methodology across the whole study area. The new fluvial flood extents as derived above serve as a guide for the likely changes that could occur as a result of increased flows of 20%. It is assumed that similar lateral changes to flood extents will also occur at other locations in the study area with equivalent topography and settlement patterns.

3.5 Tidal and Coastal Risk

Areas are at risk of tidal flooding when they are low lying and adjacent to the coast or near to an estuary. Within Weymouth and Portland this includes areas such as the A354 connecting Weymouth and the Isle of Portland, Radipole Lake and Lodmoor. Where high tides, especially Spring tides combine with strong onshore winds the associated waves and spray can overtop defences causing coastal flooding and in some cases structural damage caused by the water itself or by debris within it. Areas at risk of coastal flooding include Weymouth Esplanade and properties on the Western edge of Chiswell.

Radipole Lake is a SSSI which is leased to the RSPB as a nature reserve. It has an area of approximately 0.87km² and is located in the centre of Weymouth, as shown in figure 2.6. It was a tidal estuary until 1921 when Westham Bridge was constructed. This bridge acts as a tidal barrier therefore converting Radipole Lake into a freshwater lake.

Figure 3.5
Location plan of Radipole Lake



Water enters Radipole Lake from the Chafey and River Wey catchments. It is stored in the lake then discharges via Weymouth Harbour and the marina into Weymouth Bay. Westham Bridge tidal barrier retains the water in the lake although there have been problems in the past in maintaining optimum water levels due to operational failings of the barrier. The aim is to maintain the water level between high and low tides. This provides a storage volume at times of fluvial flood and prevents the lake becoming tide locked at high tide.

There is a risk of fluvial flooding upstream of Westham Bridge due to conveyance problems when high fluvial flows combine with high tides. Hydraulic modelling carried out for the Water Level Management Plan (2001) found that the main two areas at risk from flooding caused by Radipole Lake are the Swanson's Restaurant near Westham Bridge and the RSPB visitors centre. All other areas around the lake are on high ground and therefore not at risk from fluvial flooding.

Westham Bridge is the main control of the water level in Radipole Lake. The bridge contains eight culverts; four of which have tidal flaps, and four have electronically controlled penstocks which were recently replaced. Also in place is a timber drop board on the tidal flaps to maintain the minimum water level required by RSPB. Currently there are the following problems with this system:

- The timber drop board is very difficult to move and therefore cannot be adjusted easily when necessary.
- Maintenance requires work by divers and is therefore costly and dangerous.
- The penstocks can get jammed open therefore reducing the flow control.
- Saline intrusion occurs at very high tides therefore allowing sea water into the lake, producing a salt wedge, which may affect habitats in this SSSI.
- There are cracks in some locations

Details of the settings for the penstocks and the Proposed Water Level Management Regime are given in the Radipole Lake Water Level Management Plan held by W&PBC.

3.6 Rapid inundation zones

Potential inundation could occur where there is risk of breaching or over-topping of raised defences and in steep catchments through flash flooding generally caused by heavy rainfall and excessive surface flow. Water behind a raised defence can build up to levels higher than the surrounding land and create additional strain on the defence. This may cause it to collapse or the retained water can spill over the top rapidly inundating adjacent low lying ground. Fast flowing water or deep flooding that occurs quickly can create a risk of loss of life. Flooding from the overtopping and undermining of defences occurs along the Esplanade in Weymouth town centre causing widespread damage and disruption.

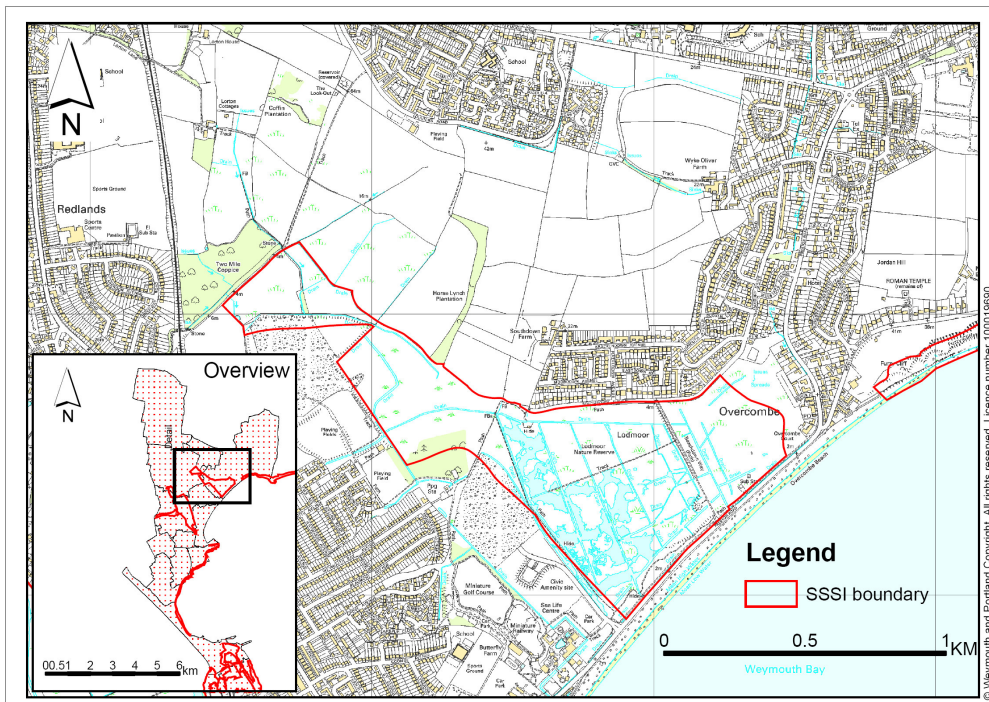
Defences are indicated on the A1 maps and the GIS shapefile layer (based on data currently available from the EA National Flood and Coastal Defence Database (NFCDD)) and can be interrogated to determine their exact locations. At present in Weymouth and Portland approximately 8.8km of defences (fluvial and tidal) are recorded as raised within NFCDD. These are found at Chesil Beach, Weymouth Harbour, Preston Beach and Littlemoor. Clarification should be sought from the EA if development is proposed to ensure that the latest information is available and represented. Care should also be taken regarding the condition of the defences, particularly regarding water seeping through some of the defences.

Lodmoor Site of Special Scientific Interest (SSSI) covers an area of approximately 0.75km² immediately east of Weymouth, as shown in figure 3.6, and is managed by the Royal Society for the Protection of Birds (RSPB). It is an area of low-lying land which is sandwiched between the shingle ridge of Preston Beach and higher ground on the edge of Weymouth.

Water is known to enter Lodmoor Nature Reserve from Preston Brook, springs, drains, surface water runoff and from saline intrusion through Preston Beach. The only outflow by which water can leave the reserve is the tidal outfall in the south-east corner of the reserve, which has a tidal flap valve to prevent tidal flooding of the reserve. A study undertaken by Posford Haskoning (1998) found that the reserve was capable of discharging at least a 1 in 50 year flood event before causing road flooding.

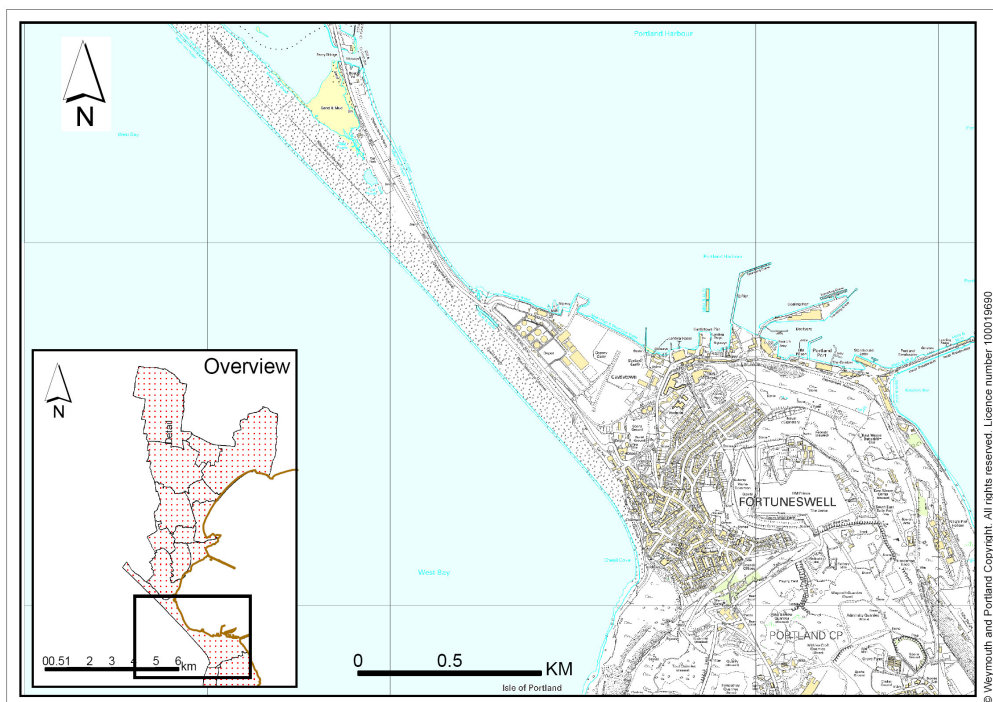
If the defences (i.e. sea wall and shingle ridge) at Preston Beach are breached then Lodmoor and surrounding low lying areas will be at risk of rapid flooding. The risk of excessive saline intrusion into the area would then occur, which is likely to affect the ecology and biodiversity of Lodmoor and therefore the SSSI designation of this area.

Figure 3.6
Location map of Lodmoor SSSI



Chiswell and Chesil Beach (as shown in figure 3.7) are areas that are particularly susceptible to flooding due to large wave systems from the Atlantic. The waves produced can overtop or breach the ridge and send large quantities of flood water into the village of Chiswell.

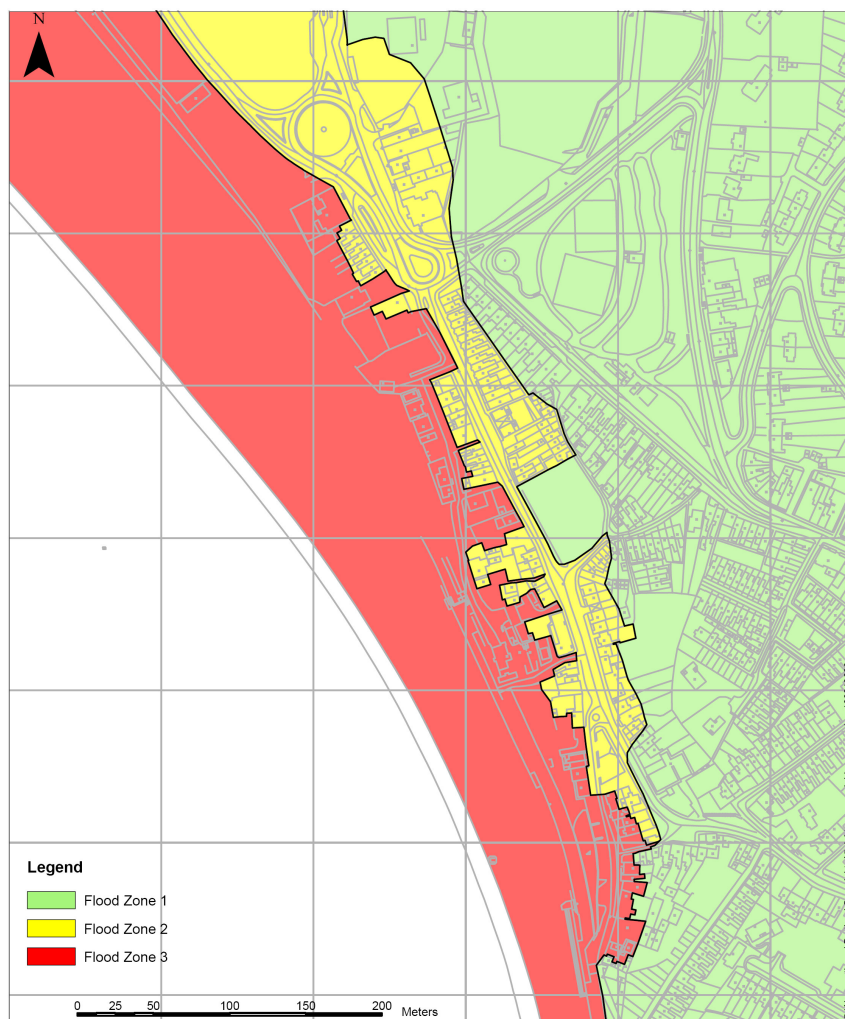
Figure 3.7
Chesil Beach and Chiswell



Sea defences have been constructed at the Portland end of Chesil Beach to try to alleviate the overtopping and flooding problems at Chiswell and are currently built to a 1 in 5-10 year Standard of Protection. A flood drainage channel scheme designed to carry away floodwater quickly has also been constructed underneath the shingle ridge of Chesil Beach.

The main sea wall was constructed in 1959. It is comprised of two walls joined by concrete beams and stone. Work has been undertaken by Royal Haskoning to review the division of Flood Zones 1, 2 and 3 in this area taking account of hydraulic modelling produced by a two dimensional flow modelling technique (TuFlow) as shown in figure 3.8.

Figure 3.8
Revised Flood Zones at Chiswell



3.7 Ground water

Flooding from groundwater occurs when water stored beneath the ground reaches the surface and is generally associated with porous rocks such as sands, gravels, limestone and chalk. Generally, ground water flooding is not a significant problem within the area of W&PBC but areas that may be vulnerable are those at the foot of the chalk escarpment (Ridge Hill, Bincombe Down, West Hill and East Hill) running along the north of the study area. Springs exist in these areas but can be seasonally affected by changes in groundwater and flows may differ substantially depending on the time of

year, with some springs drying up completely during the summer months. Groundwater seepage is known to occur in Sutton Poyntz along the River Jordan.

There may also be issues with coastal erosion caused by an increase in localised groundwater. Development that leads to higher surface water flows and increased drainage requirements could over time weaken the top strata of the porous chalk cliff through an increase in the presence of groundwater resulting in cliff slippage and potential loss of land and property. Sustainable Drainage Systems (SUDS) could help to reduce this affect.

It is a requirement of PPS25 that groundwater flooding and any potential effects it has must be assessed as part of any FRA.

3.8 Sewage Treatment Works outflows and sewer flooding

In urban areas, rainwater is frequently drained into surface water sewers or sewers containing both surface and waste water, known as combined sewers. These sewers can be overwhelmed by heavy rainfall, become blocked, or be of inadequate capacity, resulting in flooding of the surrounding area until the water can drain away. This is particularly a problem when a combined sewer is involved because there is then a high risk of contaminated water flooding a property internally.

Any new development needs to address the impact on the existing capacity of the sewer system and any associated sewage treatment works. Increases in discharge may lead to the overloading of receiving watercourses and consequently an increase in flood risk. It is a requirement of PPS25 that the potential of this occurring and any mitigating measures must be assessed as part of any FRA.

Specific records of sewer flooding are not available from Wessex Water for use within this study. Low lying areas such as Park District and Easton Square are susceptible to sewer flooding. Flooding has previously occurred in 1983, when two properties on Doncaster Road, Wyke Regis were flooded internally, and in 2000 when highway flooding was recorded by the EA (FRIS records) in Westcliffe Road, Weston, Portland.

4 MANAGING FLOODING

4.1 General information

The government aims to reduce the risks to people and the developed and natural environment from flooding by discouraging further built development within floodplain areas. Government guidance (PPS25) has been produced for local planning authorities to help them when allocating land for development in order to meet this aim. In undertaking the SFRA this guidance has been examined and used to provide a robust and consistent system for assessing flood risk anywhere within the local planning authority.

The following issues concerning flood risk within the Weymouth and Portland Borough Council area have been highlighted to provide additional awareness and assistance to aid the decision process outline above.

