Environment Agency

Thames Estuary 2100

Managing flood risk through London and the Thames estuary

TE2100 Plan

November 2012

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Foreword

David Wardle
Thames Estuary Programme
Executive Manager
Environment Agency

I am pleased to present our Thames Estuary 2100 (TE2100) Plan. This document sets out our recommendations for flood risk management for London and the Thames estuary through to the end of the century and beyond. London and the Thames estuary communities benefit from a robust and well organised system of tidal flood risk management but increasing pressures, including climate change, mean that flood risk is increasing. The Government's 2004 Foresight[1] project reviewed the long-term impact of climate change on the UK and concluded that "Hard choices need to be taken – we must either invest more in sustainable approaches to flood and coastal management or learn to live with increased flooding."

TE2100 is the first major flood risk project in the UK to have put climate change adaptation at its core. It also falls within our national aim to act to reduce climate change and its consequences. Working with the Met Office Hadley Centre and other key organisations, we have used the latest science and improved our understanding of future climate change impacts in the Thames estuary. This gives us confidence that our Plan is adaptable to future climate change.

Flooding, from any source, can cause great distress and disturbance to those who experience it. The summer 2007 floods in the north-east and west midlands, highlighted in the recent Pitt Review[2], were an unwelcome reminder of the devastation that unpredictable high intensity rainfall, and river flooding can bring to local communities. The primary risk of flooding to the Thames estuary communities however is from the sea. It is this tidal flood risk that this Plan seeks to manage. The potential impacts of a tidal flood could be far more catastrophic than those from rivers or surface drains. However some of the lessons learned in the Pitt Review are equally relevant. We recognise in this Plan the importance of working in partnership with other organisations to improve our preparedness for flooding, and in reducing the consequences of a tidal flood in the unlikely event it happens.

"Hard choices need to be taken – we must either invest more in sustainable approaches to flood and coastal management or learn to live with increased flooding[3]."

Our Plan is needed to provide confidence to those who live and work in London and the Thames estuary area that flood risk is understood and is manageable. Planners and investors will be reassured that there is an effective plan to manage flood risk today and for future generations.

A primary purpose of the TE2100 project has been to plan proactively for the future rather than waiting for the next flood catastrophe to provoke society into action. Our Plan is founded on sound science and an understanding of the opportunities and constraints in the Thames estuary, with adaptability to future change at its heart.

Our Plan is the result of many years of serious investigation, study and dialogue with planners, investors and those who live and work in the Thames estuary tidal flood risk area. We have

[1] KING, D., 2004. Foresight: Future Flooding. London: Office of Science and Technology

[2] PITT, M., 2008. Learning Lessons from the 2007 Floods. London: Cabinet Office

[3] KING, D., 2004. Foresight: Future Flooding. London: Office of Science and Technology

consulted with a wide range of partners throughout the development of this Plan and worked hard to ensure that the plans and strategies of other organisations are able to take account of our ideas as we have progressed. I am delighted that the Greater London Authority's Climate Change Adaptation Strategy and Communities and Local Government's Thames Gateway Eco-Region Prospectus, to name but two, have already identified our work in helping to deliver their objectives. This demonstrates that we cannot plan for the future alone; we must work together to ensure mutual success.

Finally, we welcome the time and effort that organisations and the public have taken to contribute to our public consultation, which has added to the wealth of information we already have on the Estuary. The information and views supplied have helped us to adapt our Plan so that all partners can make the right flood management decisions for people and the environment on the Thames estuary. Our Action Plan has been designed to support and facilitate the multi-partner approach that is needed to ensure a successful implementation of the TE2100 Plan.

Understanding the icons and navigation

The icons below are used throughout this document to help communicate important messages.

Time horizons

The following icons are used to illustrate three distinct phases defining the actions required over the Short, Medium and Long Term. The icon colours are also used as a highlight behind text as an additional visual aid.

Flood risk management policy

The following icons are used to illustrate the five levels of flood risk management policies.

Information icon

The following icon is used to signify that more information is available.

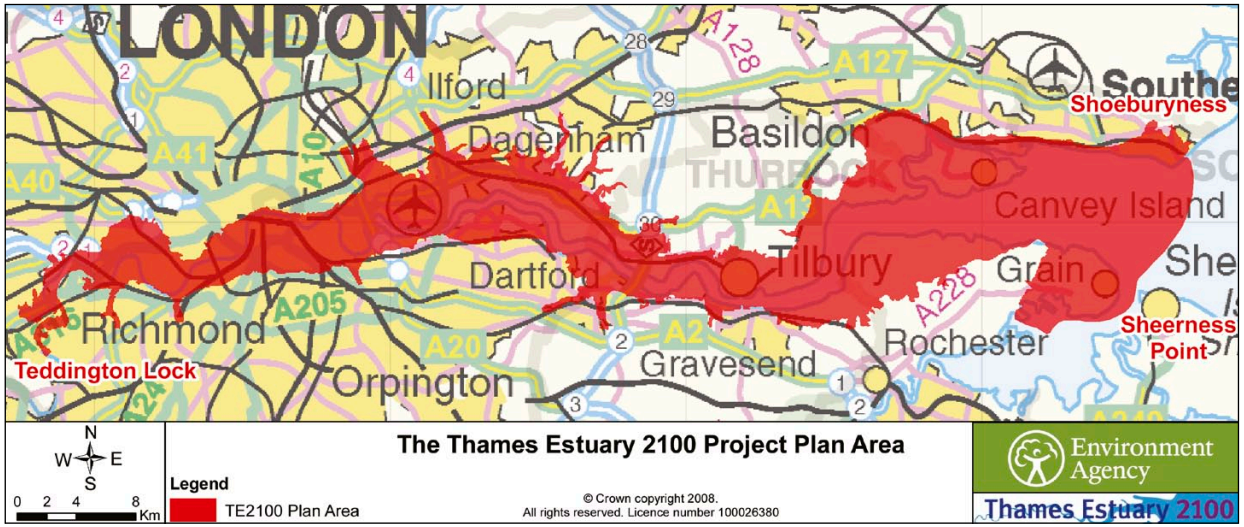
Colour-coded page navigation

The following colour-coded page tabs are used for cross-referencing the policy units within each of the action zones. Each action zone is identified by a different colour.

Contents

Thames Estuary 2100

The Thames Estuary 2100 project was established by the Environment Agency in 2002 with the aim of developing a strategic flood risk management plan for London and the Thames estuary through to the end of the century. The Plan primarily looks at tidal flooding, though other sources of flooding including high river flows as a result of heavy rainfall and surface water flooding are considered. The key driver for the project was to consider how tidal flood risk was likely to change in response to future changes in climate and people and property in the floodplain. Additional to this there was an understanding that many of the existing flood walls, embankments and barriers were getting older and would need to be raised or replaced to manage rising water levels. It was time to plan for the future and make recommendations on what actions were needed to adapt to a changing estuary.



Over six years we undertook a wide range of studies and worked with many organisations across the Thames estuary to gain a thorough understanding of how flood risk is managed today, and the options and actions that could manage tidal flooding through this century.

The TE2100 Plan covers the tidal Thames and its floodplain from Teddington in the west to Sheerness/Shoeburyness in the east. It connects our adjoining catchment flood management plans (CFMPs), which cover non-tidal flood risk management, with the shoreline management plans (SMPs) in Kent and Essex, which cover coastal flood and erosion risk management. This suite of plans sets the strategic direction for future flood risk management in the areas which adjoin the Thames estuary and it is important that each plan supports the others and they all work well together.

The good news is that we start our planning from a position of strength. We have a world class system of tidal flood risk management which includes the Thames Barrier and associated defences. Our TE2100 investigations have shown that there is greater capacity in the current flood management system than had been previously understood. This means that although we must maintain our high standards of maintenance and operation and make some improvements, major changes to the structure of the system will not be needed until much later in the century – under Government's current climate change guidance new arrangements must be in place by 2070.

What does this Plan contain?

This Plan sets out the recommendations and actions that are needed to manage flood risk through this century. In developing this Plan we have investigated and understood flood risk in the Estuary today, how it might change in the future and the many ways we can manage and adapt to those changes. In the Plan we describe:

- **The future shape of flood risk management and the range of options which can manage a change in water levels through this century.** To put together an estuary-wide approach requires local decisions on what action is needed alongside estuary-wide options to manage and reduce future flood risk. To achieve this we have split the Estuary into 23 policy units which share similar flooding characteristics and assets at risk. These are set out in Chapter 6.
- **How we have decided on the Plan through the assessment, appraisal and selection of what strategic action is needed and the range of options to achieve this.** We have appraised each of the 23 policy units considering the social, economic and environmental costs and benefits of undertaking future flood risk management activities. This has enabled us to set the policy or future direction of flood management at a local level. Each of the estuary-wide options that we have recommended have been appraised and their environmental impacts identified, along with how they comply with environmental legislation. This is explained in Chapter 7.
- **What local actions are needed in the short, medium and long term.** Who we need to work with to deliver the actions and how we think this can be done. We have taken the policies we have identified for each policy unit and identified the flood risk management actions that are needed to achieve them. We have split the action plans into three time horizons which are driven by our current understanding of how the climate is going to increase flood risk and the ability of the existing flood defences, spatial and emergency planning to manage it. The TE2100 action plan in Chapters 8 and 9 sets out the short, medium and long-term actions required by all implementation partners.
- **How we need to address the impact of rising sea-levels on the environment.** We have examined the impact of our existing flood defences on the internationally designated habitats along the margins of the Estuary. We estimate that during the life of our Plan, 1200 hectares of this important habitat will be lost through "coastal squeeze". As sea levels rise, these habitats are unable to migrate landwards because the defences are in the way, and the habitats are squeezed out of existence. These habitats support a wide range of plants and animals, all of which make the Estuary not only a beautiful place but a valuable place. Estuarine mudflats and saltmarshes provide the feeding and breeding grounds for commercial fish and shellfish. We have a responsibility to replace these habitats and our recommendations for potential sites are set out in the TE2100 action plan in Chapters 8 and 9.

The Plan is explained in Chapter 5 and supported by the TE2100 Technical Report, Statement of Environmental Particulars and Environmental Report.

Should you wish to find out more detail about a particular aspect of the Plan these reports and their supporting annexes can be made available. Details on how to find these are in Chapter 10.

What does the Plan do?

It will direct our future work on flood warning, flood plain management and expenditure needed to maintain and replace the 330 km of walls, embankments, flood barrier and gates.

It will inform the work and expenditure of our partners who are responsible for flood planning and recovery such as local authorities, resilience planning forums and the "blue light" services.

It will provide key information and actions for regional and local government to inform their spatial plans and help them make decisions on new and regenerated developments across the floodplain.

It will raise awareness and improve the knowledge of tidal flooding for people living and working in the floodplain, as well as those building new homes and businesses and those involved in insurance and conveyancing of properties.

Public consultation and how it has shaped this Plan

Consultation has played an important part in the development of the TE2100 Plan. As well as the public consultation on the draft Plan which took place between April and July 2009, we had two earlier consultations in 2005 and 2008 on key early findings of the project. The 2005 and 2008 consultations were each supported by a programme of public meetings and a web based consultation. At every stage in the development of our Plan we have invited people to tell us their views and have taken these into account as the Plan developed.