4.2 Defences

The SFRA has identified existing defences, for example at Chesil Beach (photo 4.1), that are maintained by the EA or W&PBC. Defences comprise a structure (or system of structures) for the alleviation of fluvial or tidal flooding. The SFRA does not identify privately maintained defences. Private walls may exist in the area but are not classed as 'flood defences'. Furthermore, not all banks are flood defences.

Photo 4.1
Chesil Beach Sea defence wall



Defences are designed to protect from flooding of a certain level - a standard of protection. The standard of protection is the maximum flood event that the defence can protect against before it is breached or overtopped. For example the flood relief culvert on the Preston Brook at Overcombe is stated to have a 1 in 25 year standard of protection. However it cannot be assumed that the level of defence is still at the original

design standard because of changes to the way floods are estimated, the effects of climate change and deterioration of the structure.

Changes to the land use in areas near to defences can also have an effect on the standard of protection provided by the defence by changing the flow patterns of groundwater and surface water runoff. Therefore any proposed development must be closely examined during a detailed flood risk assessment to ensure that the existing and future development has the appropriate level of protection. PPS25 suggests that the appropriate level of defence against fluvial floods should be a 1 in 100 year standard (1% probability flood) and against tidal floods should be a 1 in 200 year standard (0.5% probability flood).

The Preston Beach area is defended by a shingle storm beach backed by a concrete seawall, as shown in photo 4.2, which extends approximately 1.4km from the rock armour terminal groyne at Greenhill (Weymouth) as far as the Overcombe Café to the north east. The defence comprises the storm beach and a paved rear slope with a concrete promenade on top, whilst a second lower concrete wall at the rear of the promenade contains any loose shingle deposited during storm events.

The wall is designed to prevent flooding to the road and Lodmoor Nature Reserve by wave action during storms, and to prevent the deposition of shingle from the original narrow beach onto the coast road during storm events whilst creating an improved amenity with beachside access.

**Photo 4.2
Preston Beach Sea wall**



In addition to the hard defence, the Preston Beach Management Strategy highlights the need to carry out periodic maintenance of the mobile beach, particularly after storm

events. The maintenance includes periodic recharge and the recycling of beach material along the frontage to reinstate vulnerable areas.

4.3 Surface Water and Sustainable Drainage Systems (SUDS)

Flood risk from surface water flooding is of concern within the study area. A number of flood incidents have occurred within the area caused by surface water alone, or in combination with river flooding. Some of these events are highlighted on the maps as recorded by the EA (FRIS). The EA Flood Zone Maps do not show flood risk due to surface water flooding.

Urban developments can have a big effect on the quantity and speed of surface water runoff. By replacing vegetated ground with buildings and paved areas, the amount of water being absorbed into the ground is severely reduced, therefore increasing the amount of surface water present. This additional surface water increases the demand on drainage systems in built up areas. Traditional drainage systems are designed to get rid of the water as quickly as possible to prevent flooding in the built up area. This can cause problems, particularly downstream, by altering the natural flow patterns of the catchment. In addition, water quality can be affected due to pollutants from the built up areas being washed into the watercourse. One technique which can reduce this problem is the use of Sustainable Drainage Systems (SUDS).

Sustainable Drainage Systems (SUDS) are techniques designed to control surface water runoff before it enters the watercourse. They are designed to mimic natural drainage processes, along with treating the water to reduce the amount of pollutants getting into the watercourse. They can be located as close as possible to where the rainwater falls and provide varying degrees of treatment for the surface water, using the natural processes of sedimentation, filtration, adsorption and biological degradation.

SUDS are more sustainable than traditional methods because they can:

- Manage the speed of the runoff
- Protect or enhance the water quality
- Reduce the environmental impact of developments
- Provide a habitat for wildlife
- Encourage natural groundwater recharge.

In addition, they can be used to create more imaginative and attractive developments and are designed so that less damage is done, than conventional systems, if their capacity is exceeded.

Surface water management using SUDS can be implemented at all scales and in most urban settings, ranging from hard-surfaced areas to soft landscaped features, even if there is limited space. Most techniques use infiltration but even if the area has little or no infiltration SUDS can still be used in the form of green roofs, permeable surfaces, swales and ponds.

SUDS are made up of one or more structures built to manage surface water runoff, and used in conjunction with good site management. There are five general methods:

- a. Prevention** – this can involve minimizing paved areas, replacing tarmac with gravel, rainwater recycling, cleaning and sweeping, careful disposal of pollutants, and general maintenance.

- b. **Filter strips and swales** – these are vegetated surface features that drain water more slowly and evenly off impermeable areas. Swales (figure 4.1) are long shallow channels whilst filter strips (figure 4.2) are gently sloping areas of ground. Both of these mimic natural drainage by allowing rainwater to run in sheets through vegetation, slowing and filtering the flow.

Figure 4.1 - Cross-section of a Swale

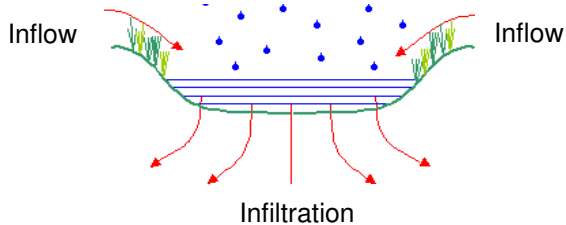
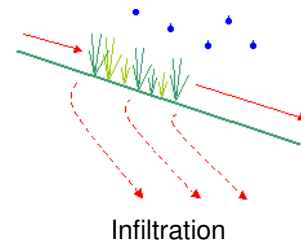


Figure 4.2 - Cross-section of a Filter Strip



- c. **Permeable surfaces and filter drains** – these are devices that have a volume of permeable material below ground to store surface water. Runoff flows to this storage area via a permeable surface.
- d. **Infiltration devices** – these enhance the natural capacity of the ground to store and drain water. They include soakaways, infiltration trenches and infiltration basins. See figure 4.3.
- e. **Basins and ponds** – these are areas for storage of surface runoff e.g. floodplains, wetlands, and flood storage reservoirs. They can be designed to control flows by storing water then releasing it slowly once the risk of flooding has passed. See figure 4.4.

Figure 4.3 - Cross-section through an Infiltration Basin

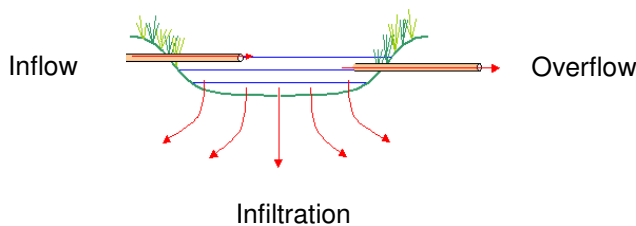
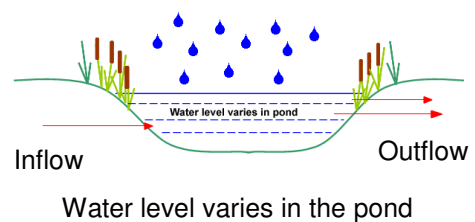


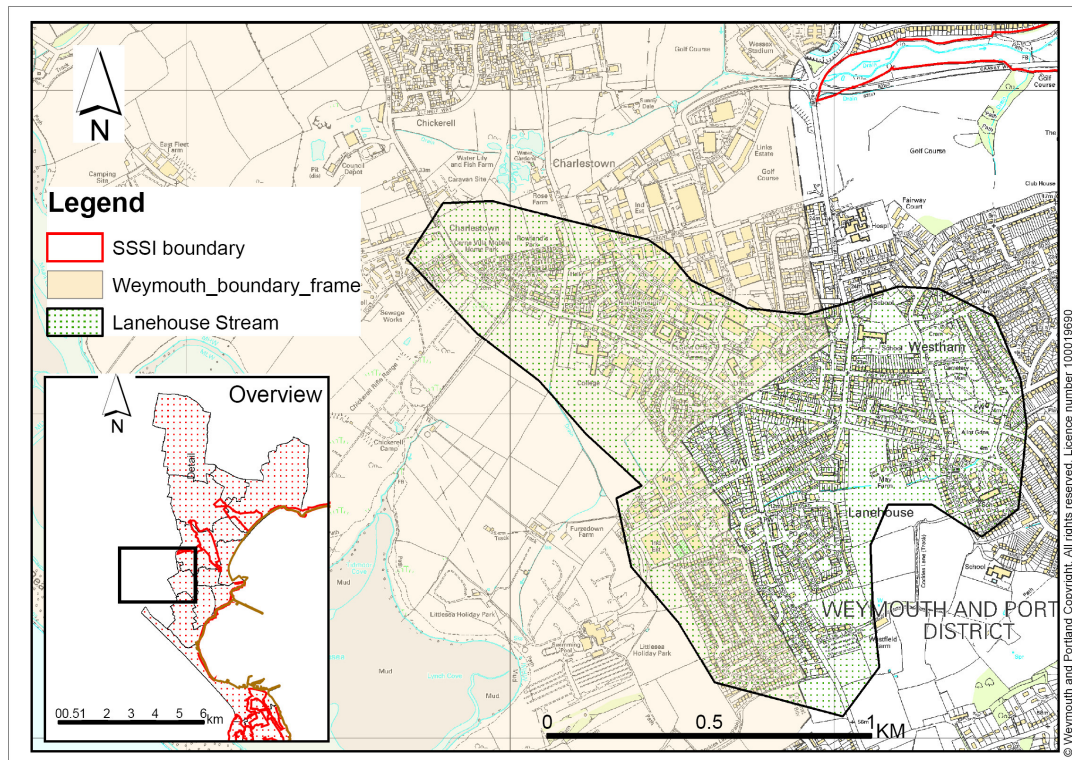
Figure 4.4- Cross-section of a Pond



Flooding from surface water is known to be an issue in the Lanehouse Stream area and affects several houses on Overbury Close. This flooding is due to overland flows from the Littlesea Industrial Estate following heavy, localised storms. A flood risk assessment was undertaken by Royal Haskoning in June 2005 to investigate the existing capacity of the Lanehouse Stream and its structures downstream of Lanehouse Rocks Road. Following the study, predictions can be made regarding the downstream effect of any improvements to drainage works in the area, with the aim to reduce the risk of internal property flooding.

The Lanehouse Stream catchment, as shown in figure 4.5, is a small, urban catchment, covering 1.16km². The stream is a mixture of culverted and open-channel sections. As the watercourse flows downstream it is joined by a number of surface water sewers, some of which drain the Littlesea Industrial Estate and the large residential area of Lanehouse.

Figure 4.5
Location map of Lanehouse Stream



A hydrological study was carried out, followed by HEC-RAS hydraulic modelling. The HEC-RAS modelling highlighted the insufficient capacity of the culverts downstream of Lanehouse Rocks Road. New developments therefore need to implement Sustainable Drainage systems (SUDS) to minimise the affect of the development on the downstream flood risk and to ensure the problem is not moved downstream.

4.4 Managed retreat and river erosion

Managed Coastal Retreat is concerned with planning for the potential threat of rising sea levels by looking at the options available to protect the coastline. In some areas it may not be suitable to build bigger flood defences to protect against flood risk associated with rising sea levels and increased wave action. It may even be necessary to remove some defences, especially on eroding cliffs to allow for the provision of extra material such as sand and silt for the sea to deposit elsewhere by natural processes. Managed coastal retreat may also mean setting back sea walls so that beaches, salt marshes and other natural features can help in defending from the sea.

An example of coastal erosion can be seen at Newton's Cove (photo 4.3). A coastal protection scheme was undertaken to protect and enhance the SSSI and local built environment.

Photo 4.3
Newton's Cove coastal protection scheme



As a large proportion of the study area is coastline, in the future, managed coastal retreat may become a relevant planning issue for Weymouth and Portland, although the current Shoreline Management Plan policy is to hold the line both now and in the long term. At present there are no known plans for managed coastal retreat in Weymouth and Portland Borough Council and due to the shoreline topography it is an unlikely option in the foreseeable future. However PPS25 notes that development in Flood Zone 3 or close to eroding cliffs should avoid coastal areas which will, or may in the future, be needed for managed coastal retreat.

More information on the risk of cliff erosion and future policy for the area can be found in the Durlston Head to Rame Head Shoreline Management Plan (SMP2) which is currently out for consultation and is available on the internet.

In considering the influence of geomorphological processes on flooding within a catchment it is essential to consider the whole river corridor, including the river floodplain where it exists. Transfers of water and sediment typically occur between rivers and associated floodplains during high flow events, and form part of the natural function of the river system. Floodplain connectivity refers to the degree to which river and floodplain processes are inter-related in this way, and is important for the functioning of many wetland habitats. As long and linear systems, rivers act as corridors for the movement of sediment, fish and other wildlife. The degree to which a river forms a continuous corridor has a strong influence on the natural functioning of the river system.

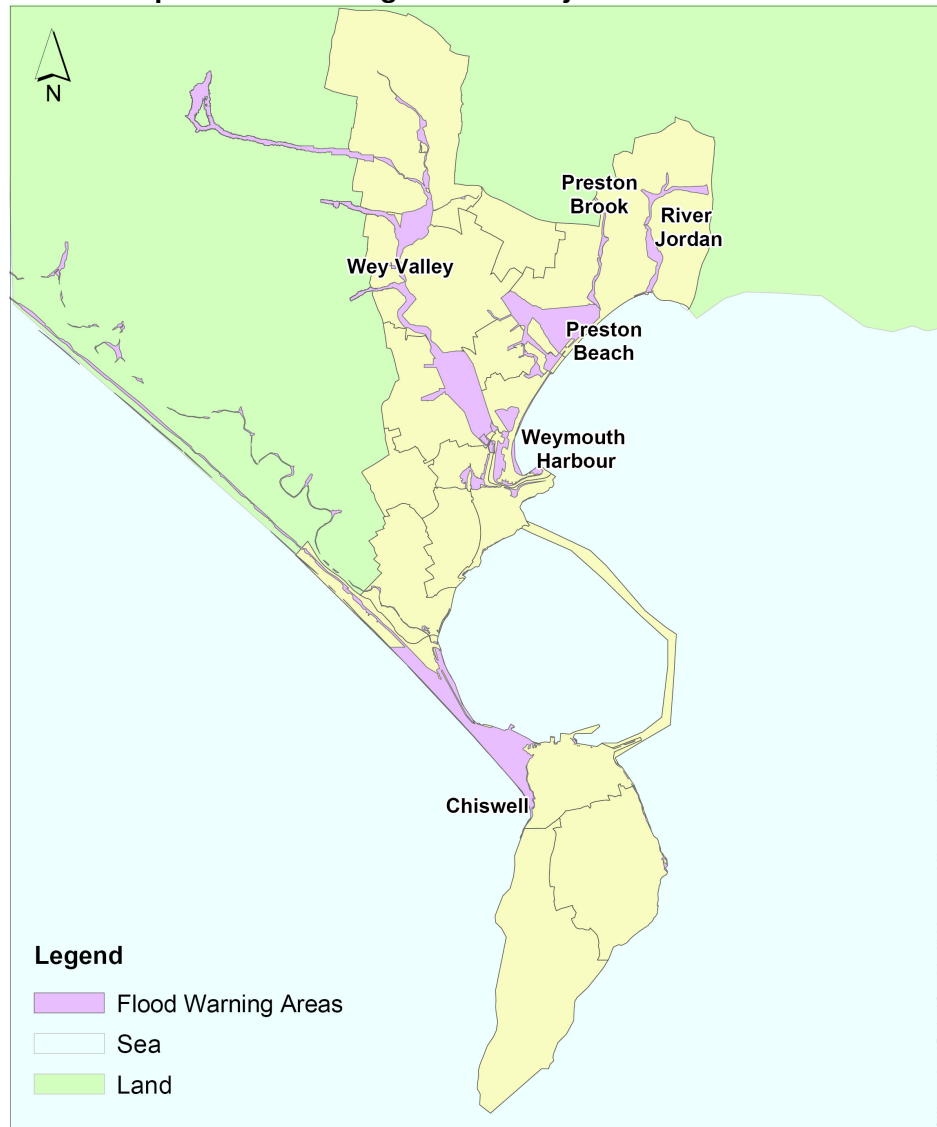
Flood defences within the W&PBC area have been constructed to reduce fluvial and tidal flooding. Fluvial floodplain connectivity is disrupted by raised defences in the lower reaches of the River Wey modifying the natural function of the floodplain in this area. As existing fluvial defences are isolated and localised in small settlements they are not likely to significantly limit fluvial floodplain connectivity at the catchment-scale.

As well as cliffs and beaches eroding, rivers can naturally change their course. Although no specific high risk areas have been identified in this SFRA, planners and developers should be aware that the course of rivers can change over time. Looking at County Series (1890 onwards) Ordnance Survey mapping can help identify where river erosion is a risk, by comparing the course of the river then and now. Such maps can be found in the Local Records Office. Where potential river erosion may occur this should be investigated as part of a FRA particularly if it could cause developed land to become at risk of flooding in the future.

4.5 Flood warning

The EA are responsible for flood watches and flood warnings across the whole of England and Wales. Flood warnings are broadcast by television and radio services and are also available on the EA website. Within the study area the designated flood warning areas are as shown on figure 4.6.

Figure 4.6
Map of flood warning areas in Weymouth and Portland



Warnings are provided for designated flood warning areas either directly or indirectly. The indirect system is based around the internet and the Floodline dial-up-and-listen service, where members of the public and other parties can obtain current flood warning information for their area. The Floodline number is 0845 988 1188 and the website address is www.environment-agency.gov.uk/subjects/flood/floodwarning. Flood warnings are also broadcast by television and radio services.

The direct warning service requires people in at risk properties in designated flood risk areas to register their telephone number with the EA under the Floodline Warnings direct scheme. They can then receive automatic warning messages if a flood is likely.

Flood warnings can be very difficult to accurately predict particularly when catchments respond rapidly to rainfall. For example the River Wey is a flashy catchment with increases in development and associated surface water flows making it one of the most difficult catchments to predict in terms of flood warning in the South Wessex Area. On the Wey, the risk has been known to rise from below Flood Watch to above Severe Flood Warning in less than an hour.

Applicants for any proposed development which takes place in EA Flood Zone 3, which is not in an existing designated flood warning area, should assess the potential for such a service in conjunction with the EA and make provisions for such within any FRA, in order to meet PPS25 requirements.

Safety and evacuation procedures should also be addressed for developments within EA Flood Zone 3 and for civil infrastructure within Flood Zone 2 such as schools and hospitals. Provisions such as refuges, safe access and exit routes (which are above flood levels) should be incorporated into the design of such sites. Access for emergency vehicles will also need to be considered.

Emergency planning in the area is currently covered by W&PBC in their generic incident plan for the whole of Weymouth. Any major development within the urban areas of Weymouth and Portland should consider the impact of new development on the existing plan. It should be ensured that the procedures can be applied to the new development or modified if necessary, in conjunction with Dorset County Council and the EA.

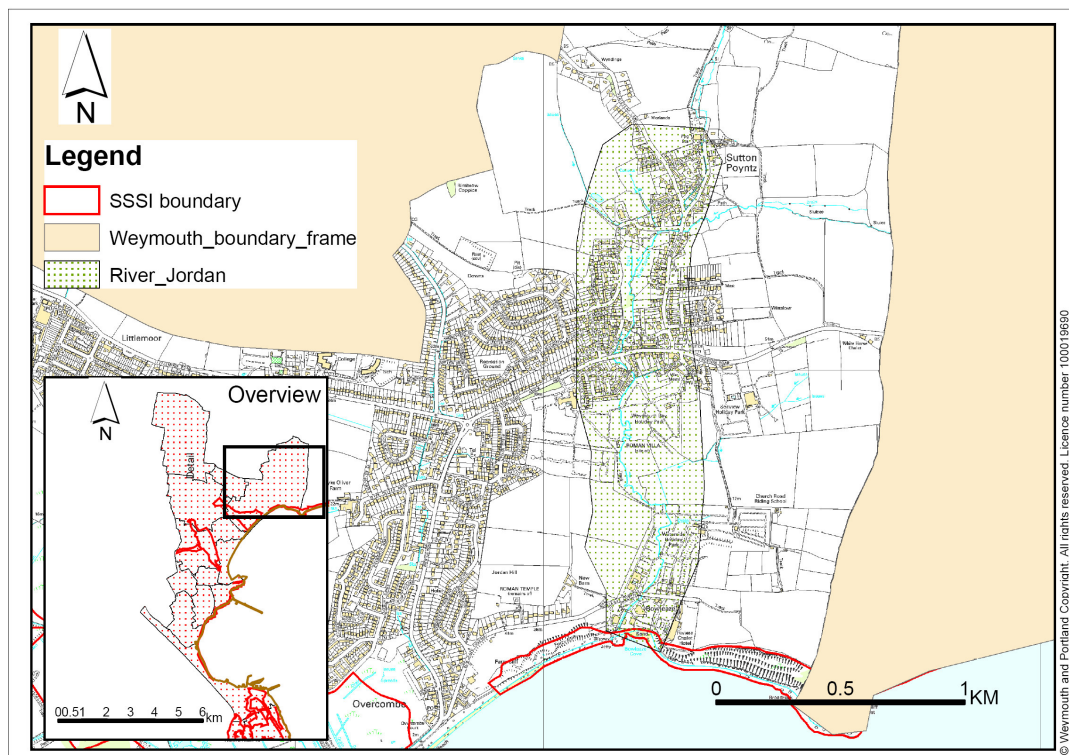
5 AREAS AT RISK OF FLOODING

5.1 Vulnerable areas

Areas sensitive to flooding have been highlighted by historic records of flooding from both W&PBC and the EA and by the information detailed on the EA Flood Zone maps. These areas are identified on both the A1 paper plans and the GIS shapefile layers. Flooding can be caused by overtopping of river banks, surface water runoff, tidal flooding and blockages of drains and culverts within W&PBC. Flood damage to properties largely results from conveyance issues where existing channels are not of sufficient capacity to cope with high flows due to heavy rainfall and increased surface water runoff mainly through urbanisation. Specific areas where this is known to be a problem are the Esplanade in Weymouth town centre, along the River Jordan, as shown in figure 5.1, and the Preston Brook, as shown in figure 5.2.

Following the commission of a feasibility study for the River Jordan, a hydrological assessment was carried out, including hydraulic modelling using HEC-RAS software. These studies highlighted areas where water overtops the bank due to inadequate culverts (Mission Hall Lane, Sutton Poyntz), bridges (Fisherbridge) and drainage systems or locations where a number of significant flows converge (Sutton Road Bridge). In addition, the study indicated areas where the drainage systems are overwhelmed due to rapid runoff (Puddledock Lane) causing overland flow. The Environment Agency is currently investigating this area in more detail using a 2 dimensional hydraulic model. Using the outputs from this modelling a range of options to reduce the damage caused by flooding have been investigated and a preferred option chosen.

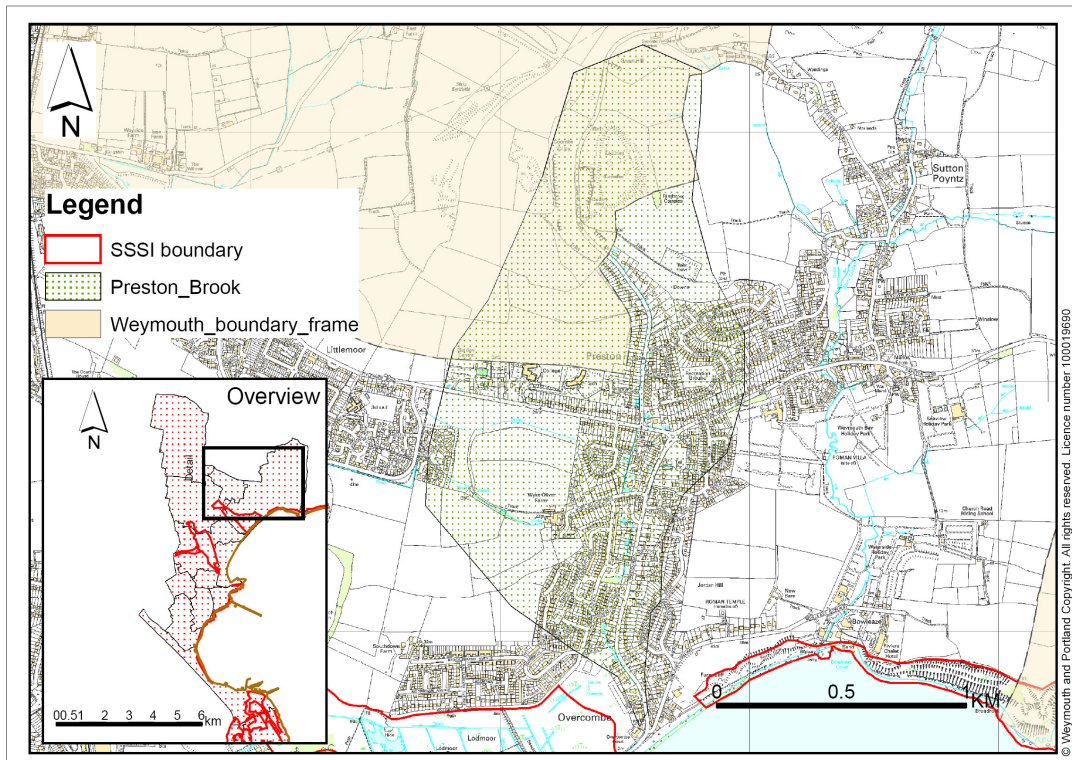
Figure 5.1
Location plan of River Jordan Feasibility study area



The flooding of properties is known to occur along Preston Brook at numerous locations and is caused by three mechanisms; direct watercourse flooding, overland flooding and surface water flooding. The majority of the problems in this area are caused by blocked or inadequately sized culverts. The watercourse flows through residential gardens; therefore encroachment of vegetation has reduced the capacity of the watercourse in this area and maintenance has been difficult due to the lack of access to private properties. Debris easily becomes lodged across the screens and bridges even during moderate events.

A number of flood defences have been put in place, including a balancing pond on the Littlemoor Stream tributary and a flood bank adjacent to Abbeyfields on Wyke Oliver Road. The balancing pond would be capable of attenuating a 1 in 50 year flow if there was a fully operational screen and discharge structure installed. As mentioned in Section 3, additional ponds have been installed as part of the Weymouth Flood Relief Road.

Figure 5.2
Location map of Preston Brook Flood Alleviation Scheme



HEC-RAS hydraulic modelling was used to estimate peak water levels along the Preston Brook for a range of flows to determine the viability of flood alleviation options which resulted in channel improvements, raising the standard of protection to 1 in 25 years for properties within the study area.

5.2 Current levels of flood risk

Only a small proportion of the population of W&PBC are currently at high risk of fluvial or tidal flooding. The majority of properties at risk are coastal properties that suffer tidal flooding, whilst only a very small number of properties are at risk from fluvial flooding.

The maps that accompany this report highlight that there are other sources of flooding, such as surface water flow, within the study area which affect additional properties.

Chart 5.1 shows the percentages of the population which live within either EA Flood Zone 2 or 3. It should be noted that the chart does not consider other sources of flooding. The property data used is sourced from the National Property Dataset (NPD).

Chart 5.1
Proportions of the population at risk of fluvial or tidal flooding

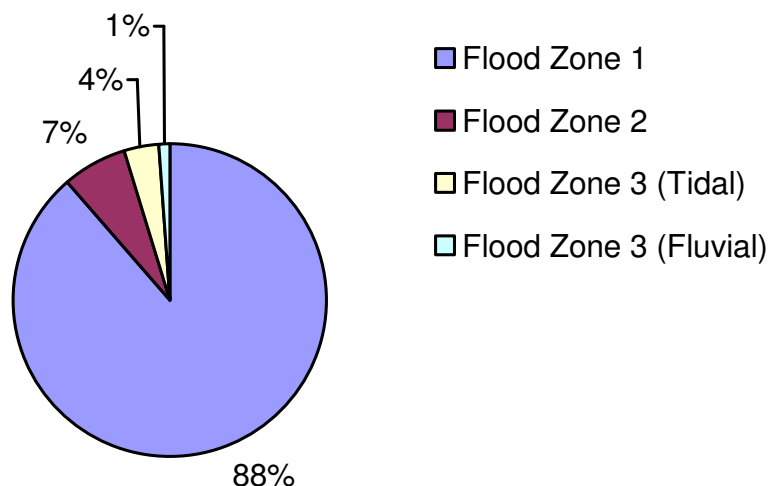


Table 5.1 highlights the main urban wards within Weymouth and Portland where properties are located within EA Flood Zone 3. The table indicates the approximate number of properties at risk, and the primary sources of flooding. This table has been updated and the figures were produced using the most up-to-date EA Flood Zone 3 data provided by the Environment Agency.

Table 5.1
The number of flooded properties within wards of Weymouth and Portland

Ward*	No. of properties	No. of properties in EA FZ3	Percentage of properties within EA FZ3	Main sources of flooding
Melcombe Regis	3482	717	20.59	Tidal flooding
Preston	2403	103	4.16	Tidal and fluvial flooding due to heavy rainfall, surface water runoff with inadequate bridges and culverts leading to backing up.
Underhill	1762	121	6.9	Tidal flooding due to severe weather
Weymouth East	1987	94	4.7	Tidal flooding

Ward*	No. of properties	No. of properties in EA FZ3	Percentage of properties within EA FZ3	Main sources of flooding
Westham East	1768	3	0.17	Tidal flooding with some problems of fluvial flooding
Upwey & Broadwey	1616	67	2.16	Fluvial flooding due to runoff from fields and heavy rainfall
Radipole	1582	15	0.95	Tidal flooding due to drainage problems
Wey Valley	1460	13	0.9	Fluvial flooding due to the River Wey overflowing
Westham North	2388	1	0.04	Tidal and fluvial flooding due to runoff and the River Wey overtopping

* The wards are shown on the location plan – Figure 2.1.

With reference to historic flooding events there are approximately 49 properties, representing 0.16 % of the total number of properties within ten metres of a known historic flood event and 156 properties (0.51%) within twenty metres.