As well as understanding the views of different communities, we have built up relationships with groups and organisations who will play a key role in the future implementation of the TE2100 Plan.

Public consultation on the draft TE2100 Plan

Between April and July 2009 we undertook our public consultation on the draft TE2100 Plan. This was our most far reaching public consultation to date. We held 15 local workshops and public meetings across the Estuary, and had over 50 meetings with key organisations, to provide stakeholders with an opportunity to feed back and ask questions on any aspect of the Plan or its recommendations.

We received over 120 written responses to the consultation. These have been used to inform our Plan.

What's changed in the final TE2100 Plan because of public consultation

Important changes have been made to the Plan as a result of our public consultation. These are summarised in the table on pages 8–9.

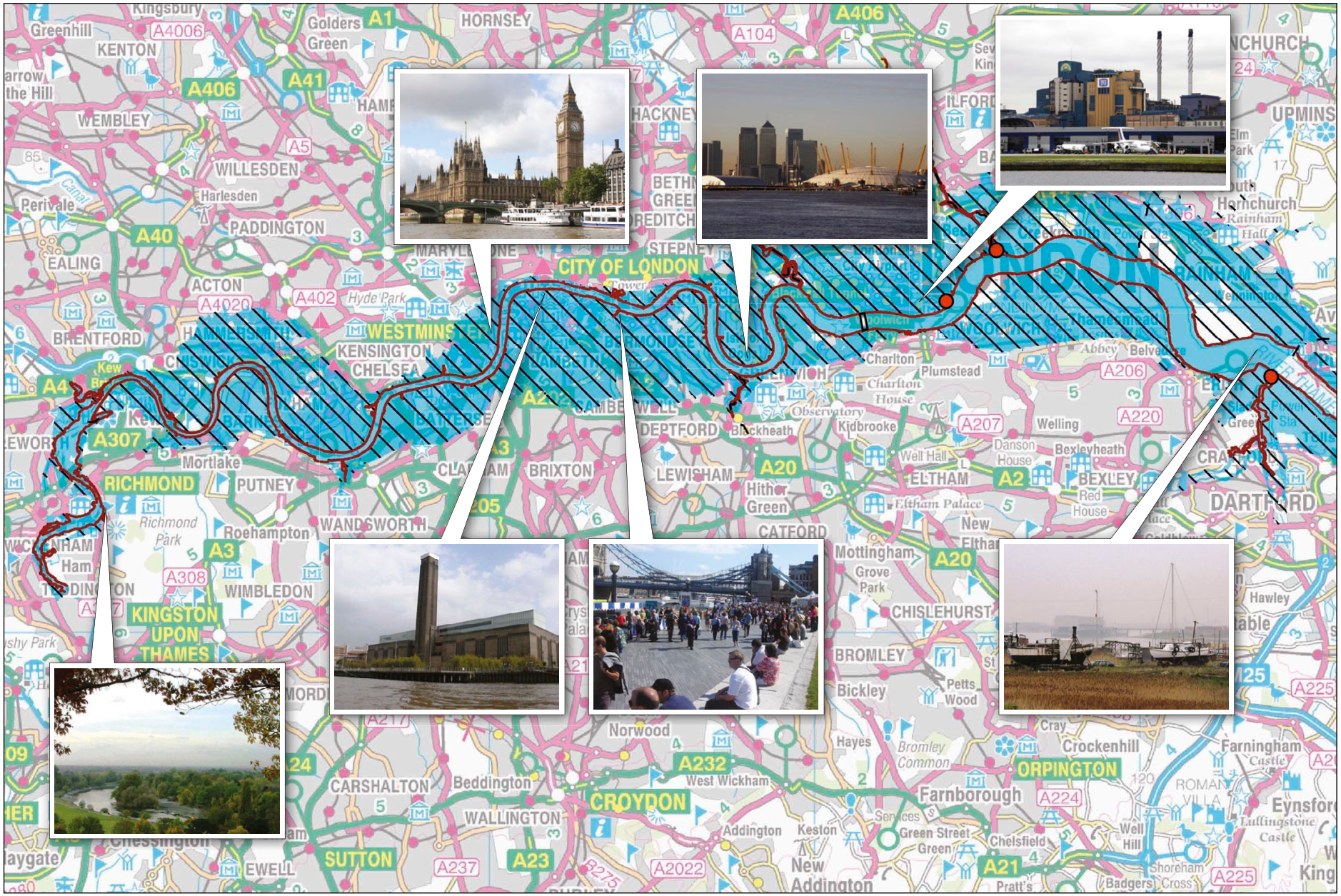
Table 1.1 How is the TE2100 final Plan different from the draft?

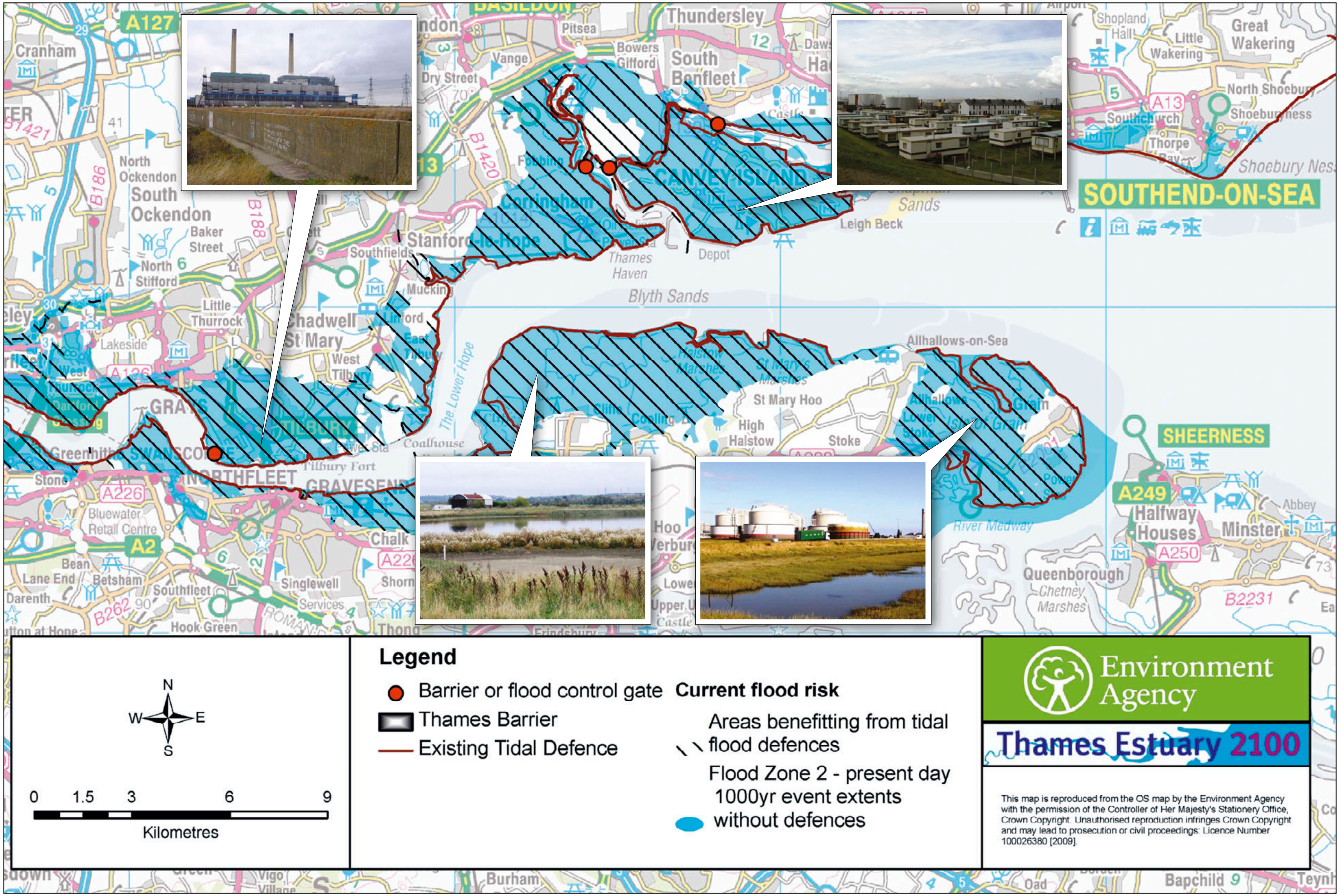
Changes made	What this means
Identified our preferred sites for intertidal habitat creation and revised the amount of compensatory habitat required	Habitat creation on selected sites in the Thames estuary will create enough intertidal habitat to satisfy our requirements up to 2100. Delivery of these sites will be based on comprehensive public consultation, maximising partnership opportunities in the Estuary and consideration of our indicators for change. Successful habitat creation on these sites will create enough intertidal habitat to satisfy our requirements up to 2050. We do not know what conditions will exist in the Estuary after this time. If climate change mitigation worldwide has been unsuccessful, the Estuary will look very different indeed and the choices for us all will be stark. However, if climate change mitigation has been successful then the choices will be easier and more varied. The TE2100 recommendations for the second half of the century, including further intertidal habitat requirements, will be made around 2050. They will be based on a comprehensive public consultation and consideration of our indicators for change at that time. Our initial studies indicated that 1200ha of intertidal habitat were required. However, further work has indicated that this number can be reduced to approximately 1000ha (details can be found in the Greater Thames Catchment Habitat Management Plan, CHaMP).
Changed our recommended flood risk management policy for Hadleigh Marshes and Two Tree Island	As a result of information provided to us during the consultation about contaminated land on Hadleigh Marshes and Two Tree Island we have reappraised and amended our flood risk management policy for the area. The P2 policy (reduce current action to manage flood risk) has been changed to a P3 policy (maintain the flood defences at their current level accepting that as sea level rises flood risk will increase) to reflect the environmental damage that could be caused if contaminated materials contained within the defences were to leach out into the river. This highlights the constraints that are placed on flood risk management by land contamination. Alongside reappraising the flood risk management policy for Hadleigh Marsh and Two Tree Island we have strengthened Action 6.4 (see action tables in Chapter 9) highlighting the urgent need to investigate land contamination issues in the area.

Table 1.1 How is the TE2100 final Plan different from the draft? (continued)

Changes made	What this means
Amended our indicators for change	Suggested improvements in the wording and emphasis of our indicators for changes have been accepted in some cases. In addition, a new indicator has been added that takes account of other major changes that could affect the Plan. Examples of major changes include a major development that could affect the location of a new barrier, or a change in Government Policy.
Identified future implementation partners	A number of organisations and groups have told us that they or others should be included as future implementation partners of the Plan. We welcome this enthusiasm for involvement and we have added these partners to our action plan (see chapter 9).
Improved the way we describe our flood risk policies	Numerous comments from stakeholders highlighted confusion over what was actually meant by some of our policy descriptions. We changed the way we describe our P3 and P4 flood risk management policies to make them more succinct and easier to understand whilst remaining consistent with national policy descriptions.
Highlighted the historic value and sensitivity of key sites, historic landscapes and urban townscapes in the Estuary	A number of consultation responses said that the Plan did not reflect the broad range of TE2100 studies on the historic sensitivity of the Thames estuary (reported in the TE2100 Strategic Environmental Assessment and Environmental Report). Others told us that the text in our Plan did not sufficiently appreciate the importance of particular historic landscapes or urban townscapes as well as the historic importance of some key sites in the Estuary. We have used this feedback to improve the way we describe the Estuary characteristics in chapter 9 of the Plan.
New glossary of key terms and abbreviations	To improve the clarity of the Plan text we have added a glossary of key terms and abbreviations.
Included cost estimates for floodplain management	Many of our local authority and transport and service provider implementation partners asked for more details on the provision of their part of the TE2100 Plan actions which are not related to the operation, maintenance and improvement of defences and flood warning – and were therefore not included in the presentation of costs. In preparing our TE2100 final Plan we have included costs and further details for this essential floodplain management activity to enable Local Authority and other partners to plan with confidence as an integral part of the TE2100 Plan implementation.
Changed the time horizons for implementation and profile of expenditure over the century	Many of our stakeholders felt that it was difficult to comment on decisions that would be made late in the century, but were happy to relate to decisions and planning to the middle of the century. Following discussions with these implementation partners together with a review of additional information on costs and lead-in times for the major end of the century option, we have adjusted the time horizons for implementation to reflect the fact that work must start on the end of the century option well in advance of 2070 – so that it is ready for use by 2070. The first 25 years (2010–2034) period remains the same but now includes third party costs for floodplain management. The middle transition period has been reduced from 35 to 15 years (2035–2049). The final time horizon (from 2050) will see the end of the century option, planned, designed and constructed taking the flood risk management in the Thames estuary into the 22nd century [all dates based on current climate change guidance].

Chapter 2: The Thames estuary – tidal flood risk today




Legend
Barrier or flood control gate
Thames Barrier
Existing Tidal Defence
Current flood risk
Areas benefitting from tidal flood defences
Flood Zone 2 - present day 1000yr event extents without defences
N
W
E
S
0 1.5 3 6 9
Kilometres
Environment Agency
Thames Estuary 2100
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SOUTHEND-ON-SEA
SHEERNESS
CANVEY ISLAND
Thundersley
South Benfleet
Stanford-le-Hope
Corringham
South Ockendon
North Ockendon
Chadwell St Mary
TILBURY
GRAVESEND
NORTHFLEET
SWANSCOMBE
Allhallows-on-Sea
St Mary Hoo
High Halstow
Stoke
Queenborough
Halfway Houses
Minster
Shoeburyness
Great Wakering
Little Wakering
Blyth Sands
Leigh Beck
Thames Haven
River Medway
Isle of Grain
Bluewater Retail Centre
Lakeside
Southfleet
Hook Green
A127
A13
A2
A226
A249
A250
A1089
B1420
B188
B186
B262
B2231

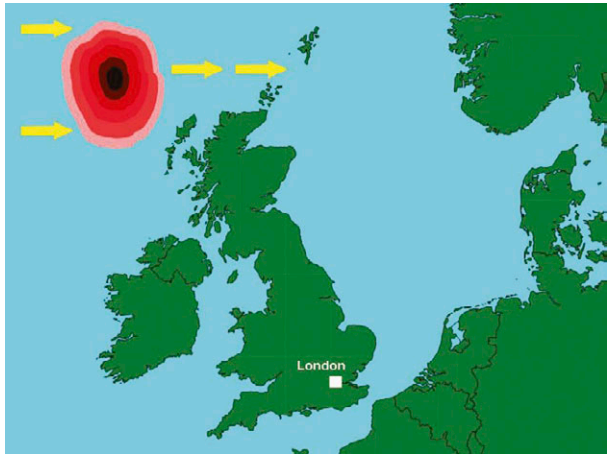
Sources of flooding on the Thames estuary

The Thames estuary is the meeting place of the freshwater River Thames, its many tributaries and the North Sea. The blue floodplain on the map on the previous page shows the extent of the area which could flood from a combination of freshwater flow and tidal waters. Everyday, twice a day the freshwater Thames which flows across Teddington Weir in west London is met by the incoming tide from the North Sea. The Thames estuary has an average daily rise and fall of water levels of 7 m.

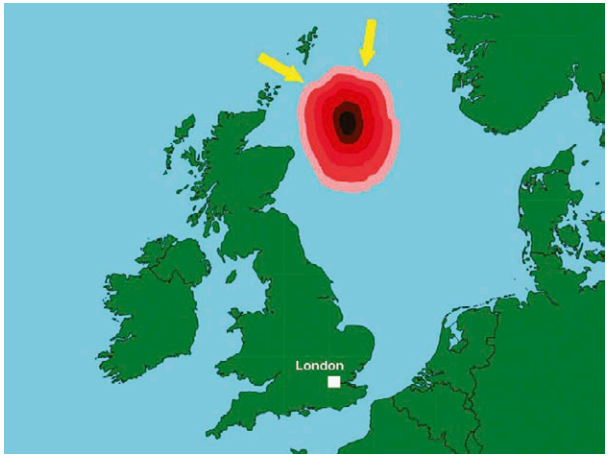
In addition to the daily tides, the Thames estuary is prone to an increase in water levels caused by a North Sea surge. Surge tides occur when a band of low pressure or 'depression' moves across the Atlantic towards the British Isles, the sea under it rises above the normal level creating a hump of water. This hump moves with the depression, passing the north of Scotland and moves south into the North Sea. A surge tide happens when this mass of water moves down the east coast of England, growing higher as it gets squeezed between our coastline and mainland Europe's, and funnels up the Thames estuary. On top of this, strong northerly winds can further increase the height of the surge. A surge tide entering the Thames estuary can increase water levels by 1 to 3 m and can be a major flood threat especially if this happens during a 'spring' tide when normal tide levels are higher.

The Thames flowing over Teddington Weir

Low tide at Tower beach



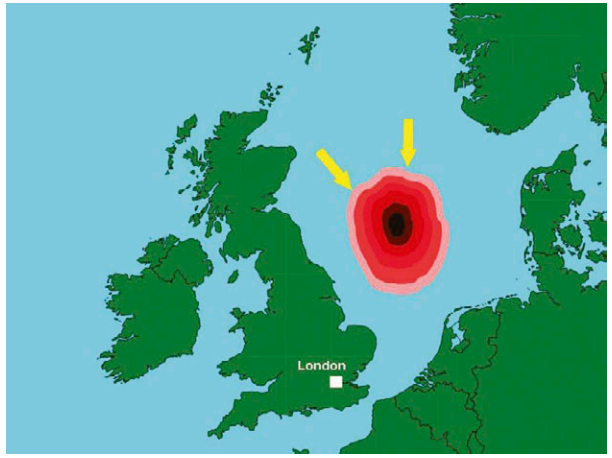
Storm surge; depression originating in the Atlantic



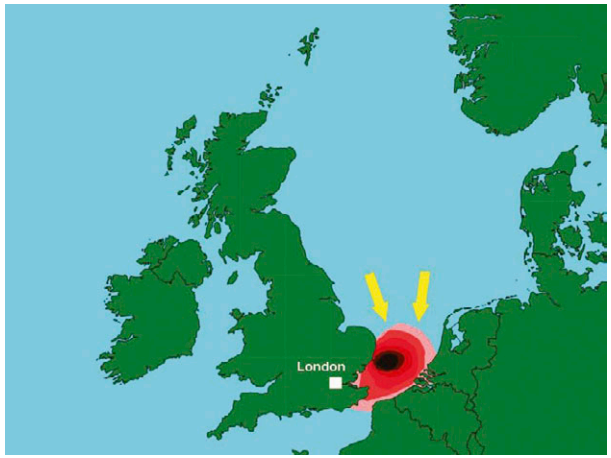
Depression passes Northern Scotland and enters the North Sea

High tide in central London

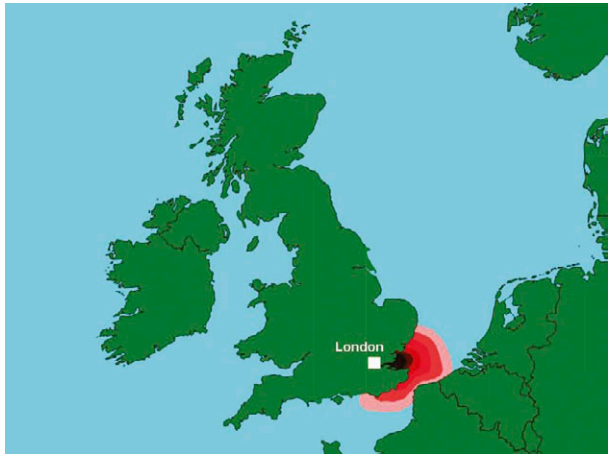
Surge tide event at the Thames Barrier



Surge moves down the East Coast towards the Thames estuary



Surge tide approaches the Thames estuary



Surge tide enters the Thames estuary

What is at risk?

The Thames tidal floodplain forms a corridor which passes through London and eastwards through North Kent and South Essex towards the North Sea. In addition to the large number of people who live and work on the floodplains, there are vital institutional and business centres and heritage sites. These include the Houses of Parliament, central and local government buildings, the Canary Wharf business district, the Tower of London and the National Theatre. There are also major transport links and numerous schools, hospitals, power stations and other key sites. The assets and people at risk in the tidal Thames floodplain are summarised in the table.

Table 2.1 Assets and people at risk in the tidal Thames floodplain

350 sq km land area
55 sq km designated habitat sites
1.25 million residents (plus commuters, tourists and other visitors)
Over 500,000 homes
40,000 commercial and industrial properties
£200 billion current property value
Key Government buildings
over 3100 hectares of sensitive heritage sites
400 schools
16 hospitals
8 Power stations
More than 1000 electricity substations
4 World Heritage sites
Art galleries and historic buildings
167 km of railway
35 Tube stations
51 Rail stations (25 mainline, 25 DLR, 1 international)
Over 300 km of Roads


Daily Mirror
FORWARD WITH THE PEOPLE
200 DEATH-ROLL IS FEARED AS
Two to whom death came in a night of terror . . .
SEA-FLOOD HORROR STRIKES BRITAIN

Newspaper headline following 1953 flood

What is at stake? 1: Central and local government

Despite some dispersal of central government functions to the regions over recent decades, most recently following the 2004 Lyons Review of Public Sector relocation, London remains a vital seat of government and parliamentary activity for the UK and the city region. The central government district of Whitehall is wholly within the natural Thames floodplain, as are the Houses of Parliament and the Greater London Authority's City Hall. Much of Pimlico and Victoria, where significant government offices are also situated, are similarly vulnerable. This includes Westminster City Hall. Hammersmith, Tower Hamlets and Lewisham town halls are also within the natural floodplains of the Thames or its tributaries.

Despite business continuity arrangements for major crises, the costs of dislocation to public sector activity and Parliament arising from a major flood in central London would still be severe. As an illustration of just one consequence of a day's flood in London; if the London-based central civil service (numbering 87,000 people) lost only one working day after a major tidal flood, the cost in lost staff time alone is estimated at £10 million.