5.3 Climate change results

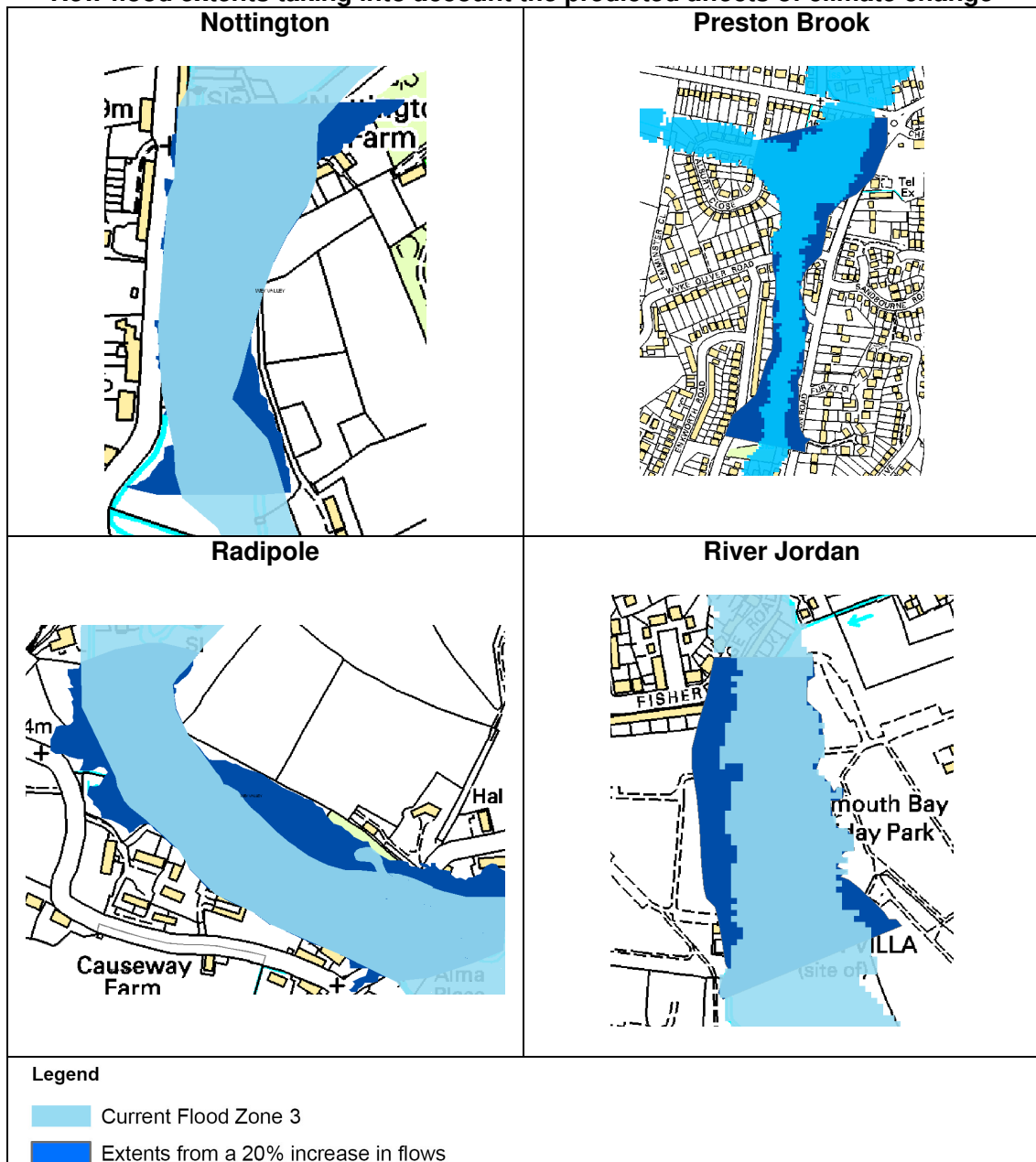
Lateral changes to existing fluvial flood extents and the increases (if any) in numbers of properties affected due to the predicted 20% increase in flows as a result of climate change (as detailed in PPS25), are given in table 5.2 below. The new fluvial flood extents, shown in figure 5.3, are based on the most up to date Flood Zone 3 data and have been created for key areas using the LiDAR Digital Terrain Model (DTM) data.

Table 5.2
Lateral changes to flood extents and properties affected due to climate change

Area	Climate Change Statistics	
	Lateral extent changes (m) due to 20% increase in flows	Number of additional properties affected due to 20% increase in flows
Nottingham	0-31	0
Preston Brook	17-90	3
Radipole	5-35	0
River Jordan	20-34	1

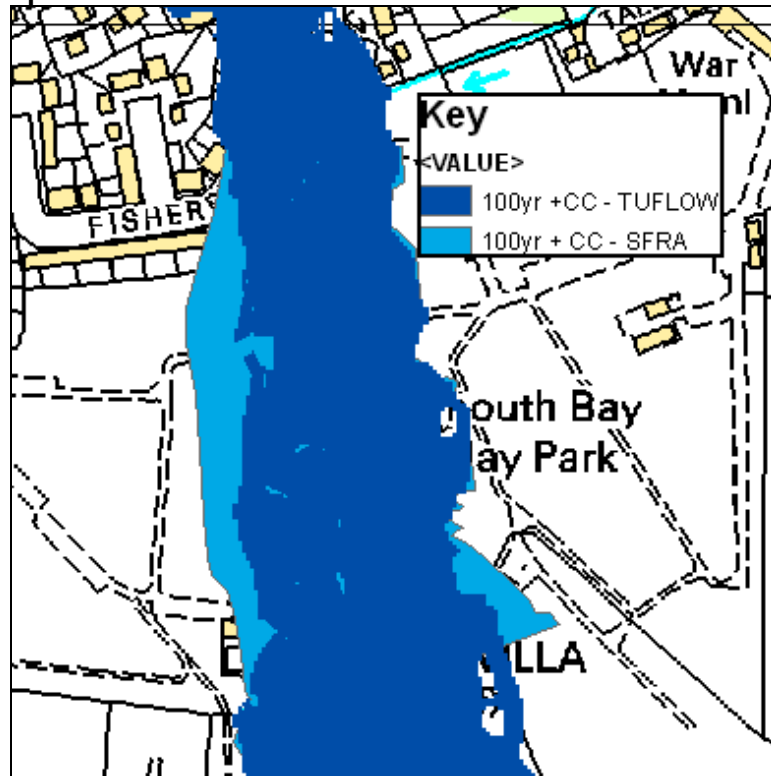
The specific methodology is detailed in Appendix C. The locations chosen for these detailed studies were identified by locating FRIS hotspots and other known locations of high frequency flooding, the availability of suitable LiDAR DTM data and the presence of existing Flood Zone 3 data. The only area where significant numbers of properties are affected due to climate change is at Preston Brook where the number of properties in the new flood extent has doubled from those currently in EA Flood Zone 3.

Figure 5.3
New flood extents taking into account the predicted effects of climate change



Since the original level 1 SFRA further hydraulic modelling has been undertaken for a reach of the River Jordan using 2 dimensional modelling (TUFLOW). Figure 5.4 shows the 100 year fluvial event with climate change from the TUFLOW model with the 100 year fluvial event plus climate change outline produced for this SFRA. On the eastern extent the two outlines match, whilst on the western edge the outline from the SFRA extends further west.

Figure 5.4
Model outputs for the 100 Year +CC extent from TUFLOW and SFRA method

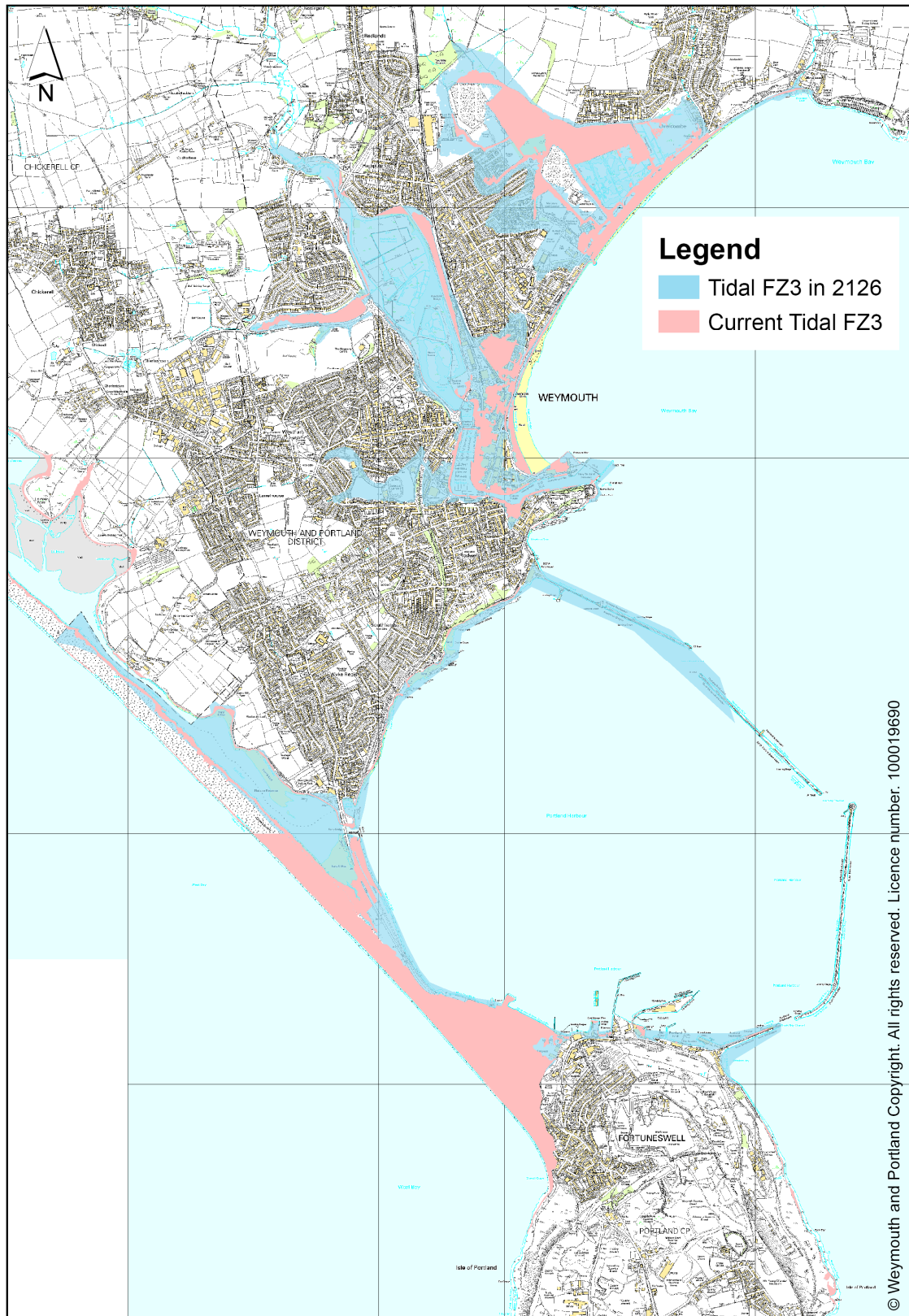


The predicted affects of sea level rise (based on guidance in PPS25) are shown in Table 5.3 and Figure 5.5 below. The main areas where there could be a significant increase in the number of properties affected are in Weymouth Town Centre, namely the wards of Melcombe Regis, Preston, Westham East, Westham West and Radipole. This is primarily due to the effects of tidal inundation due to climate change in the low lying areas of Radipole Lake and Lodmoor Nature Reserve. Note that the wards of Upwey and Broadway, Littlemoor and Tophill East are not expected to be at risk of tidal flooding either now or in 2126 based on current climate change predictions.

Table 5.3
Number of properties affected by the predicted tidal climate change

Ward	Number of properties currently in EA Tidal FZ3	Number of additional properties affected by 2126
Melcombe Regis	857	3101
Underhill	121	255
Weymouth East	94	286
Westham East	2	229
Radipole	15	533
Preston	25	121
Wey Valley	-	20
Wyke Regis	-	17
Westham North	-	25
Westham West	-	53
Weymouth West	-	3
Tophill East	-	2

Figure 5.5
Predicted 2126 1 in 200 year tidal flood extent



6 DATA AND MAPPING

6.1 Data collection

To produce this SFRA data have been collected from both the EA and W&PBC.

Data collected from the EA include:

- EA Flood Zone mapping
- EA data on flood defences (NFCDD)
- EA Historic Flood Map
- Flooding Incidents recorded by the EA (FRIS)
- Flood warning areas and flood watch areas
- LiDAR DTM data
- Chiswell Flood Zone data

Data collected from W&PBC:

- Ordnance survey mapping at 1:10,000 scale
- Aerial photographs
- Historic flooding incidents recorded by W&PBC
- Known flooding problems and observations as recorded by W&PBC
- W&PBC boundary
- W&PBC proposed and existing defences

As part of the study, we produced the following GIS based data

- Potential Flood Risk Areas (section 3.1)
- Limited new flood extents (as discussed in section 6.3.2) based on existing EA Flood Zone 3 and climate change predictions (section 5.3 and Appendix C)

We also produced the following guidance documents:

- PPS25 Decision Flow Charts (Appendix D)
- Guidance for developing housing in a flood resistant manner (Appendix E)

6.2 Data quality

The quality of the flood related data collected and produced varies due to the source and age of the data. In addition, some areas have been carefully mapped using hydraulic modelling, whilst other areas are less precise. For that reason a cautious approach has been taken in this SFRA, using the best data available at the time of writing.

Each data set has been given a data quality suffix reflecting the views of Royal Haskoning about the quality and accuracy of the data when considering flood risk, as detailed in Appendix A. This is to help planning officers, developers and members of the public judge how to use the data when considering flood risk and the need for further study.

Improvements may be made to the data and therefore the data collected must be updated regularly to ensure that the most up-to-date and accurate data are used to guide any decisions regarding flooding and flood risk. Where data is not available for the SFRA, it has been necessary to make assumptions based on professional experience, local knowledge and recorded literature. The least reliance is placed on those cases where only assumptions based on engineering judgement is available. The latter category should be used with particular caution. For this reason, whilst information is

shown on the maps in a relatively precise way, it is not possible to be completely certain from the outputs of this SFRA that any individual property, particularly those near the boundaries of zones of risk, is definitely within that risk zone.

6.3 Mapping

The following sets of A1 maps have been produced to accompany this report:

- Historic and Defence
- Flood Risk Existing and Future

Each map covers a 5x5 kilometre area. The maps help to class land into different categories of current and future flood risk and are to be used as an aid when considering sites for development. It must be noted that these maps are part of a strategic analysis of the flood risk and should not be used to make decisions regarding flood risk to individual properties.

6.3.1 Existing Flood Risk and Climate Change

The A1 maps show the current flood extents along with the predicted tidal flood extent for 2126. These maps show the EA Flood Zones 2 and 3 as well as the RH defined Potential Flood Risk Areas.

Most of the EA Flood Zones have been defined using hydrological and hydraulic models and mapped using detailed information on the topography of the ground. It should be noted that changes can be made to the EA Flood Map and therefore it is important to check that the map is up-to-date when considering development.

The mapping of flood risk is helpful in the SFRA process as it shows where flooding could occur, and therefore where potential new developments should be carefully considered before giving planning permission. Where possible, the type of flooding e.g. fluvial, tidal or a combination has been shown on the map to highlight the problems that occur in each area for Flood Zone 2 and 3.

The exact changes to EA fluvial Flood Zone 3 extents due to climate change have not been evaluated for the whole study area. Therefore the new extents are not depicted on the A1 maps. From the localised studies carried out using LiDAR DTM data, lateral increases in the EA Flood Zone 3 are predicted to vary between 0 and 90 metres as a result of a 20% increase in flows. It is beyond the scope of this SFRA to apply this climate change methodology across the whole study area.

The new fluvial flood extents which include the effects of climate change, serve as a guide for the likely changes that could occur as a result of increased flows of 20%. It is assumed that similar lateral changes to flood extents will also occur at other locations in the study area with equivalent topography and settlement patterns.

As an approximation, land which lies between the boundaries of EA Flood Zones 2 and 3, and is closer to the boundary of EA Flood Zone 3 than EA Flood Zone 2, should be treated as being within EA Flood Zone 3 for the purpose of guiding planning officers about the possible affects of climate change. The effects of climate change also need to be considered with regard to Potential Flood Risk Areas following a pragmatic but cautious approach to take account of their uncertainty. As a guideline, the possibility of

flood risk should be considered for land within a 10m lateral distance and 2m height of the Potential Flood Risk Areas. However, a site specific Flood Risk Assessment, considering in detail the possible effects of climate change, should be undertaken for any proposed development within or close to an EA Flood Zone 3 and/or a Potential Flood Risk Area.

6.3.2 Historic flood events and defences

One method to investigate flood risk is to look at the areas which have flooded in the past. The flooding can be from a range of sources e.g. fluvial, tidal, surface water runoff, groundwater or a combination, although the majority of events indicated on the maps are from fluvial, tidal or surface water runoff.