Source of data: LYONS, M., 2004. Well Placed to Deliver?, London: HM Treasury

What is at stake? 2: Commerce

London is the UK's largest urban cluster of economic activity, contributing some £250 billion in goods and services annually. A number of its business sectors are important players internationally. In particular, the financial and business services sectors operate in the global marketplace alongside New York and Frankfurt. Although the traditional "square mile" of the city of London is outside the natural floodplain of the Thames, the more recent centre of Docklands (left) is wholly within it. Whilst well protected against flooding now, climate change will make existing defences vulnerable, and the costs of a major flood would be severe in terms of damage and disruption.

The costs to the London financial sector are particularly significant because its competitors are in other international centres, so any economic costs will tend to be losses to the nation as a whole. This could also be true for the tourism sector as London's losses would to some extent be taken up by other European and international capitals, at least for a period.

Sources: GLA Economics, 2007, London's Economic Outlook: The GLA's medium-term planning projections, October 2007

What is at stake? 3: The people living and working in London

Some 1.25 million people live in the Thames tidal floodplain and are therefore vulnerable to flooding if the current defences were to fail or be overtaken by more serious flooding as a result of sea level rise induced by climate change. In addition, there are 400 schools at risk, so the basic infrastructure of family life would be seriously damaged and disrupted in a London-wide flood. Moreover, the facilities that would help recovery from a major flood are also at risk.

This applies to fire stations, police stations, clinics, and the shops and suppliers that would be needed to provide the necessary repair and replacement items damaged in the flood. There are 16 hospitals in the flood risk area, including major facilities such as St Thomas's and St Bartholomew's. Therefore not only would people's homes be damaged but the necessary conditions for response and recovery would themselves be unavailable to the population affected.

What is at stake? 4: Heritage and culture

The Thames estuary is rich with history and holds within it some of Britain's most visited sites, theatres, museums and art galleries.

The following are examples of assets which lie in the floodplain which could be affected by a major tidal flood which overwhelms existing defences:

- Westminster Abbey* and Cathedral
- Palace of Westminster* and Parliament Square
- Tate Gallery and Tate Modern
- Tilbury and Coalhouse forts
- Festival Hall, the South Bank Centre and the Globe
- Tower of London*
- Maritime Greenwich* and the Millennium Dome
- Bishops Park and Fulham Palace
- The historic marshlands of Kent and Essex
- Royal Botanic Gardens, Kew*
- Chiswick, Syon and Ham Houses.

* Part of UNESCO world heritage sites

In addition, there are a vast number of other, less well known, but locally valued assets at risk. In total, TE2100 estimates that there are over 3100 hectares[4] of sites across the Estuary floodplain with heritage value which would be highly sensitive to flooding. One illustrative indicator of worth is perhaps revenue from tourism, which currently stands at around £15 billion per annum.

[4] Sources: Capita Symonds and TE2100, 2006. Historic Sensitivity Mapping Report, July, 2006.

What is at stake? 5: The London Underground

The Underground is a central element of life in London. In addition to its vital transport role – fulfilling nearly 1 billion passenger journeys each year – the "Tube" is famously seen by Londoners as a refuge in time of crisis. However, serious flooding is one crisis in which the Underground would cease to perform either of its roles. With much of the central area of the Tube network below street level, and many of those streets being in the floodplain, the Underground is particularly vulnerable. There are 15 Underground stations in the Wandsworth to Deptford policy unit alone including Waterloo which is the busiest Tube station on the network, handling 46,000 passengers in each morning peak.

A major flood of the Tube could potentially disable the affected line or lines for an extended period, based on experience of flooding elsewhere (i.e. weeks if not months with no service). Clearly the costs of prolonged Tube closures to London's economy could be very significant. On one day (7 August 2002), flooding incurred a cost in passenger delays alone of £0.74 m. This figure does not include knock-on impacts on these or other users.

Sources: Passenger/journey numbers: http://www.tfl.gov.uk/tube/company/facts.asp; Delay costs from current rainfall-related flooding: Climate change and London's transport systems, LCCP/Atkins, Technical report, September 2005. Public domain photo

What is at stake? 6: Surface transport and commuting

Although the London Underground network is particularly vulnerable to increased flood risk in the Thames estuary, low-lying surface transport could also increasingly be affected by flood events, given current defence standards. Estuary-wide transport assets which could be at increased risk include the A13 trunk road, and the London, Tilbury and Southend, and North Kent, railway lines.

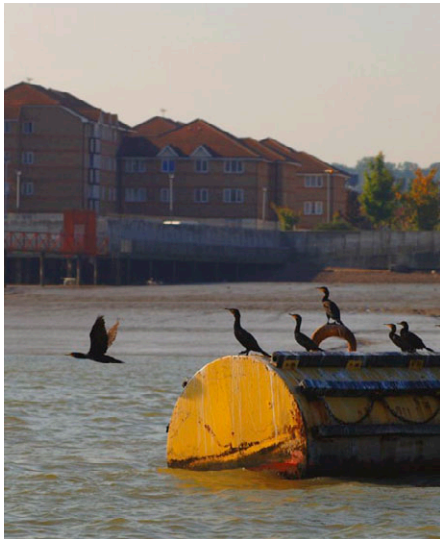
Under-Thames road tunnels at Dartford and Blackwall form part of national trunk routes and the costs arising from inundation – in terms of damage, delays and knock-on losses – could be very large.

At a more local level, the Wandsworth to Deptford TE2100 policy unit is a particular area in which transport assets would be vulnerable. This area contains a number of major rail lines, and Waterloo, Charing Cross, London Bridge and Clapham Junction railway stations (the latter reportedly the busiest station in Europe, with some 2000 trains passing through daily). Not all lines are elevated above the floodplain, and stations could be cut off by a major flood.

The costs of this in terms of disruption (if not actual damage) could be very large, given London's continued reliance on in-commuting.

Sources: Environment Agency flood mapping

What is at stake? 7: Nature conservation in the Estuary



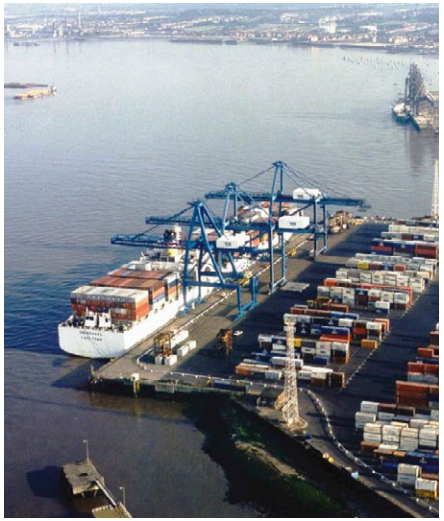
There are scores of important ecological sites at risk of flooding in the Thames estuary, many protected by national and international designations (e.g. Ramsar sites).

To take just a single example, one of very few ancient landscapes remaining in London is at Rainham Marshes. These medieval marshes right next to the River Thames were closed to the public for over 100 years and used as a military firing range.

The RSPB acquired the site in 2000 and set about transforming it into an important place for nature and an important visitor site. Now one can expect to see breeding wading birds in spring and summer, and large flocks of wild ducks in winter. Birds of prey and rare birds are regularly seen too. There are also water voles in the ditches and rare dragonflies are a common sight in summer.

Important bird species at Rainham include the Lapwings visiting during the year. Wintering birds are replaced by breeding birds in spring, and other birds that have bred further north pass through in summer and autumn. Also Little Egrets can now be seen here in large numbers throughout the year. The large concentrations of wildfowl and waders regularly attract hunting Peregrines – especially in autumn and winter.

What is at stake? 8: The Port of London



The Port of London Authority (PLA) comprises Tilbury and around 70 specialist wharves from Fulham to Canvey. The wharves are operated independently and handle a vast range of goods. The Port handles over 50 m tonnes of imports and exports (53.8 m tonnes in 2005, only 12% less than in 1964). London remains the largest UK port by traffic for non-fuel goods, and its market share is growing.

Research for the PLA suggests the Port generates over 35,000 full-time jobs and makes a total contribution to the UK economy of £3.4 bn each year. In 2005, the PLA itself had a turnover of nearly £41 m and an operating profit of £1.2 m. For the future, the biggest single development of London as a port could be the building of the London Gateway facility at Shell Haven, extending over nearly 170 hectares, 93 of them reclaimed from the Thames estuary.

Flood risk, and responses to it, both affect port and shipping operations, and are affected by them. Currently, the operation of flood barriers – particularly the Thames and Barking barriers – can have impacts on the passage of shipping with the potential for knock-on costs. Future flood risk solutions will need to be designed and built with shipping operations in mind.

Sources of data and photo: Port of London Authority

What is at stake? 9: The Thames Gateway

The Thames Gateway is the UK's largest regeneration programme, stretching 60 kilometers along the Thames estuary from the London Docklands to Southend in Essex and Sheerness in Kent. The government has committed to £9 billion to create thousands of new homes and jobs in the area.

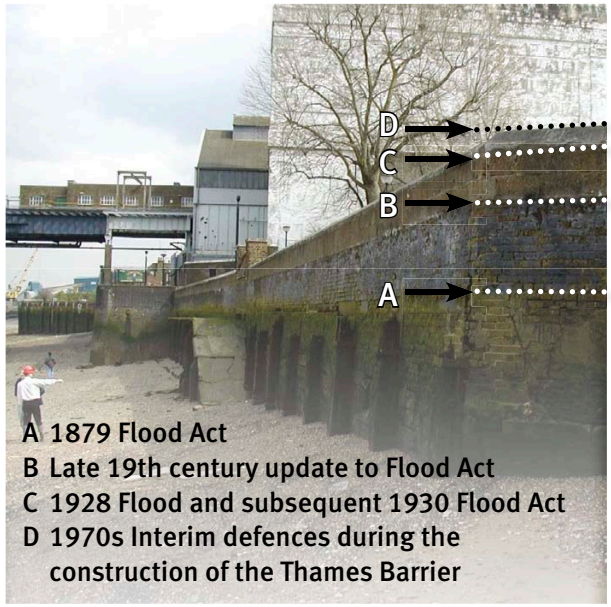
The Thames tidal floodplain cuts right through the Gateway, putting new homes and business at risk from flooding. Key growth areas such as Tilbury, east London and Dartford are all on the banks of the Thames and therefore at risk from flooding. To sustain the investment of central government, local authorities and other partners we need to ensure that communities in the Thames Gateway continue to benefit from the high standard of flood protection they have today, and that best practice principles for floodplain management are adopted in the new developments.

What has shaped how we manage tidal floods today?

Managing floods on the Thames estuary is not a recent activity. There were tidal defences on the Thames estuary more than 1500 years ago. These defences protected Anglo-Saxon settlements in Kent and Essex.

In the first century AD, the Romans built their city Londinium on the high ground which is today the 'square mile' of the city; well above the 5 m contour level which approximately defines the area of tidal flood risk today. But the successful expansion of London over the centuries saw it cover the adjoining marshlands, and as sea levels rose relative to land, the challenge of maintaining tidal defence for our capital city was born.