Where the information is of good quality, the map shows the area which is thought to have flooded. This information has been provided by the EA in the form of Historic Flood Mapping. Where there is no information about the extent and exact location of the flooding, the map is marked with a dot-symbol indicating the flood event. This information has been provided by W&PBC Engineers. It should be noted that this dot-symbol does not mean that flooding happened at this exact point, but that flooding did occur in the general location. This information can be used for assessing future flood risk, particularly for small catchments or urban areas where repeat flooding occurs, but there is little mapping or other data to substantiate the risk.

The map set also shows the location of existing flood defences maintained by either the EA or W&PBC. This is useful for a number of reasons:

- This allows planners, developers and the general public to put the potential flood risk into context, especially where historic flooding and flood defences are shown in the same location; the historic flooding may have occurred before flood defences were in place.
- Knowing where flood defences are can indicate areas where flood risk may be reduced, although further investigation regarding the standard of protection that is currently afforded by the defence will be required.
- By referring to the current Standard of Protection, areas of floodplain which are classed as defended can be incorporated into development plans as part of an FRA.

Where there are no defences, the floodplain can be defined as functional or natural floodplain i.e. an area that can store water which has overtopped river banks in times of flood. This floodwater can then drain away through watercourses. A general principle of PPS25 is to maintain a constant amount of functional floodplain. Providing defences will therefore reduce the amount of functional floodplain.

6.3.3 Geographical Information System (GIS)

A Geographical Information System (GIS) is a computer-based system for using data that is spatially referenced. This means the information can be viewed on electronic maps, where the maps also provide links to the underlying database and attribute information about the graphics displayed on the maps. The data sets that have been collected to undertake the SFRA have either been supplied in a GIS format, or have been adapted to a GIS format from hardcopy data by Royal Haskoning.

The information is provided to W&PBC in ESRI shapefile format to be integrated within their own corporate GIS. This will allow users to view additional GIS layers such as development sites and designations within the context of the SFRA datasets. In addition, users will be able to carry out appropriate analysis as assessment using both sources of data to quickly locate areas and assess flood risk at potential development sites.

By using a GIS based system, W&PBC can add to the existing datasets keeping records up to date and linking to the latest data such as the updated Flood Zone datasets supplied quarterly from the EA. Therefore the SFRA GIS project becomes a fluid and adaptable information source that is not referenced to a set point in time like hardcopy maps and can always be made into hardcopy as and when required.

7 SFRA USER GUIDANCE

This SFRA is a strategic overview of flood risk throughout the W&PBC area. In accordance with Government planning policy flood risk within the area has been categorised into three flood risk zones – Zone 1 (Little or no risk), Zone 2 (Low to medium risk) and Zone 3 (Medium to high risk). This categorisation into zones is intended to give an indication only of flood risk at any particular location within the area and is not intended to represent a detailed assessment of the flood risk appertaining to any particular building or piece of land within the study area. It is to be noted that the all maps (paper and GIS based) included as part of this SFRA show only the extent of Zones 2 and 3, that is any areas not assessed as lying within a Zone 2 or Zone 3 are deemed to be Zone 1 as described in section 3.1.

The Government aims to reduce the risk from flooding to people and the developed and natural environment by discouraging development within areas at medium to high risk of flooding. Government guidance has been produced for local planning authorities to help them when allocating land for development in order to meet this aim. The current guidance is contained in Planning Policy Statement 25: Development and Flood Risk (PPS25).

Therefore, this SFRA is intended to be used by planners and developers alike to assess the suitability of any particular site to support or not a particular type of development. This is subject to the level of flood risk, the vulnerability of the proposed usage and the extent to which the combination of other factors and mitigation might exempt the development from the application of this guidance (i.e. flood risk would not be a reason for refusal at planning).

7.1 Planning Policy Statement 25

PPS25 provides Government policy that sets out a number of important points in relation to planning and flood risk. These are that:

- Flooding cannot be wholly prevented, but its impacts can be avoided through good planning and management.
- Climate change will lead to increased and new risks of flooding within the lifetime of planned developments.
- All forms of flooding and their impact on the natural and built environment are material planning considerations.
- Good planning and management avoids, reduces and manages flood risk by taking full account in decisions on plans and applications of:
 1. Present and future flood risk involving both the statistical probability of a flood occurring and the scale of its potential consequences, whether inland or on the coast; and
 2. The wider implications for flood risk of development located outside flood risk areas.
- Flood risk should be taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding.
- Regional planning bodies (RPBs) and local planning authorities (LPAs) should prepare and implement planning strategies that help to deliver sustainable development by appraising, managing and reducing risk using a partnership approach.

PPS25 does recognise that in some areas it will be necessary to locate some development in an area at higher risk of flooding. However, this will happen in exceptional cases only and these developments must not only be safe from flooding, they must make sure that flood risk elsewhere does not increase as a consequence of the development. In addition, where possible this type of development should try to reduce the overall flood risk to the wider surrounding area.

The assessment of land for development requires 4 stages:

1. Flood Zone Classification (Table D1 PPS25)
2. Sequential Test through the use of PPS25 Decision Flow Charts (Appendix D)
3. Flood Risk Vulnerability Classification (Table D2 PPS25)
4. Exception Test where indicated by table D3 of PPS25

7.2 Flood Zone Classification

Table 7.1 below sets out the Flood Zone classification from PPS25. This classification is used as the basis of the Sequential test described in Section 7.4 of this report. It identifies the probability of flood risk in each type of flood zone.

Table 7.1- Flood Zone Classification

Flood Zone	Definition
Zone 1 Low Probability	This zone comprises land assessed as having a less than 1 in 1000 annual probability of fluvial or tidal flooding in any year (<0.1%).
Zone 2 Medium Probability	This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of fluvial flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of tidal flooding (0.5% – 0.1%) in any year.
Zone 3	Zone 3 is split into two parts; Flood Zone 3a High Probability and Flood Zone 3b Functional Floodplain. All areas within Zone 3 should be considered as Functional floodplain (Zone 3b) unless an appropriate FRA shows that it can be considered as Zone 3a and the EA agrees this.
Zone 3a High Probability	This zone comprises land assessed as having a 1 in 100 or greater annual probability of fluvial flooding (>1%) or a 1 in 200 or greater annual probability of tidal flooding (>0.5%) in any year.
Zone 3b The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. It is defined as land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the EA. This includes water conveyance routes. Flood storage areas are considered to be Functional Floodplain due to the essential role they provide in storing flood water.

All areas in Flood Zone 3 should be considered as functional floodplain (3b) until an appropriate FRA demonstrates otherwise.

7.3 The Sequential Test

Local Authorities and developers can both use the Sequential Test to highlight areas of development. The aim of the Sequential test is to direct development to Flood Zone 1. Where there is no reasonable land available, development can then be considered in

Flood Zone 2, and then Flood Zone 3, taking account of flood risk vulnerability where sites have to be placed in these higher risk areas. The types of development allowed in each Flood Zone, classified using the Flood Risk Vulnerability Table, becomes more limited the higher the risk of flooding becomes, with development in land classified as Functional Floodplain (Zone 3b) extremely limited in order to maintain space for water to be stored naturally, a central aim of PPS25.

Table 7.2 below details the type of development permitted in each flood zone, along with any FRA or developer requirements. Table 7.3 summarises the relationship between the different Flood Zones and the Flood Risk Vulnerability classifications.

The Sequential Test should be applied by local planning authorities in land allocation for spatial plans e.g. LDF. Developers will also need to apply the sequential test if a site they wish to develop is not identified by the LDF and is at risk from fluvial or tidal flooding. If developers make applications on sites that have already been through the sequential test as part of the LDF process then they are not required to undertake the test again, although they should apply a sequential approach at the site. Additionally this type of approach should be used in areas at risk from other forms of flooding.

Table 7.2 – PPS25: Planning response to sequential characterisation of flood risk

<p>Zone 1 Low Probability</p> <p>Appropriate uses All uses of land are appropriate in this zone.</p>
<p>Zone 2 Medium Probability</p> <p>Appropriate uses The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure are appropriate in this zone. Subject to the Sequential Test being applied, the highly vulnerable uses are only appropriate in this zone if the Exception Test is passed.</p>
<p>Zone 3a High Probability</p> <p>Appropriate uses The water-compatible and less vulnerable uses of land are appropriate in this zone. The highly vulnerable uses should not be permitted in this zone. The more vulnerable and essential infrastructure uses should only be permitted in this zone if the Exception Test is passed. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for users in times of flood.</p>
<p>Zone 3b The Functional Floodplain</p> <p>Appropriate uses Only the water-compatible uses and the essential infrastructure that has to be there should be permitted in this zone. It should be designed and constructed to:</p> <ul style="list-style-type: none"> • remain operational and safe for users in times of flood; • result in no net loss of floodplain storage; • not impede water flows; and • not increase flood risk elsewhere. <p>Essential infrastructure in this zone should pass the Exception Test.</p>

Table 7.3 – Summary of appropriate uses in each flood zone

Flood Zone	Flood Risk Vulnerability Classification				
	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	ET	✓	✓
Zone 3a	ET	✓	x	ET	✓
Zone 3b	ET	✓	x	x	x

Key:

✓ = Development is appropriate in terms of flood risk

x = Development should not be permitted due to flood risk

ET = Exception test must be passed for the development to be permitted on the basis of flood risk.

In applying the sequential test, local planning authorities should consult and take the advice of the EA on the distribution of flood risk and the availability of flood defences in their areas. Flood defences for most new housing developments should be designed and constructed to protect against a flood with an annual probability of 1% for fluvial flooding and 0.5% for coastal flooding taking into account climate change (for a period of 100 years). Commercial and industrial development should aim to achieve the same minimum standard of defence (over a period of approximately 60 years).

This links to PPS25 Decision Flow Charts that have been produced using the information given in the sequential test. The flow charts can be followed by planning officers, potential developers and members of the public to assess at a strategic level the flood risk to a piece of land. They clearly indicate whether a piece of land would require a specific and detailed FRA to be provided with a planning application and are designed to provide a robust and consistent system for assessing flood risk anywhere within W&PBC area. The PPS25 Decision Flow Charts can be found in Appendix D. There is a flow chart for each of the Vulnerability Classifications given in table 7.4.

7.4 Flood Risk Vulnerability Classification

Following the Sequential Test a flood risk classification which groups land uses, infrastructure and buildings into five categories of vulnerability needs to be carried out to assign one of five vulnerability criteria to the proposed development site(s). A summary of these classifications, with examples of the elements which lie within them, are outlined in table 6.4 below.

Table 7.4 - PPS 25: Flood Risk Vulnerability Classification

Flood Risk Vulnerability Classification	
1. Essential Infrastructure	<ul style="list-style-type: none"> • Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
2. Highly Vulnerable	<ul style="list-style-type: none"> • Police stations, Ambulance stations, Fire stations, Command Centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent.
3. More Vulnerable	<ul style="list-style-type: none"> • Hospitals • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels. • Non-residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
4. Less Vulnerable	<ul style="list-style-type: none"> • Buildings used for: shops; financial; professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non-residential institutions not included in 'more vulnerable'; and assembly and leisure. • Land and building used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment plants. • Sewage treatment plants (if adequate pollution control measures are in place).
5. Water-compatible Development	<ul style="list-style-type: none"> • Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel workings. • Docks, marinas and wharves. • Navigation facilities. • MOD defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports, recreation and essential facilities e.g. changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

Flood Risk Vulnerability Classification

Notes

- *This classification is based partly on Defra/Environment Agency research on flood risks to people and also the need of some uses to keep functioning during flooding.*
- *Buildings with combined activities should be placed in the higher of the relevant classes of flood risk sensitivity. Developments that allow uses to be distributed over the site may fall within several classes of flood risk sensitivity.*
- *The impact of a flood on the particular uses identified within this flood risk vulnerability classification will vary within each vulnerability class. Therefore, the flood risk management infrastructure and other risk mitigation measures needed to ensure the development is safe may differ between uses within a particular vulnerability classification.*
- *Some elements of classifications are subject to a specific warning and evacuation plan.*

7.5 The Exception Test

In circumstances where the Sequential Test has been applied, and possible development locations cannot be found in zones of lower probability of risk, then the Exception Test can be applied as indicated on the PPS25 Decision Flow Charts. The Exception Test should only be used under specific circumstances where the wider aims of sustainable development need to be addressed. When required the decision-makers should apply the Exception Test at the earliest possible stage of the planning process. It should be applied to all Local Development Documents (LDD) as well as all planning applications with the exceptions of domestic extensions and householder developments.

PPS25 states that the following criteria must be met for the Exception Test to be passed:

- a. it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared. If the Development Plan Documents (DPD) has reached the 'submission' stage the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal;
- b. the development should be on developable brownfield (previously-developed) land, unless no reasonable alternative options exist; and
- c. a FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

The Exception Test should be used in locations with extensive areas liable to flooding or areas where restrictive designations such as landscape and nature conservation designations, e.g. Areas of Outstanding Natural Beauty (AONB) and Sites of Special Scientific Interest (SSSIs) reduce the amount of available land for the sustainable development required.

The Exception Test should not be used to justify 'highly vulnerable' development in Flood Zone 3a or 'less vulnerable'; 'more vulnerable'; or 'highly vulnerable' development in Flood Zone 3b. The Exception Test should only be used in exceptional circumstances where no suitable land for development can be found in a lower flood risk area or the wider sustainable development objectives outweigh the residual flood risk.

7.6 Additional guidance

As part of this SFRA certain properties will fall within a Flood Zone or PFRA. This information is not meant to alarm residents of W&PBC area, but provides a warning to

prepare for potential flooding should it happen. Flooding could happen at almost any time, but in any individual year the risk of a flood may be low. The EA publishes advice on dealing with flood risk and installing preventative measures. The advice can be obtained by contacting Floodline on 0845 988 1188 or through the EA website at www.environment-agency.gov.uk/. Individuals and developers should also consider their responsibilities for what to do to reduce the flood risk to themselves and others, their property and the people who use it. Guidance is provided in Appendix E for developing housing in a flood resistant manner. Further guidance can be found in *Development and Flood Risk: A practice guide companion to PPS25* (June 2008), or *Improving the Flood Performance of New Buildings: Flood Resilient Construction* (May 2007), both written by the Department for Communities and Local Government.

7.7 Sustainability drivers

The test in PPS25 means that development is directed first to Flood Zone 1, to avoid places of higher flood risk. But it is not always possible for development to be in the lowest risk areas and flood risk is not the only consideration. There are strategic sustainability drivers to be taken into account. These are key matters, which determine the broad sustainability of plans and proposals. They are a mix of targets, objectives and constraints. The drivers shape the plans' objectives, policies and proposals. Singly or together those drivers may justify having development in higher risk areas as an exception if the drivers mean it cannot be delivered only in the low risk areas. If necessary, development in higher risk areas must pass the Exception Test set out in PPS25.

The 'development plan' for the plan area is the main source of the strategic drivers. It must be taken into account when determining applications. Development Plan Documents are updating the existing development plans. When adopted, those Documents will replace the adopted Local Plans.

8 RECOMMENDATIONS AND CONCLUSIONS

Flooding is an important issue which must not be ignored. In the future it is likely that flooding could occur more frequently and with more severity due to climate change. By using this SFRA, in combination with site specific Flood Risk Assessments submitted with planning applications for development or change of use, it is possible to allocate land for development in a sustainable way. For example, new housing developments in areas at an unacceptable risk of flooding could be restricted and guided towards areas of lower risk and functional floodplain could be maintained or improved through areas at high risk of flooding.

- 1) Every application for development or change of land use must be considered by planning officers in terms of its potential flood risk using the GIS information supplied as part of this study. This is because:
 - a) There are a range of potential sources of flood risk within W&PBC including fluvial and tidal influences, surface water runoff, channel obstructions and ground water.
 - b) Most areas within W&PBC have the potential to be at risk of flooding from at least one of these sources or have the potential to increase flood risk elsewhere.
 - c) Although a site may already be developed, a proposed change in land use may not be suitable for that site, or may increase flood risk elsewhere.
 - d) Climate change may increase areas at risk of flooding over time. Land should be allocated today in a way which will be sustainable in the future.
 - e) Where development is proposed behind existing flood defences it should not be assumed that the standard of protection originally designed for is the same as what would be found today, using updated flood estimation techniques.
- 2) The data and information contained within this SRFA constitutes the best available data at the time of writing. Some GIS datasets are periodically updated and it is advised that W&PBC update these accordingly. Details of the datasets to update can be found in Appendix A. This will ensure that decisions are made by W&PBC using the best available data at all times.
- 3) Land which is found to be unsuitable for certain types of development (residential) due to flood risk, may still be suitable for other uses, for example environmental and recreational areas. The PPS25 guidance in conjunction with the PPS25 Decision Flow Charts (Appendix D) can be used to suggest suitable alternative land uses.
- 4) If the site has potential flood risk, Vulnerability Classifications (section 6.4) must be applied and the relevant PPS25 Decision Flow Chart (Appendix D) should then be used to test whether the land is suitable for the development proposed, and if so, whether a specific Flood Risk Assessment is required. This is to be completed by the developer.
- 5) If a specific Flood Risk Assessment is required, this must be submitted with the planning application. Planning officers, developers and the general public should consult the PPS25 best practice advice and refer to sections 3 and 4 which cover types of flooding and management of flooding.
- 6) All site specific Flood Risk Assessments must be considered by the EA as part of the planning consultation process. It is recommended that EA comment is taken seriously and applied wherever possible.

- 7) The Strategic Flood Risk Assessment should be used in testing general locations for strategic growth and site specific allocations in the Local Development Frameworks being produced by the Local Planning Authorities. This includes investigating the impact of proposals for new development in the vicinity of, and particularly upstream of, areas sensitive to flooding (where there have been past flood events).
- 8) The Local Development Frameworks, through their policies, justification and proposals, should make clear the implications for development and regeneration particularly regarding town centres in areas of high flood risk, including where there is risk of rapid inundation and reflect the guidance in this SFRA. This will need to reflect any programmes and proposals, or otherwise, for providing or improving flood defences.
- 9) This SFRA is a working document that will require updating in the future in order to fulfil changes to Government guidance and recommendations from the EA. As Local Development Framework policies should reflect the guidance in this SFRA they will need to be reviewed as and when the SFRA is updated.

REFERENCES

- *Chiswell Strategic Flood Risk Assessment*, (2006), Royal Haskoning
- *Dorset Rural Profile*, (December 2002)
- *Planning Policy Statement 25: Development and Flood Risk (PPS25)*, (December 2006), Department for Communities and Local Government
- *PPS25 Practice Guide (June 2008)*, Department for Communities and Local Government
- *Environment Data book*
- *Lanehouse Stream Flood Risk Assessment, Final Report*, (June 2005), Royal Haskoning
- *Level B 2002-4 South Coast tidal mapping study*
- *Lodmoor Site of Special Scientific Interest Water Level Management Plan, Deposit Copy*, (October 2002), Royal Haskoning
- *Durlston Head to Rame Head Shoreline Management Plan 2 (Draft, 2009)* Halcrow
- *Lyme Bay and South Devon Shoreline Management Plan*, (June 1998), Posford Duvivier
- *Portland Bill to Durlston Head Shoreline Management Plan*, (June 1998)
- *Portland Census Town Profile* (2005)
- *Preston Beach Weymouth – Volume 1 Interim Beach Management Plan*, (October 2001), Posford Duvivier
- *Preston Brook Flood Alleviation Scheme – Project Appraisal Report, Final Report*, (April 2003), Royal Haskoning
- *Proposed Modifications, Weymouth & Portland Local Plan Review*, (June 2005), Weymouth & Portland Borough Council
- *Proposed Planning Policy Statement 25: Development and Flood Risk (PPS25)*, (2005), ODPM Publications
- *Radipole Lake Site of Special Scientific Interest Water Level Management Plan, Deposit Copy* (September 2001), Royal Haskoning
- *River Jordan Feasibility Study – Report on Economics* (October 2005), Black & Veatch
- *River Jordan Feasibility Study – Report on Hydraulics* (October 2005), Black & Veatch
- *River Jordan Feasibility Study – Report on Hydrology* (October 2005), Black &

Veatch

- *River Jordan Feasibility Study – Stage 1 Report* (November 2005), Black & Veatch
- *Teignbridge District Council Strategic Flood Risk Assessment*, (October 2005), Royal Haskoning
- *Weymouth Census Town Profile* (2005)
- *Geological Maps; sheet 327 Bridport, sheet 328 Dorchester and sheet 341 & 342 West Fleet & Weymouth*

Websites

- www.ciria.org/flooding/reducing_the_impact.htm
- www.ciria.org/suds
- www.dorsetforyou.com
- www.environment-agency.gov.uk
- www.soton.ac.uk/~imw/portnew.htm
- www.weymouth.gov.uk

10 GLOSSARY OF TERMS

Catchment	The area contributing surface water flow to a point on a drainage or river system (the area drained by that river, including areas away from the watercourse network). Can be divided into sub-catchments.
EA Flood Zone 1	Little or no risk
EA Flood Zone 2	Low to medium risk. Probability of fluvial flooding is 0.1 – 1% and probability of tidal flooding is 0.1 – 0.5%
EA Flood Zone 3	High risk of flooding. Probability of fluvial flooding is 1% or greater and probability of tidal flooding is 0.5% or greater.
EA Flood Zone 3a	Developed areas of Flood Zone 3.
EA Flood Zone 3b	Functional floodplains of Flood Zone 3.
Environment Agency (EA)	Non-departmental public body responsible for the delivery of government policy relating to the environment and flood risk management in England and Wales.
Flood Defence	A structure (or system of structures) for the alleviation of fluvial or tidal flooding.
Flood Risk	The level of flood risk is the product of the frequency or likelihood of the flood events and their consequences (such as loss, damage, harm, distress and disruption).
Flood Risk Assessment	Considerations of the flood risks inherent in a project, leading to the development of actions to control, mitigate or accept them.
Floodplain	Any area of land over which water flows or is stored during a flood event, or would flow but for the presence of flood defences.
Fluvial	Pertaining to a watercourse (river or stream).
GIS	Geographical Information System. A computer-based system for capturing, storing, checking, integrating, manipulating, analysing and displaying data that are spatially referenced.
Groundwater	Water occurring below ground in natural formations (typically rocks, gravels and sand).
HEC RAS	Hydraulic modelling software.
Hydraulic model	A computerised model of a watercourse and floodplain to simulate water flows in rivers to estimate water levels and flood extents.
Lagoon	A pond designed for the settlement of suspended solids or storage of excess river flow.
Main River	Watercourses defined on a 'Main River Map' designated by DEFRA. The EA has permissive powers to carry out flood defence works, maintenance and operational activities for Main Rivers only.
Potential Flood Risk Area	The possible extent of flooding along watercourses that have not been covered by the EA Flood Zones.
PPG25	Planning Policy Guidance 25 for Development and Flood Risk.
PPS25	Planning Policy Statement 25: Development and Flood Risk.
Probability	The likelihood of an event occurring.

Return Period	The average time period between rainfall or flood events with the same intensity and effect.
Sheet runoff	The flow of water across the land surface which can occur when the rainfall rate exceeds the infiltration capacity of the soil.
Standard of protection	The level of flood that a defence is designed to protect against before it is outflanked or overtopped.
Surface Water Runoff	Water flowing over the ground surface to the drainage system. This occurs if the ground is impermeable, is saturated or if rainfall is particularly intense.
Sustainable Drainage Systems (SUDS)	A sequence of management practices and control structures designed to drain surface water in a more sustainable fashion than some conventional techniques.
Topography	The shape and form of the land, in terms of hills, steepness of slopes, or flat land

=O=O=O=

Appendix A - Data Sources & Data Quality

DATA SOURCES AND DATA QUALITY SUFFIX

Data Quality

All data that has been collected and produced for use in this study has been assigned a data quality suffix. This makes it easy to distinguish between qualities of data so that the need for future updates can be prioritised, and the reliability of the mapping can be judged easily. The Data Quality Suffix (DQS) system is described realistically in Table 1.

Table 1
Data Quality Suffix System

Data Quality Suffix	Description
A	Best of breed, no better available, unlikely to be improved upon in the near future.
B	Data with known deficiencies, to be replaced as soon as improved data is available
C	Gross assumptions, not made up but deduced from experience or related literature
D	Heroic assumptions, no reliable data sources available or found, data based on engineering judgement.

Datasets

Table 2
Information on source and quality of datasets used

Dataset	Notes	Source	Data Quality
10K Basemaps	Large scale full colour raster backdrop mapping giving detail such as fences, field boundaries, road names and buildings. Supplied in edge matched 5kmx5km tiles to create a seamless data layer. Visible up to a scale of 1:10000.	W&PBC	B
Aerial photos	Coverage supplied by GetMapping from October 2003 at a resolution of 25cm. Supplied in edge matched 10kmx10km tiles to create a seamless data layer. Visible up to a scale of 1:20000.	W&PBC	B
Contour Mapping	5m contours derived from 5m resolution Digital Terrain Model (DTM) supplied by Intermap. A DTM has had vegetation, buildings and other cultural features digitally removed using TerrainFit® software to derive terrain elevations based on measurements of bare ground contained in the original radar data. The vertical measures given are accurate to an average of 0.5m. Visible up to a scale of 1:10000. Filenames: <ul style="list-style-type: none"> • 5mcontour.shp 	W&PBC	B

Dataset	Notes	Source	Data Quality
Environment Agency Flood Zone 2	<p>Indicative of natural undefended floodplain (i.e. without defences) at the 1:1000 year event for fluvial and tidal data. Indicates whether flooding will be an issue in an area. Currently climate change not considered. Used to guide planning consultations and to raise awareness of flood risk. There is no attribution to distinguish between fluvial/tidal/fluvial and tidal.</p> <p><i>Currently update quarterly by direct Local Authority supply from the Environment Agency (EA)</i></p> <p>The Latest files were received March 2009 for the Level 1 update.</p> <p>Filenames:</p> <ul style="list-style-type: none"> • FLOOD_ZONE_2.shp 	EA	B
Environment Agency Flood Zone 3	<p>Indicative of natural undefended floodplain (i.e. without defences) at the 1:100 year event for fluvial data and at the 1:200 year event for tidal data. Indicates whether flooding will be an issue in an area. Currently climate change not considered. Used to guide planning consultations and to raise awareness of flood risk. There is an attribution to distinguish between fluvial/tidal/fluvial and tidal.</p> <p><i>Currently update quarterly by direct Local Authority supply from the EA.</i></p> <p>The Latest files were received March 2009 for the Level 1 update.</p> <p>Filenames:</p> <ul style="list-style-type: none"> • FLOOD_ZONE_3.shp 	EA	B
Environment Agency Historic Flood Map	<p>The maximum extent of all recorded flood outlines combined together taking into account the presence of defences. Derived from flood event outlines.</p> <p>This data is updated based on reconnaissance work after flood events.</p> <p>Filename:</p> <ul style="list-style-type: none"> • HFM.shp 	EA	B
Flooding Incidents recorded by Environment Agency	<p>Different sources of flooding for geo-referenced features affected by flood incidents. Derived from the EA Flood Reconnaissance Information System (FRIS) maintained by Dorset Area office.</p> <p><i>W&PBC may wish to request an annual update of</i></p>	EA	C

Dataset	Notes	Source	Data Quality
	<p><i>this data from the EA Dorset Area office to keep this up to date.</i></p> <p>Filename:</p> <ul style="list-style-type: none"> Weymouth_&_Portland_Incidents.shp 		
Flooding Incidents recorded by W&PBC	<p>Information taken from historic flooding maps held by W&PBC.</p> <p>Filename:</p> <p>WPBC_Historic_Flooding.shp</p>	W&PBC	D
FRIS Properties	<p>Geo-referenced dataset highlighting properties known to have flooded internally. Derived from the EA Flood Reconnaissance Information System (FRIS) maintained by Dorset Area office.</p> <p><i>W&PBC may wish to request an annual update of this data from the EA Dorset Area office to keep this up to date.</i></p> <p>Filename:</p> <ul style="list-style-type: none"> W&P_FRIS_Properties.shp 	EA	C
NFCDD Defences	<p>A defence is a natural or constructed entity which retains, stores or channels water. It is a component of a flood defence system that protects an area from flooding from a river, estuary and/or the sea e.g. weirs, groynes and provides a locality with its standard of flood defence.</p> <p>This data has been sourced from the EA National Flood and Coastal Defence Database (NFCDD) as maintained by the Dorset Area office. Whilst confidence in the quality of the fluvial defence data is high work is currently being planned for the improvement of coastal defence data. <i>This dataset is currently not complete. W&PBC may wish to liaise with EA Dorset Area Office to ensure the dataset is up-to-date.</i></p> <p>Filename:</p> <ul style="list-style-type: none"> Defences_polyline.shp 	EA	B
Potential Flood Risk Area	<p>Indicative of natural undefended floodplain (i.e. without defences) at the 1:100 year event for watercourses not mapped by the EA. These generally tend to be small watercourses and in the upper reaches of the catchment. Used to guide planning consultations and to raise awareness of flood risk. Low confidence.</p> <p>Filename:</p> <ul style="list-style-type: none"> Potential_Flood_Risk_Area.shp 	RH	D

Dataset	Notes	Source	Data Quality
W&PBC Boundary	Weymouth & Portland Borough Council Boundary supplied by Ordnance Survey Boundary Line. <ul style="list-style-type: none"> boundary.shp 	W&PBC	A
W&PBC Defences	Proposed and existing defences as identified by W&PBC. This is not a complete inventory of information. <i>W&PBC may wish to update this layer as and when further details of existing and proposed defence schemes become available.</i> Filename: W&PBC_Defences.shp	W&PBC	D
W&PBC Defences (detail)	Outline detail of certain existing W&PBC Defences. <i>W&PBC may wish to update this layer as and when further details of existing and proposed defence schemes become available.</i> Filenames: <ul style="list-style-type: none"> W&PBC_Defences_detail.shp 	W&PBC	A
W&PBC Notes & Observations	Notes with geo-referenced locations produced from meetings between W&PBC and RH. More detailed lines have been produced where accurate information is known and flow routes have been plotted in select locations. Filenames: <ul style="list-style-type: none"> W&PBC_notes&observations.shp W&PBC_notes&observations_lines.shp WPBC_direction_of_floods.shp 	W&PBC	C

Appendix B - Methodology for mapping potential flood risk areas

ROYAL HASKONING POTENTIAL FLOOD RISK AREA METHOD

Flood zones have been produced by the Environment Agency for all the main rivers and some of the ordinary watercourses in the Weymouth & Portland Borough Council area, leaving the smaller watercourses with no mapped floodplain.

To give a rough idea of the Potential Flood Risk Areas for these smaller watercourses, we developed a simple method to represent the possible extent of flooding.

This method used site visits, LiDAR DTM data, 2m contour mapping (created by RH from LiDAR) and engineering experience to indicate an approximate boundary for a 1% probability (1 in 100 years) fluvial event.

It must be noted that this boundary is an estimate. Any development proposed within or near to the boundary of a Potential Flood Risk Area requires a detailed FRA to determine a more accurate flood extent, taking into account climate change.

The rules used to produce this boundary were:

- Assume that in rural areas the floodplain will extend approximately 1m from the river (average floodplain extent for rural watercourses of this nature in relatively low risk locations)
- Assume that in urban areas the floodplain will extend approximately 2m from the river. (average floodplain extent for urban watercourses of this nature taking into account the increased potential risk to property and assets)
- At bridges and other constrictions the flow will back up slightly on the upstream side of the bridge.
- In very steep areas the flood boundary will not be drawn as the flow will be significantly constrained by the topography.