In the 17th century, Dutch engineers reclaimed Canvey Island and turned its three islands into one. Further upstream, with the construction of the docks, associated wharves and urban development, large areas of marshland on either side of the Estuary were reclaimed for a variety of uses including grazing marsh and agriculture. By the late 19th century, there was very little of the Thames estuary which had not been modified in some way by human intervention. The network of tidal defences required constant attention to keep pace with rising sea levels and the first of the London Flood Acts was passed following a series of damaging floods in London during the 19th century.



Response to floods past: river wall at Greenwich

There was a major tidal flood in 1928 and an even worse catastrophe in 1953. This was the catalyst for the construction of the Thames Barrier and the associated defence improvements in the 1980s.

The decision to build the Thames Barrier was taken on the advice of Sir Hermann Bondi, Government Chief Scientific Advisor during the 1960s. This followed the Waverley Committee, which reported in 1954 on the east coast floods, recommending a dual approach of engineering structures backed up with a considered approach to development in the floodplain.

We have been very successful in the first of these recommendations. The Thames Barrier and associated defences have provided confidence to London and the Thames estuary communities for 25 years. But we have been less successful in managing the consequence of flooding. Sir Hermann Bondi's statement remains as true today as it was 40 years ago.

Through our TE2100 plan we are promoting floodplain management as part of an integrated strategy for living successfully in the Thames tidal flood risk area as recommended by Waverley and Bondi.

> **"I have no doubt whatever in my mind that such a major surge flood in London would be a disaster of the singular and immense kind... It would be indeed a knock-out blow to the nerve centre of the country..."**
>
> H. Bondi, London Flood Barrier. Report to the Ministry of Housing and Local Government 1967.


Flood defences of the Thames estuary
Barking Creek Barrier
Fobbing Horse Barrier
East Haven Barrier
Benfleet Barrier
N
W
E
S
Basildon
Prittlebrook
Southend-on-Sea
Canvey Island
Shell Haven
Roding
Ingrebourne
Brent
Lea Valley
Barking & Dagenham
Royal Docks
London City
Rainham Marshes
Mar Dyke
Thamesmead
Hammersmith
Bermondsey
Greenwich
Tilbury
North Kent Marshes
Isle of Grain
Barnes
Ravensbourne
Quaggy
Cray
Dartford
Northfleet
Richmond
Wandle
Beverley Brook
Darent
Thames Barrier
KGV Dock Floodgate
Dartford Creek Barrier
Tilbury Dock Floodgate
Legend
Barriers and Gates
Walls and Embankments
Rivers
Urban Area
0 1 2 4 6 8 10
Km
Environment Agency
Thames Estuary 2100
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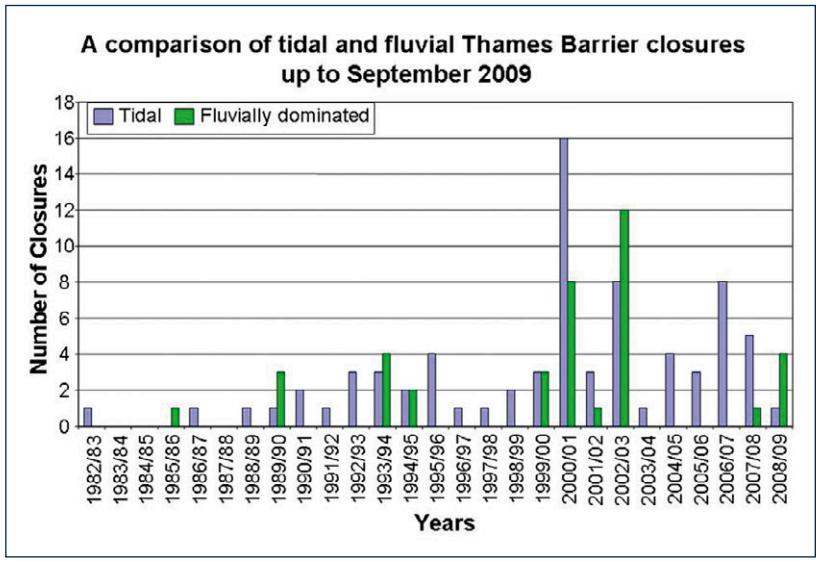
How tidal flood risk is managed today

Planning for and managing floods is the role of a number of organisations and individuals across the Thames estuary. Everyone has a role to play in managing and reducing flood risk now and in the future. The Thames tidal flood defence system is made up of the Thames Barrier and eight other major flood barriers owned and operated by the Environment Agency. It also includes 36 industrial flood gates, more than 400 smaller movable structures and over 330 km of walls and embankments which are in over 3000 different ownerships.

We, the Environment Agency, are responsible for delivering sustainable flood and coastal erosion risk management solutions and for overseeing the delivery of local solutions by others. Our job includes:

- understanding and planning for a changing climate;
- flood forecasting, warning and responding to floods;
- maintaining, renewing, improving and operating flood defences;
- overseeing the work on flood defences owned by others;
- providing advice to local authorities on spatial plans and planning applications relating to flood risk.

Regional and local authorities are responsible for ensuring that flood risk is taken into account at all stages of the planning process in order to manage and reduce the consequences of flooding. Working through local and regional resilience forums they lead in:



25 years of Thames Barrier closures

- planning for flood events by producing flood plans and recovery/continuity plans;
- dealing with the consequences of flooding such as humanitarian assistance, emergency housing and clear up operations;
- providing advice to local communities on what action they can take before, during and after a flood.

Businesses and the community as a whole have an important role in preparing for floods by finding out if they live or work in a flood risk area, signing up for our flood warning service and taking appropriate action to keep their property, employees and family safe. The charity National Flood Forum aims to provide an independent voice for those at flood risk.

The Department for Environment, Food and Rural Affairs (Defra) has national policy responsibility for flood and coastal erosion risk management and provides funding through grant in aid to the Environment Agency which also administers grant for capital projects to local authorities.

Planning how flood risk is managed in the future

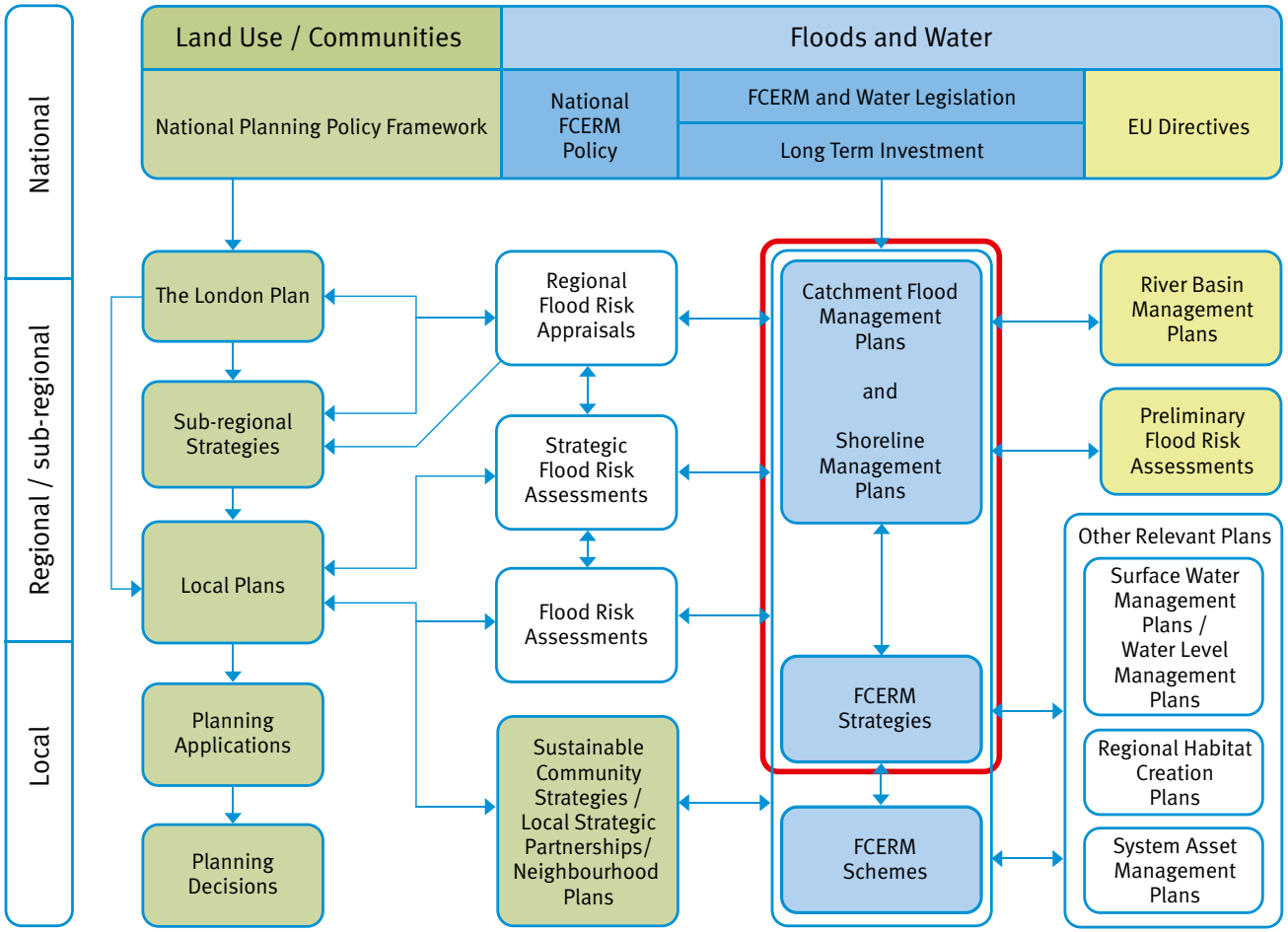
A long term strategic view is taken to managing flood and coastal erosion risk management. Flood risk management starts with a high level strategy, such as a Catchment Flood Risk Management Plan (CFMP) or Shoreline Management Plan (SMP). These strategies set the preferred direction for flood risk management based on a high level assessment of current risk; how that risk will change over time and how it will affect a particular river catchment or coastal area. It is important that these plans make links with other relevant planning initiatives such as the London Plan and Local Development Documents, River Basin Management Plans and Green Infrastructure Networks.

SMPs and CFMPs then inform more detailed local strategies. These strategies identify schemes and actions that need to be delivered to ensure flood risk management in a given area is appropriate, sustainable and delivers value for money in the long term.

Where does TE2100 fit into this approach?

TE2100 fulfils the purpose of high-level plans such as SMPs and CFMPs and bridges the gap to a more detailed strategy. The TE2100 Plan also informs and is informed by the other relevant planning initiatives outlined above. Figure 3.1 below demonstrates where the TE2100 Plan fits within the flood risk management strategic planning framework; and presents the relationship between high-level plans, strategies, schemes and other planning activities.

Table 3.1 An indicative illustration of the relationship between high level plans, strategies, schemes and other planning initiatives – and how the TE2100 Plan fits into this hierarchy.



Key: ▭ = TE2100 Flood Risk Management Plan sits within this area.

The challenge

The Thames estuary is a successful compromise of a thriving man-made landscape coexisting with a rich and diverse estuarine environment. However it is a dynamic, ever-changing system which through this century will face increasing and new challenges.

Future challenges and changes which have driven us to review current flood risk management activities and prepare us all for the future are:

- climate change
- ageing flood defences
- the physical environment
- socio-economic change
- public and institutional awareness.

Climate change

Climate change presents the greatest challenge in terms of future uncertainty. The tidal impacts include expected rises in mean sea level, peak surge tide level, and wave heights. Of particular concern is uncertainty over the rate of sea level rise. Whilst current rates are low (of the order of 3 mm/year relative to land level) there are regular reports of change to the global climate, the impacts of which are uncertain[5]. In addition, freshwater flood flows from tributaries that drain into the Estuary will increase due to higher winter rainfall.

Ageing flood defences

As would be expected, much of the current flood management infrastructure, constructed 30 years ago and in some cases more, is gradually deteriorating and will come to the end of its useful life during the period 2030 to 2060. It will require replacement or major repair at a cost of several billion pounds. The rate of deterioration of these structures and their ability to withstand increasing sea levels is therefore a vital factor in our future planning. The riverside of the Estuary and how we use it is also changing and the form and position of our flood defences may also not be suitable for the Estuary today or in the future.

The physical environment

Land levels in the south-east of England are slowly sinking as an after effect of the last ice age when the northern part of the country was covered in a mass of ice. This is a process called isostatic rebound. The result of this, quantified through our studies, is that the land level is going down relative to sea levels by around 1.5 mm per year. Although this appears a small amount, over the century it can add a significant difference to the protection afforded by the defences. Changes in the morphology of the Estuary can also affect flood levels and the ability of the Estuary to withstand it. Over the centuries the natural river channel has been narrowed as development in London and the Estuary has sought to take advantage of the benefits the river brings, such as river transport for trade. Today the attractiveness of the river as a site for new development continues to put pressure to encroach into the river space.

Socio-economic change

The Foresight Flood Risk project[6] identified the critical uncertainty that socio-economic development presents to the future of flood risk. Not only has there been extensive development on the Thames estuary floodplains, including throughout central London, but also the potential flood damages per property have risen. The reasons for this include changes in wealth and technology, resulting in a dramatic increase in the value of buildings and contents and their susceptibility to flood damage.

[5] CHURCH, J. A., and N. J. WHITE (2006), A 20th century acceleration in global sea-level rise, Geophys. Res. Lett., 33, L01602, doi:10.1029/2005GL024826.

[6] EVANS, E., ASHLEY, R., HALL, J., PENNING-ROWSELL, E., SAYERS, P., THORNE, C. AND WATKINSON, A. (2004) Foresight. Future Flooding. Scientific Summary: Volume II, Managing future risks. Office of Science and Technology, London.

Public and institutional awareness of flood risk

At present public awareness of flood risk on the Estuary is low. The present low chance of flooding due to the high standard of protection means that the focus of attention has been on keeping the defences in good condition and less attention has been given to public awareness of flood risk and how, through spatial and emergency planning, we might manage the consequences of a tidal flood in the unlikely event it happens. The uncertain future presented by climate change and rising flood risk means it is essential for this situation to change. Also much of the historic development in the floodplain in London and the Estuary has paid little heed to the possibility of a flood, relying wholly upon the defences to manage the risk. The recent National Planning Policy Framework looks to change this focus, and this must now be reflected in future spatial planning. Continued public and institutional confidence in flood risk management arrangements is essential. But all parties must be aware of their own responsibilities and the appropriate precautionary actions. There needs to be clarity on who does what and a more integrated response from those providers and responders involved. This was a primary recommendation of Sir Michael Pitt's review of the summer 2007 floods.

Stormy weather at Leigh-on-Sea

Responding to the changing estuary

In responding to these challenges our aim is to develop a flood management system that is adaptable to the changes that we face. It must be maintainable, and it must not threaten the ecological balance of the Thames estuary. Although we are looking to the end of the century, many of the decisions that we take now can affect our ability to adapt in the future. For example, if we are likely to raise, move or adapt defences we must ensure that we safeguard the space now to allow for that to happen in the future. The Foresight – Future Flooding report concluded that if we failed to start investing in sustainable approaches to flood and coastal risk management, increased flooding was inevitable.

TE2100 and climate change

TE2100 is the first major flood risk management project in the UK to have put climate change adaptation at its core. We have developed methods to test our flood risk management measures and options against differing climate change scenarios so that if sea levels rise beyond current predictions, we will know how effective these options will be and whether we need to change them.

The Lobster Smack in 1902: The defences were described at the time as being "practically invulnerable"

The same building in 2000: The defences, raised following the 1953 flood and raised further in the 1980s are now level with the roof eaves

The Lobster Smack – 200 years of defence raising at Canvey Island

To inform the development of these scenarios we commissioned scientific research with the Met Office and others to improve our understanding. We know that climate change could lead to increases in sea level, storm surge height and peak river flows but the question is by how much. The studies we have done have helped reduce the uncertainty in what the future might bring.

For more information on our climate change work, please see Appendix L to the TE2100 Technical Report.

We have learnt that:

- Sea level rise in the Thames over the next century due to thermal expansion of the oceans, melting glaciers and polar ice is likely to be between 20 cm and 90 cm.
- There remains a lot of uncertainty over the contribution of polar ice melt to increasing sea level rise. At the extreme, it may cause sea level to rise by a total of up to 2 m (including thermal expansion) – although this is thought to be highly unlikely.
- Climate change is less likely to increase storm surge height and frequency in the North Sea than previously thought.
- Future peak freshwater flows for the Thames, at Kingston for instance, could increase significantly, some of our climate change studies indicate this could be by as much as 40% by 2080.

Crucially, in terms of our planning for the Thames estuary, this research means that:

- These results give greater certainty that we have been planning for the right potential range of water levels this century, and the current Defra guidance for sea level rise in the Estuary is appropriate.
- Our previous worst-case scenario for increases in maximum water levels can be revised down from +4.2 m to +2.7 m (extreme water plus surge). This worst-case scenario is highly unlikely, but gives us an extreme to test our options against.
- Such a reduction in worst case scenario for this century means that a tide-excluding estuary barrage will not be necessary to manage flood risk this century and can be dropped from our final options.
- We are confident that our plan can cope with a changing climate and we can measure with confidence how much adaptation will be needed for different climate change scenarios.

Our approach and studies have been used to inform other climate change projects such as the Intergovernmental Panel on Climate Change (IPCC) 4th Assessment and the Stern Review. The results of this work also informed the Marine section of the UK Climate Projections 2009 Report (UKCP 09).

Climate change mitigation: The more the climate changes, the more it will cost us to adapt. The underlying message is that climate change mitigation makes good economic sense and we all need to try to reduce emissions and reduce our carbon footprint to slow the rate of change that we will experience. This was highlighted in the Stern Review on the Economics of Climate Change (2006).

In costing our options we have calculated the greenhouse gas costs. They are a relatively small percentage of the whole cost but it is important to recognise the need for a “carbon footprint-aware” culture.

Without effective climate change mitigation sea level rise will continue to accelerate. If this happens, in the next century London and the Thames estuary may have to deal with sea levels which exceed our +2.7 m extreme scenario.

Introducing the Plan

The TE2100 project was established by the Environment Agency in 2002 to come up with answers to the challenge of long term flood risk management planning for London and the Thames estuary.

It was agreed that a successful TE2100 Plan would be:

1. Technically feasible and adaptable to change
2. Environmentally sustainable
3. Economically justifiable
4. Socially and politically acceptable

TE2100 Strategic aim

To develop a flood management plan for London and the Thames Estuary that is risk based, takes into account existing and future assets, is sustainable, includes the needs of stakeholders. The Plan must also address the issues in the context of a changing climate and varying socio-economic conditions that may develop over the next 100 years.

Our recommendations

This Plan will direct the multi-agency actions that are needed to manage and reduce tidal flood risk over the next 100 years. It is adaptable to a changing climate to ensure that the actions that are taken are the right ones, taken at the right time and will not waste money on over-engineered solutions.

Our key recommendations

1. For each of the 23 policy units in the TE2100 Plan area, we have recommended a flood risk management policy. The **policies set the standard** for flood risk management in each policy unit. The policies direct the implementation of actions and future flood management investment, and they provide a common foundation from which all parties can plan their short-, medium-, and long-term activities. As the climate changes, we will all need to change how we manage and live with flood risk. In some areas there will be hard choices. In all areas, greater certainty is needed about current and future tidal flood risk management arrangements. This is provided by the TE2100 Plan.

2. We are starting from a good position, we have a world class system of flood defences and flood preparedness plans. Our investigations have confirmed that our predecessors have left us with a better legacy than had been previously understood – with continuing maintenance and improvement, we expect the Thames Barrier to remain viable until 2070 (under government's current climate change guidance). This means that for the first 25 years of our plan (2010 to 2034), we recommend continuing with how we manage tidal flood risk today through actively maintaining and improving the existing system at an estimated cost of £1.2 bn. In addition, we recommend that multi-agency floodplain management activities should be increased and that an intertidal habitat replacement programme should be commenced. Together with the asset management costs of £1.2bn, we anticipate **costs[7] for the first 25 years of our Plan of £1.5bn**. We must continue to work closely with implementation partners to direct new vulnerable development away from high flood risk areas and ensure that those living there remain safe today, and in the future.

[7] Excluding inflation and contingency

3. **The middle 15 years of our Plan will see recommended expenditure[8] of the order of £1.8bn** with major renewal and replacement of the Thames tidal defences, continuing floodplain management activities and intertidal habitat replacement. This period of the TE2100 Plan will bring opportunities to reshape and renew the riverside. We recommend that the multi-agency riverside strategies developed in the first 25 years are updated to inform longer-term spatial planning and asset management decisions and investments.

4. As the climate continues to change and water levels rise, we recommend that around 2050[9] the TE2100 Plan is reviewed and a decision is made on the end of the century option. Planning, design and construction must start soon afterwards to ensure that by 2070 new arrangements are in place. On the basis of our 2009 appraisal, we have identified two 'front runner' options. These are either; continuing to upgrade and modify existing flood defences and floodplain management (Option 1.4), or constructing a new barrier at Long Reach with associated works (Option 3.2). Our estimated **cost[10] for the end of the century works is £6bn to £7bn** – noting that the end of the century option may change as a result of a Plan review and changed conditions.

5. Our four generic estuary-wide options have been designed to manage rising water levels through this century and achieve the TE2100 policies. We have considered the social, economic and environmental cost and benefits of these options based on conditions today, to come up with the two 'front runners'. But we recommend that **a monitoring programme** is established to ensure that tidal flood risk in the Thames estuary is monitored together with our TE2100 10 indicators for change, and the **Plan is reviewed and updated** every 10 years – or more frequently should there be a significant change in one or more of the indicators.

6. We recommend that **876ha of intertidal habitat is created** to replace areas lost due to sea level rise over the period of the TE2100 plan. We have identified five sites which have the potential for intertidal habitat creation.