Appendix C - Methodology for mapping climate change

METHODOLOGY FOR CALCULATING FLOOD EXTENTS WITH CLIMATE CHANGE

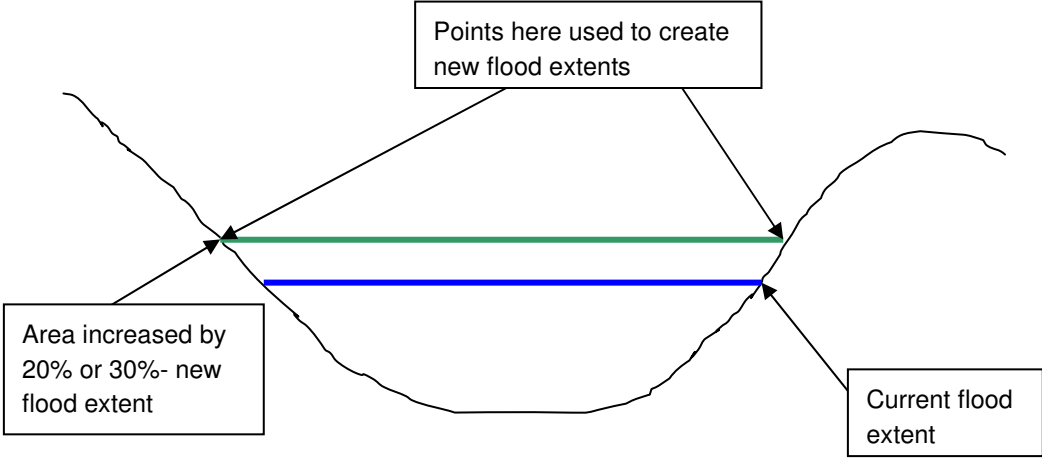
This document sets out a methodology prepared by Royal Haskoning for the calculation of new flood extents based on an increase in flow of 20% as a result of climate change. It requires the use of existing flood extent information such as Flood Zone 3 data from the Environment Agency (EA) and high resolution DTM data such as LiDAR.

This methodology has been developed for ArcView 3.2a and requires the following extensions and scripts:

- Spatial Analyst extension
- 3D Analyst extension
- XTools extension
- Lidar Tools extension (including Profile Extractor)
- Createtranssects.ave

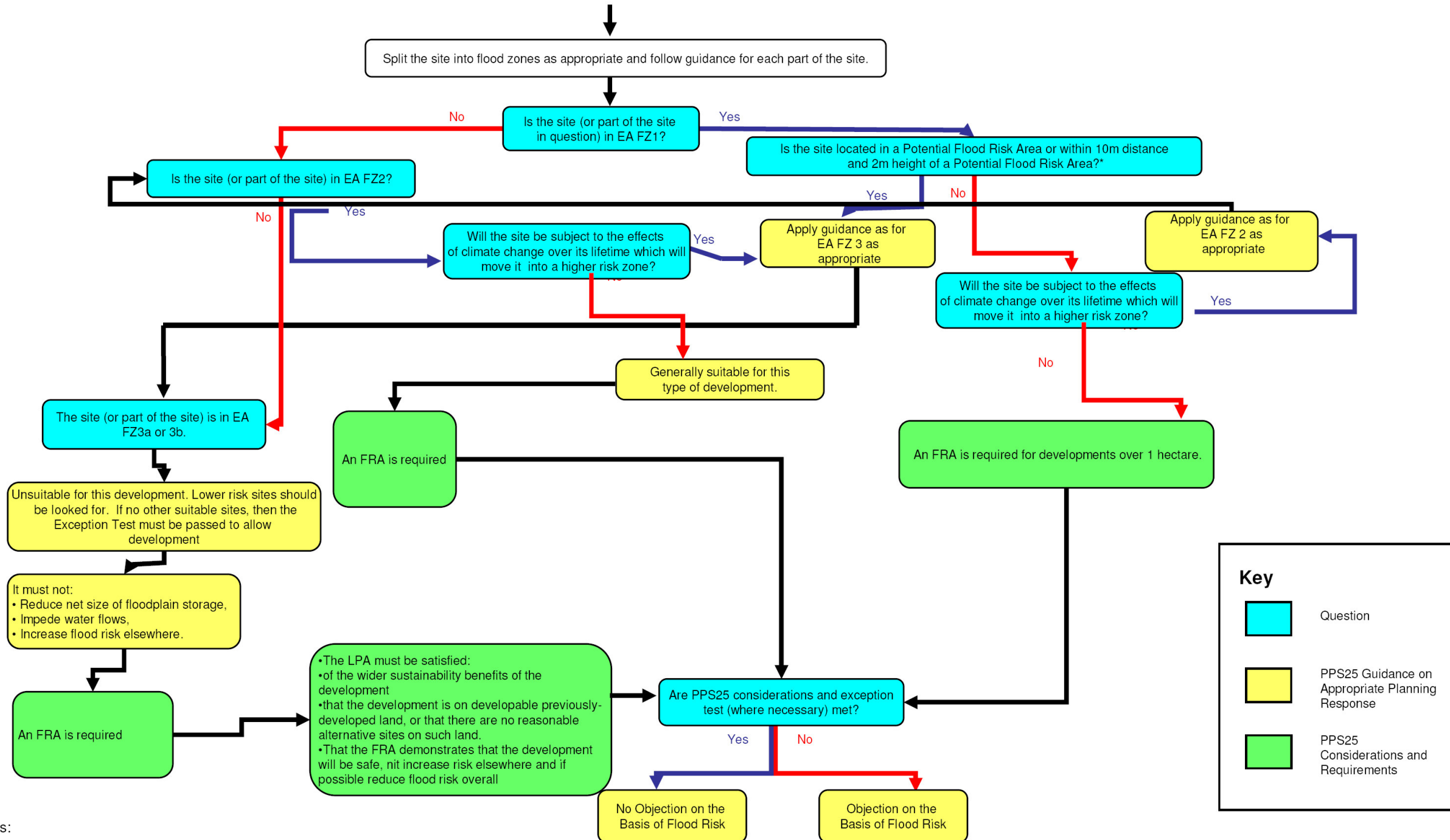
Method:

1	Identify the watercourse features (and associated flood extents) that are to be used for the assessment. Clip the data down to the relevant areas if required. One method to do this is to create a density map (using spatial analyst) from flood events such as the EA FRIS (Flood Reconnaissance database) and determine a suitable density threshold level to use to define areas of study.
2	Prepare the watercourse data by checking if it is digitised in the direction of flow with each separate named tributary saved as a polyline or multi-polyline. Using the script createtranssects.ave create the cross sections (as graphics) at 90 degrees to each watercourse spacing the sections at 50m (urban areas) or 100m (rural areas). The length of each cross section should be sufficient to cover the estimated new flood extent and 200-500m is suggested (this can be trimmed back later) Using the xtools extension save these graphics as a shapefile.
3	Prepare the cross section shapefile by assigning each cross section with a unique ID (a numeric value based on the shapefile index is sufficient). Also add columns for the cross section level and the level plus climate change.
4	Using Profile Extractor and LiDAR data calculate the height at which the cross section crosses the existing flood extent for both left and right banks, which may not be the same for each bank due to differences in scale when the mapping was first carried out. Calculate the average height and record in the level column. The length of the cross section may need adjusting based on the topography especially if the banks are raised either side of the channel. As the existing flood extent may have been produced without the use of LiDAR data some of the levels identified may need adjusting to prevent the watercourse flowing uphill.
5	It can be assumed for the purposes of this study that gradient, roughness and velocity will remain constant for an increase in flow. Therefore using $Q=VA$ where Q =Flow, V =Velocity and A =Area an increase of 20% in flow is equivalent to an increase of 20% in area respectively. Therefore the

	<p>increase in depth can be determined from the new area and how it fits the LiDAR data.</p> <p>If this is not possible the height could be determined by dividing the increase in area by the width (x) of the current flood extent $h = \frac{0.2A}{x}$</p> <p>However this method is less satisfactory as it will assume a rectangular area of increase and not take account of increases at the channel sides.</p>
6	<p>Using the initial average level obtained from the LiDAR determine the cross sectional area produced when water fills the channel to this depth. Calculate what value a 20% increase in area will give and then try different incremental levels to produce the nearest value to this area. Record the level against each cross section in the climate change column. Repeat for all cross sections.</p>
7	<p>Using the climate change levels produce a TIN of the cross section data and use this to 'flood' the LiDAR information to produce an indication of flood extents. Map these new flood extents into a shapefile to produce a new flood extent outline for the selected areas.</p>
8	<p>Carry out a visual check followed by manual adjustment to the new flood extents to verify and look for any situations where the new flood extent may be below the original Flood Zone 3 extent due to the horizontal issues noted in 4 above.</p>  <p>The diagram illustrates a cross-section of a channel with a curved bottom. Two horizontal lines represent flood extents: a blue line for the 'Current flood extent' and a green line for the 'Area increased by 20% or 30% - new flood extent'. The green line is positioned higher than the blue line. A box at the top points to the channel walls with the text 'Points here used to create new flood extents'. A box on the left points to the area between the two lines with the text 'Area increased by 20% or 30% - new flood extent'. A box on the right points to the blue line with the text 'Current flood extent'.</p>

Appendix D - PPS25 Decision Flow Charts

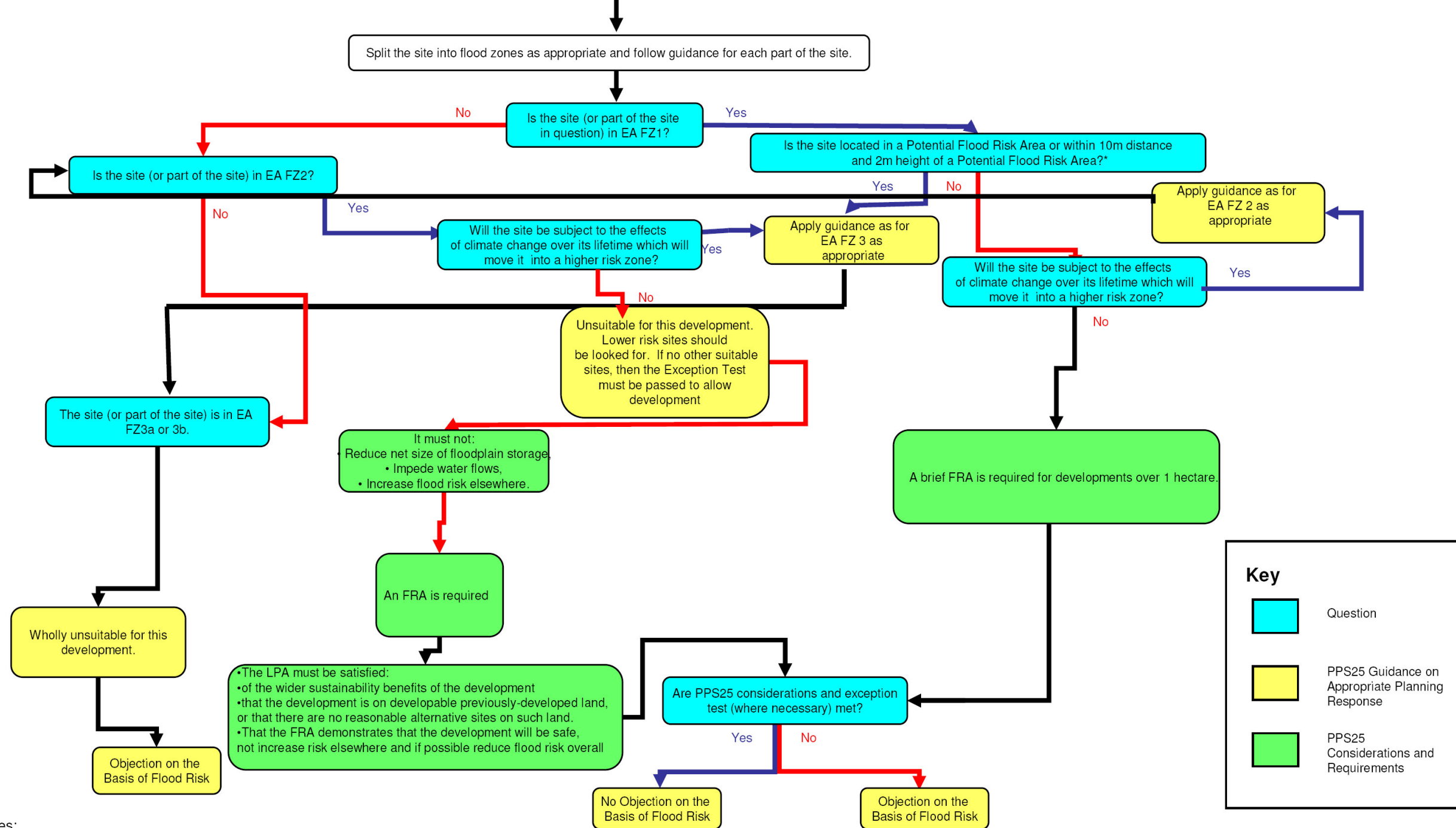
PPS25 Flow Chart 1 – Essential Infrastructure



Notes:

- All risks relate to the time at which a land allocation decision is made or an application submitted
- Development should not be permitted where existing sea or river defences, properly maintained, would not provide an acceptable standard of safety over the lifetime of the development, as such land would be extremely vulnerable should a flood defence embankment or sea wall be breached, in particular because of the speed of flooding in such circumstances.
- Minimum standard of defence for fluvial risk areas is 1:100 + climate change, and for tidal risk areas is 1:200 + climate change.
- Information above based on Section 2 of the SFRA. Refer to PPS25 for more detailed guidance.
- *This width and height allowance of 10m and 2m is to take into account the potential increase in the extent of the Potential Flood Risk Area due to climate change and the large uncertainty in the extents of the Potential Flood Risk Areas.