7. We recommend that a **Thames estuary land strategy** is developed in partnership with decision makers, land owners and managers to safeguard land for future flood risk management and to bring together the various strategic plans and vision statements from across the Estuary.

8. We recommend that our **action plan is carried out** to the timetable laid out in the plan. Our action plan contains the actions which are necessary for successful implementation of the TE2100 Plan. These actions are presented at an estuary-wide and local level and divided into three time horizons for decision-making and action. The TE2100 action plan will form the basis of continued partnership working with all those involved in flood risk management across the Thames estuary, especially where a multi-agency approach to managing flood risk is needed.

[8] Excluding inflation and contingency
[9] Based on government's current climate change guidance
[10] Excluding inflation and contingency

This is how we got there

The following pages describe the five stages through which we developed our plan:

Our Vision – the TE2100 Objectives

- To manage the risk of flooding to people, and minimise the adverse impacts of flooding to property and the environment;
- To adapt to the challenges that we will face from climate change;
- To support and inform the land use planning process to ensure appropriate, sustainable and resilient development in the tidal Thames floodplain;
- To protect the social, cultural and commercial value of the tidal River Thames, its tidal tributaries and its floodplain;
- To enhance and restore estuarine ecosystems to contribute to biodiversity targets and maximise the environmental benefits of natural floods.

Understanding flood risk and the Estuary

In the early phases of the TE2100 project we collected essential data on habitats, the plants and animals of the Estuary and the sediments to understand how the estuary's natural processes work. With low level helicopter LIDAR[11] we inspected the defences from the Thames Barrier to the sea. We studied today's flood risk and how it might change in the future and established our vision for future flood risk management. This is described by the TE2100 flood management policies.

TE2100 policies

Our aspirations for sustainable flood risk management for the next 100 years are based on an assessment of how much flood risk management activity we can justify in different parts of the TE2100 Plan area. There are five possible strategic levels of flood risk management available to us. These are defined as policies P1 through to P5. For more information on the flood risk management policies look at our Technical Report chapter 5. The policies set the strategic direction of flood risk management in each part of the Estuary.

This is essential information for planners and those who live and work in these local areas. It is also the starting point for the development of flood management options for the Estuary.

Maintaining confidence

The Thames Barrier will continue to provide flood protection to London through most of this century with some modification. Our investigations have confirmed that there is sufficient capacity in the system so major changes in the flood management system will not be needed until 2070 (based on current climate predictions).

However, significant improvements to the current tidal defence system will be needed before 2070 including raising the crest level of most of the flood defences and replacement of a large proportion of the defence structures as they reach the end of their lives. A comprehensive programme of continuing maintenance and improvements is therefore essential. Our first 40 years of the TE2100 programme includes this essential work.

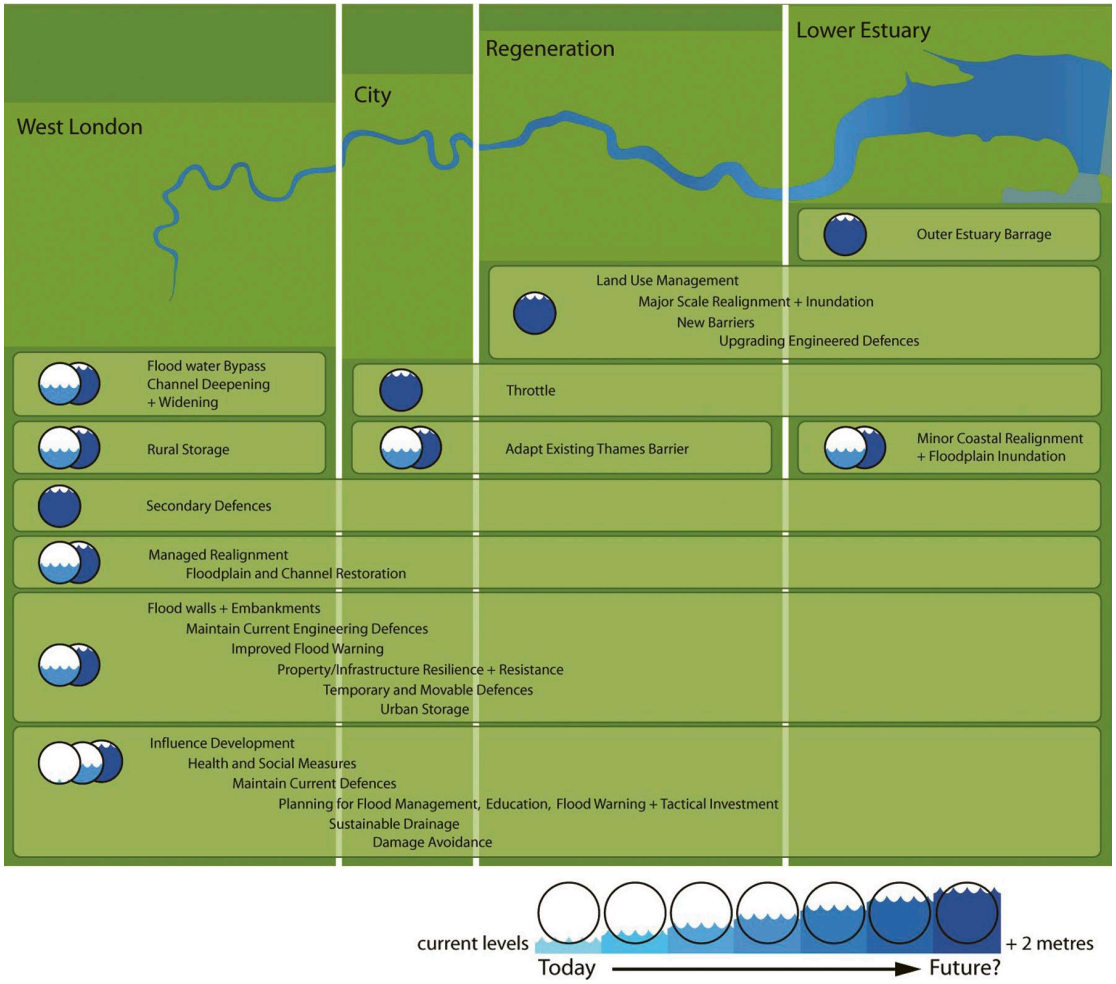
Thereafter, our Plan will continue to provide confidence to the 1.25 million people who live and work in the London and Thames estuary tidal floodplain, and will provide a shared understanding of flood risk management for our strategic partners and other groups.

Developing the options and selecting the front runners

In phases 2 and 3 of the project we developed tools, models and techniques to help us develop a range of options to manage flood risk. We studied a wide range of possible options and through our investigations and assessments we identified the most promising options to be investigated further. The diagram overleaf is from our Early Conceptual

[11] LIDAR (Light Detection and Ranging) a method of obtaining high quality measurements from a distance

Early conceptual options: our starting point for options development



Options consultation in 2005 showing a summary of the possible options for managing flood risk in the estuary.

What options have been excluded?

Following investigation, consultation and appraisal, some of these options have been excluded:

- **Throttle.** Narrowing the mouth of the Estuary by building a throttle structure was investigated but was discounted because our further investigations showed that it was not effective in reducing flood levels.
- **A tide-excluding barrage** was excluded because of the adverse impacts that impounding the Estuary would cause, including water quality, morphology and drainage.
- **A Barrier with locks** in the outer Estuary (downriver of Canvey Island) was excluded because of cost, environmental impacts and constraints to navigation to the Thames Gateway Port and other port facilities on the Estuary.
- **A Barrier in the outer Estuary** (downriver of Canvey Island) was excluded because of cost and adverse impacts on the Estuary environment and navigation.

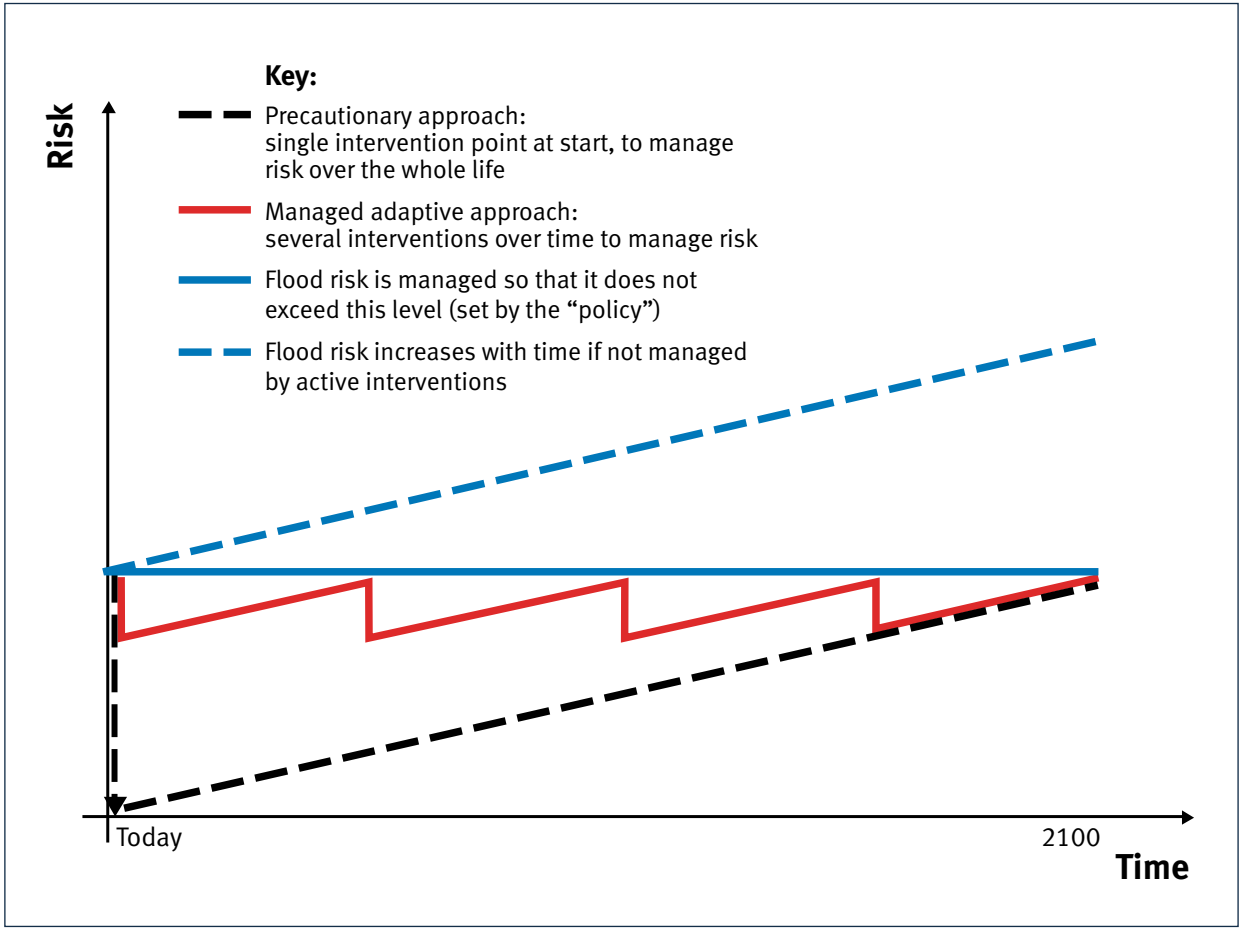
- **Improved channel conveyance** from Teddington to Brentford. This was excluded on the grounds of adverse environmental impact and lack of sustainability.