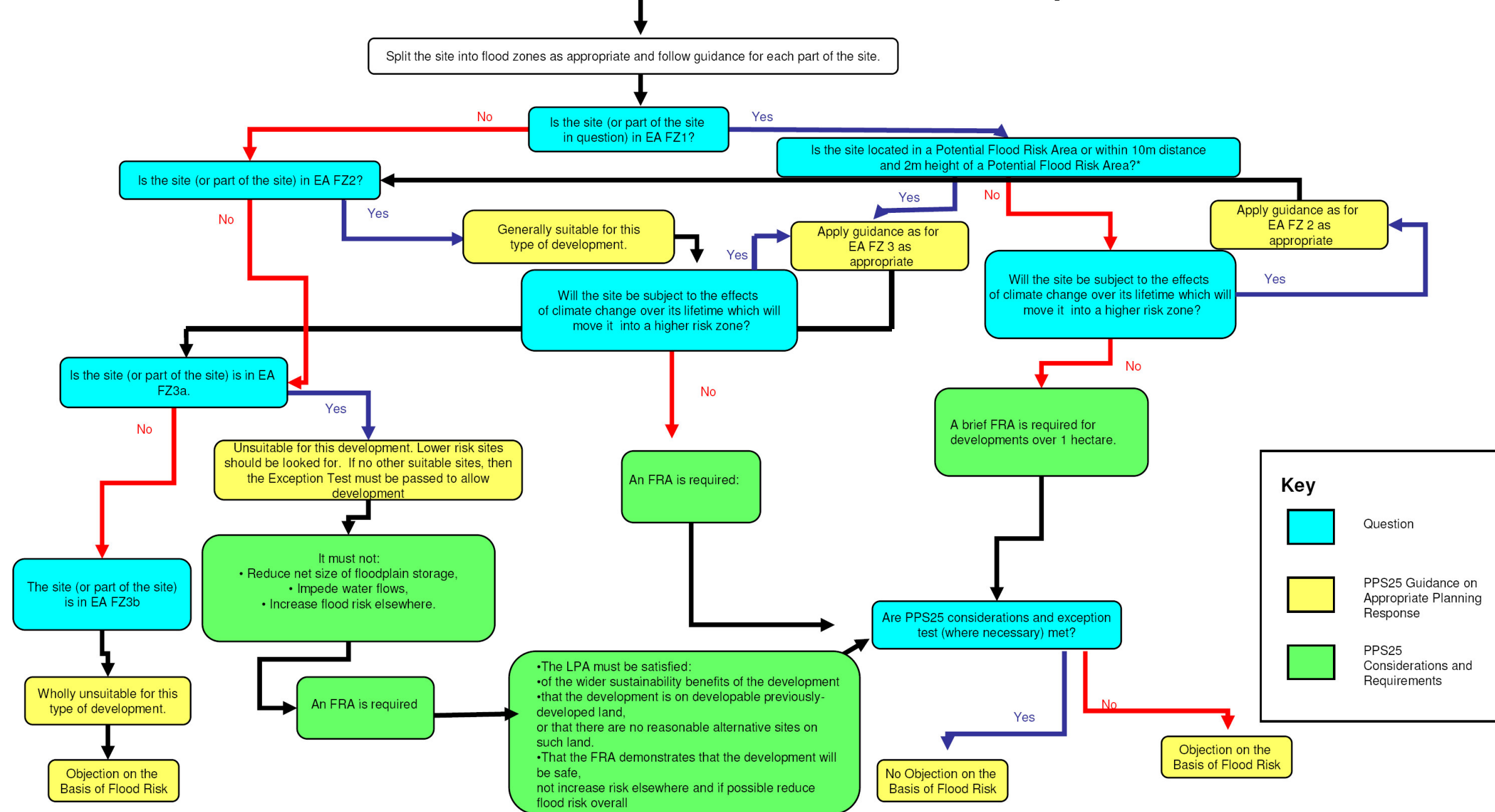
PPS25 Flow Chart 2 – Highly Vulnerable Developments



Notes:

- All risks relate to the time at which a land allocation decision is made or an application submitted
- Development should not be permitted where existing sea or river defences, properly maintained, would not provide an acceptable standard of safety over the lifetime of the development, as such land would be extremely vulnerable should a flood defence embankment or sea wall be breached, in particular because of the speed of flooding in such circumstances.
- Minimum standard of defence for fluvial risk areas is 1:100 + climate change, and for tidal risk areas is 1:200 + climate change.
- Information above based on Section 2 in the SFRA. Refer to PPS25 for more detailed guidance.
- *This width and height allowance of 10m and 2m is to take into account the potential increase in the extent of the Potential Flood Risk Area due to climate change and the large uncertainty in the extents of the Potential Flood Risk Areas.

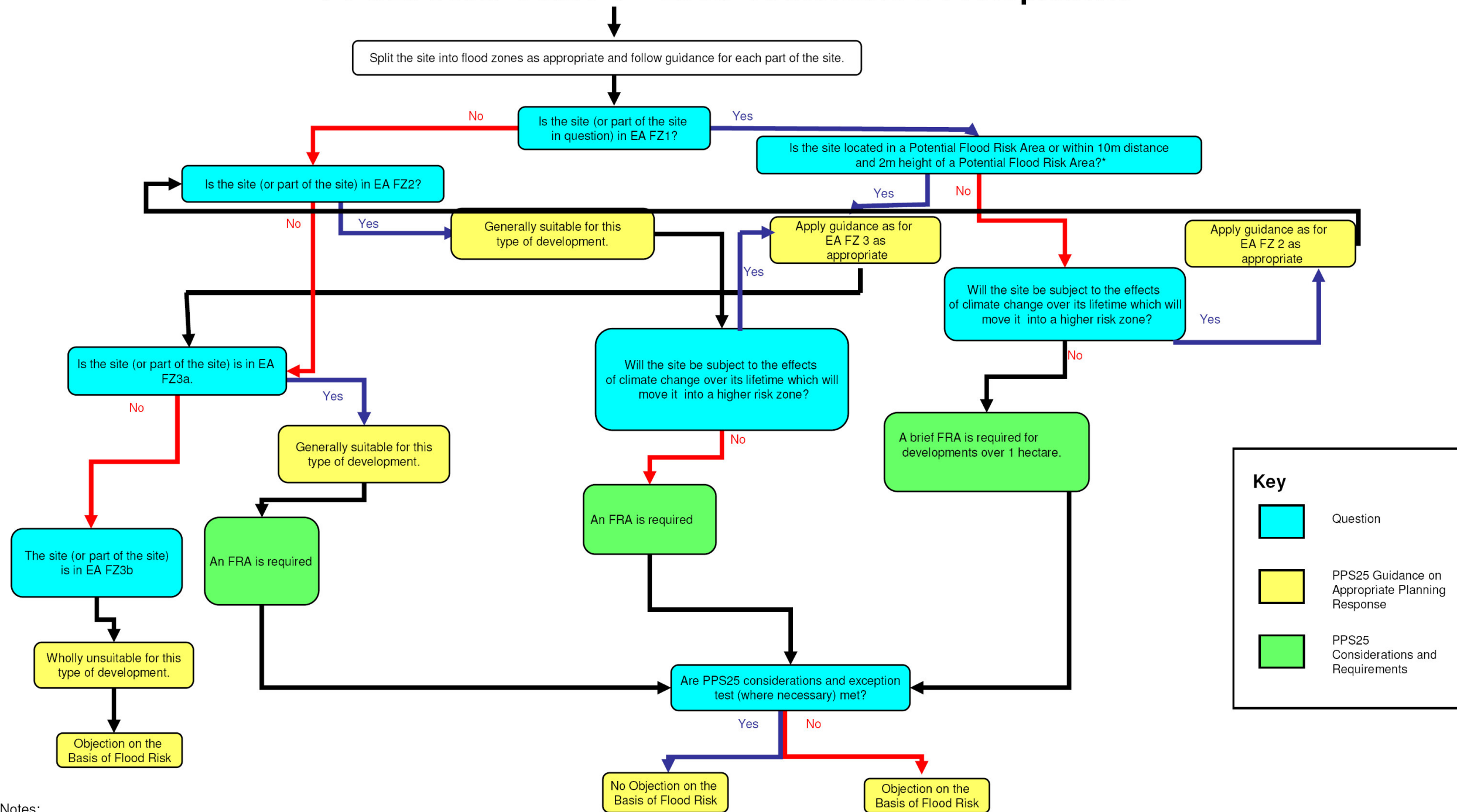
PPS25 Flow Chart 3 – More Vulnerable Developments



Notes:

1. All risks relate to the time at which a land allocation decision is made or an application submitted
2. Development should not be permitted where existing sea or river defences, properly maintained, would not provide an acceptable standard of safety over the lifetime of the development, as such land would be extremely vulnerable should a flood defence embankment or sea wall be breached, in particular because of the speed of flooding in such circumstances.
3. Minimum standard of defence for fluvial risk areas is 1:100 + climate change, and for tidal risk areas is 1:200 + climate change.
4. Information above based on Section 2 in the SFRA. Refer to PPS25 for more detailed guidance.
5. *This width and height allowance of 10m and 2m is to take into account the potential increase in the extent of the Potential Flood Risk Area due to climate change and the large uncertainty in the extents of the Potential Flood Risk Areas.

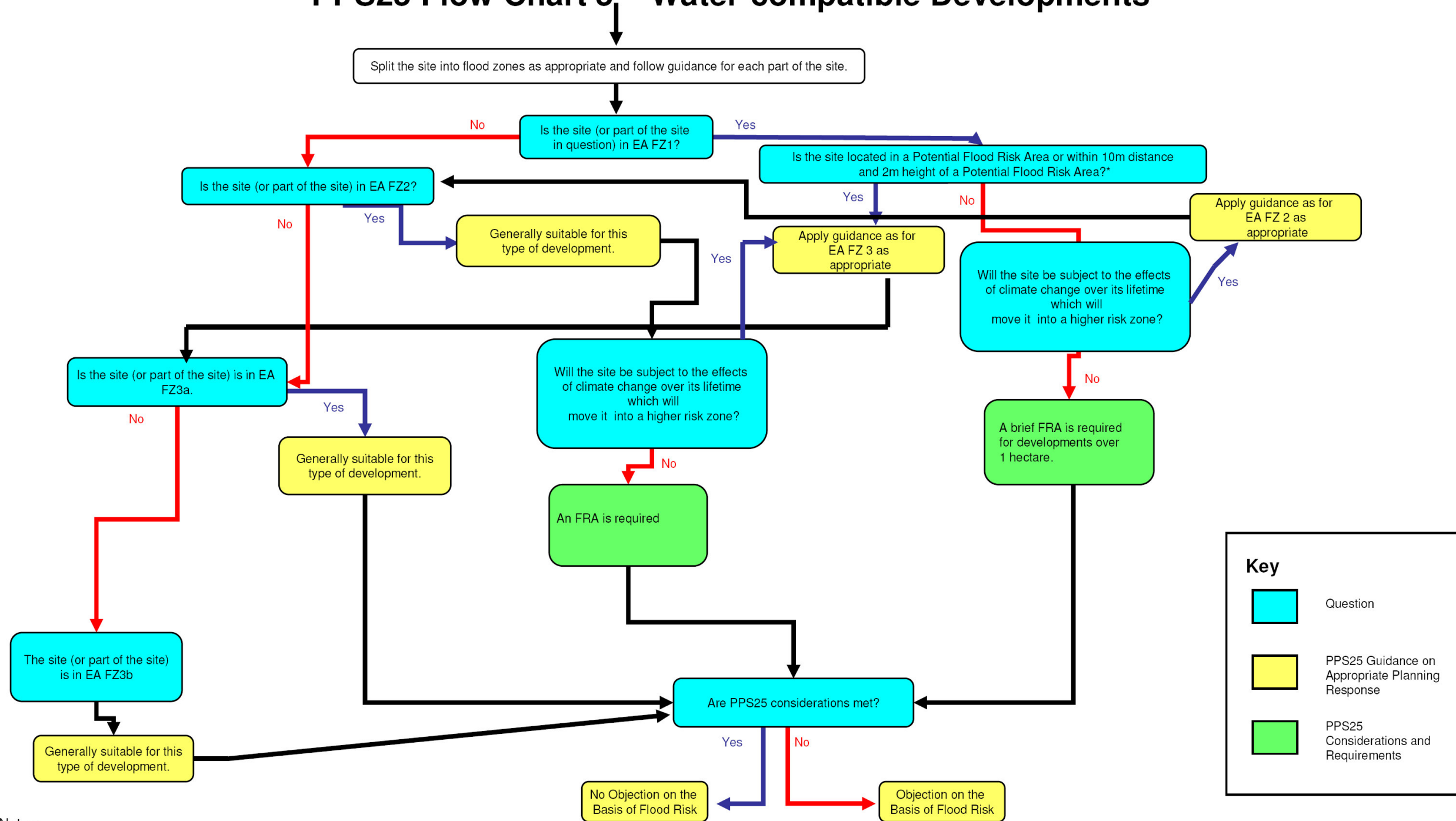
PPS25 Flow Chart 4 – Less Vulnerable Developments



Notes:

- All risks relate to the time at which a land allocation decision is made or an application submitted
- Development should not be permitted where existing sea or river defences, properly maintained, would not provide an acceptable standard of safety over the lifetime of the development, as such land would be extremely vulnerable should a flood defence embankment or sea wall be breached, in particular because of the speed of flooding in such circumstances.
- Minimum standard of defence for fluvial risk areas is 1:100 + climate change, and for tidal risk areas is 1:200 + climate change.
- Information above based on Section 2 in the SFRA. Refer to PPS25 for more detailed guidance.
- *This width and height allowance of 10m and 2m is to take into account the potential increase in the extent of the Potential Flood Risk Area due to climate change and the large uncertainty in the extents of the Potential Flood Risk Areas.

PPS25 Flow Chart 5 – Water-compatible Developments



Key

- Question
- PPS25 Guidance on Appropriate Planning Response
- PPS25 Considerations and Requirements

Notes:

1. All risks relate to the time at which a land allocation decision is made or an application submitted
2. Development should not be permitted where existing sea or river defences, properly maintained, would not provide an acceptable standard of safety over the lifetime of the development, as such land would be extremely vulnerable should a flood defence embankment or sea wall be breached, in particular because of the speed of flooding in such circumstances.
3. Minimum standard of defence for fluvial risk areas is 1:100 + climate change, and for tidal risk areas is 1:200 + climate change.
4. Information above based on Section 2 in the SFRA. Refer to PPS25 for more detailed guidance.
5. *This width and height allowance of 10m and 2m is to take into account the potential increase in the extent of the Potential Flood Risk Area due to climate change and the large uncertainty in the extents of the Potential Flood Risk Areas.

Appendix E - Guidance for developing housing in a flood resistant manner

GUIDANCE FOR DEVELOPING HOUSING IN A FLOOD RESISTANT MANNER

PPS25 states that development situated in EA Flood Zones 2 or 3 may be required to be built using flood resistant construction.

Exterior Construction

There are several measures to improve flood resistance of a wall using mortar, sealants and fillers. These measures include applying waterproof sealant to the outside face (ideally a breathable sealant), raising the level of the damp proof course, injection of fillers, closing cavities and ensuring there are no cracks or voids in the brickwork.

Excluding water will help reduce damage to the internal fabric of the building and its contents. If water does enter the house, flood resistant building materials will reduce the effects of the water and can reduce the cost of repairs.

Interior Construction

One of the most effective ways of reducing the impact of flooding is to raise the floor level of the property above expected flood levels. If this is not practical, another is to have flooring that can withstand being under water. Chipboard flooring is likely to be damaged by floodwater, so more resistant materials such as treated floorboards, WBP plywood, screed or tiles will be more suitable in flood risk areas. Fixtures that cannot be removed before a flood and might be damaged by exposure to water, such as carpets, parquet and laminate wooden floors should be avoided.

Where internal flooding cannot be avoided, some form of drainage of the water immediately post flood is recommended. In addition to protecting flooring, utility supplies should also be protected so that they can still be used in the event of internal property flooding.

- **Electricity**
If there is sufficient space, the meter and fuse box should be positioned at a level which is higher than the expected flood level.
Modern wiring is not usually affected by flooding, but long immersion may result in the need to replace wiring. Moving the ground floor ring main cables to first floor level could be considered with drop down cables to ground floor sockets. Sockets should also be raised to an appropriate height above flood levels. A further consideration is to have the house wired so that the ground floor main can be switched off, leaving the supply to the upper floors still available.
- **Gas supply**
As gas meters can be affected by floodwater it is worth considering raising meters above the expected flood levels. Provision should be made for purging gas supply pipes through the installation of appropriate valves and drain points.
- **Central heating systems**
Gas and oil fired boilers and associated pumps and controls should preferably be installed above the maximum expected flood level. Pipe insulation below the expected flood level should preferably be replaced with closed cell insulation. If new

heating is being installed, pipework routes should be made easily accessible to allow pipes to be maintained and washed down following flooding.

- **Water supply**
Water pipework insulation can be replaced with flood resistant closed cell material below the expected flooding level.
- **Telephone and cable services**
Suppliers of the relevant services should be consulted on suitable installation methods in areas liable to flooding. Where possible, incoming telephone lines and internal control boxes should be raised above the expected flood levels.
- **Oil storage tanks**
Oil tanks can be damaged during floods and can cause pollution. To avoid this it should be ensured that the tank is anchored down so that it does not float. In addition the oil feed from the tank should incorporate a stop valve at the end nearest the tank so that the tank contents will not be lost if the tank moves and the pipe breaks.

The information above is a summary of the CIRIA Advice Sheets. All the advice sheets, and further guidance for homeowners and developers, can be downloaded from www.ciria.org/flooding/reducing_the_impact.htm