How options reduce flood risk

Flood risk is increasing in the Thames estuary for the reasons described in Chapter 4. The diagram on the right shows this schematically as the sloping blue dotted line. Chapter 6 describes how each area of the Thames estuary floodplain has been assigned a flood risk policy. This sets the level of flood risk management activity or investment that can be justified in that area – shown as the horizontal blue line on the diagram.

An option is made up of a combination (or portfolio) of different interventions which act together to achieve the recommended policy. This is the TE2100 managed adaptive approach – shown by the red saw-tooth line in this diagram. It is important to know when interventions will be required because it will be necessary to make decisions ahead of when they are needed. Some actions will require a lead-in time of 20 years or more.

We have developed a series of generic estuary-wide options which can successfully manage flood risk through the century.



Managing flood risk through the century using the TE2100 managed adaptive approach

A precautionary approach (shown by the black dotted line) would be to make a single, major investment in flood defence infrastructure or activity to achieve a reduction in risk which lasts until the end of the century. But our appraisal has shown that this would be an expensive and environmentally damaging approach, and runs the risk of creating an expensive "white elephant" should flood risk rise at a slower level than predicted.

The TE2100 approach has been to develop a multi-agency plan of actions which is adaptable to a range of change indicators, including changing climate, to ensure that the actions that are taken are the right ones, taken at the right time and will not waste money on over-engineered solutions.

Our estuary-wide generic options have been further developed and variations of the options have been tested for effectiveness and efficiency in delivering our strategic vision. Our estuary-wide options and their variations are summarised in table 5.1.

Our recommended option:

We recommend maintaining and improving the existing system (Option 1.4) as the optimum approach for the first 60 years of our Plan, with new arrangements required by 2070 (under current government climate change guidance) for the option which takes us into the 22nd century. At this stage all four of our generic estuary-wide options remain under consideration. Because of the long lead-in time for construction of the major "end of the century" option, a decision on the preferred option must be made by 2050.

The TE2100 action plan (see chapters 8 & 9) presents our recommendations on how the TE2100 Plan will be implemented, who will be involved, and when the different activities must take place.

Find out more about how we have designed our options in Chapter 7.

Table 5.1 The TE2100 generic estuary-wide options

Option 1. Improve the existing defences 1.1. Raise defences when needed 1.2. Allow for future adaptation of defences 1.3. Raise defences when they are replaced 1.4. Allow for future adaptation and optimise defence repair & replacement
Option 2. Tidal flood storage Four potential sites have been identified which are in the right location to store tidal waters and reduce the level of storm surges. The sites identified are at Erith Marshes, Aveley and Wennington Marshes, Dartford and Crayford Marshes, and Shorne and Higham Marshes.
Option 3. New Barrier 3.1. Tilbury Location 3.2. Long Reach Location The new Barrier would be designed to resist the highest surge tides predicted under government climate change guidance.
Option 4. Barrier with locks 4.1. Tilbury Location 4.2. Long Reach Location 4.3. Convert Thames Barrier to a barrier with locks when the operational limit of closures per year is reached.

Sea level rise and pressure on habitats:
Valuable intertidal habitat is being lost because our defences are preventing it from migrating landwards as sea level rises. Over the 100 year life of our Plan, 876 hectares of new habitat will be needed. We have identified five sites which have the right characteristics for intertidal habitat creation, and we are likely to need to use four of these sites. The choice of sites formed an important part of our public consultation. The sites are shown on the estuary-wide option maps in our Action Plan for Zone 0. The sites are:

- Grain Marshes
- All Hallows Marshes
- St. Mary's Marsh (including a possible further expansion to the west)
- West Canvey Marshes
- Bowers Marsh

Understanding the local issues

Having established estuary-wide options for flood risk management, these must be taken down to local level. There are a number of different choices for this local implementation which must be designed to optimise flood risk management within each policy unit whilst remaining true to the requirements of the estuary-wide options. There is also a need to include managing flood risk from other local sources of flooding, for example tributaries or surface water drainage. Just because these are local issues, it does not mean they are less important. It is the local choices which have the greatest and most immediate impact on the local environment and people.

Understanding consequences

The pressures of society, the environment and the economy are increasing the risk to those in the floodplains. We need to reduce the consequences of flooding and make the floodplains a safer place. We must take pragmatic measures which take account of the protection already offered by the defences. But the measures must ensure that in the event of failure or overtopping of the defence, existing and new developments are safe. Spatial planning and emergency preparedness will have an increasing role in flood risk management in the Thames estuary. We have studied the vulnerability of communities and infrastructure within the Estuary and have a wealth of data to share with emergency planners and other implementation partners.

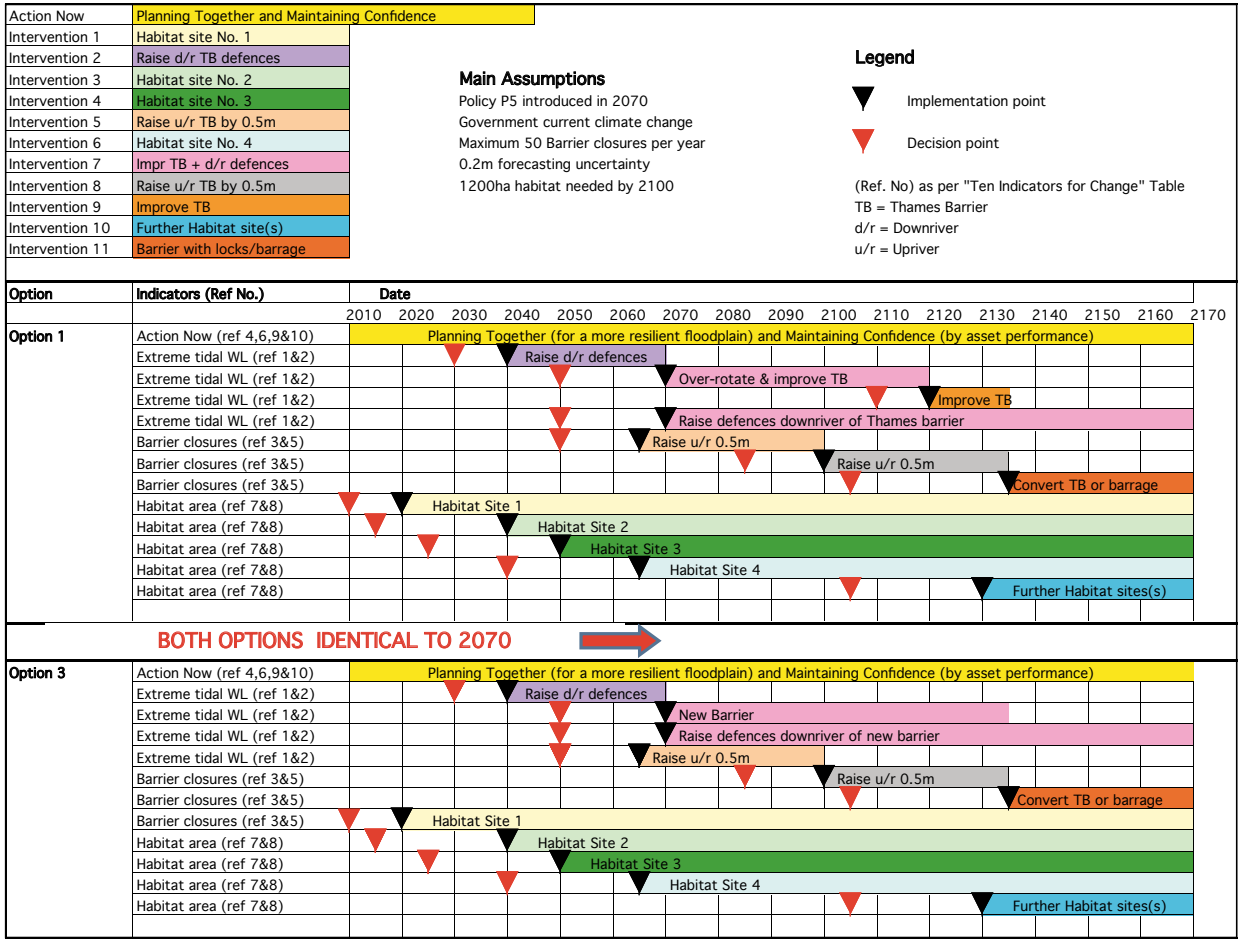
Designing an adaptable plan

Dealing with uncertainty:
Chapter 4 describes the uncertainty of future change and the challenge this presents to implementation of our Plan. Our TE2100 plan must be adaptable to change and remain fit for purpose throughout its 100 year life. To achieve this, we have identified ten key indicators of the changes which will affect flood risk management. These indicators, or "triggers for change" must be monitored throughout the life of the TE2100 Plan (see table 5.2 opposite). The outputs from this monitoring programme will inform the regular reviews and re appraisal of the Plan. Importantly, they will also trigger decision-making if rapid change occurs in one or more of the indicators.

Table 5.2 Ten indicators for change – and why they are important to TE2100

1	Mean Sea Level	Mean sea level is the level which determines the number of times per year that a barrier must be closed. This also has a major impact on the area of intertidal habitat in the Estuary. Change in mean sea level also provides an indication of how the peak surge tide level may change.
2	Peak surge tide level	The extreme (but rare) tidal flood levels which will have to be managed. Peak surge tide level also determines the crest level of the defences including the Thames and other barriers.
3	Peak river (fluvial) flood flows	The combined tidal/fluvial flood risk in West London and where tributaries meet the estuary.
4	Condition of flood defence structures	To ensure that the flood defence system will function as required, our asset performance teams will inspect and monitor the defences and required improvements will be identified to ensure the integrity of the system. To optimise the repair and renewal of defences in order to achieve the best value for money in investment programmes whilst ensuring public safety.
5	Frequency of closure and reliability of the Thames/other barriers	To ensure that the annual probability of failure of these important structures does not exceed the level required to ensure that the flood risk management policies are achieved.
6	Developed area and value/type of development	People and property at risk. Key social and economic information for flood risk management planning.
7	Extent of erosion/deposition	To identify the extent of defences that are threatened by erosion. To determine the likely impacts of erosion and deposition on intertidal areas of erosion/deposition. This will be an important part of monitoring the cumulative effects on the environment of works carried out to the defence structures.
8	Intertidal habitat area including mudflat and saltmarsh	The extent of the intertidal habitat zone, and whether we are complying with EU habitats regulations.
9	Land use planning and development activities	A measure of how well flood risk (i.e. safer floodplains) and opportunities for sustainability (e.g. the creation of green corridors) are being factored into development. Also predicts future needs for society and economics.
10	Public/institutional attitudes to flood risk	Public (hence political) appetite for risk, and institutional preparedness to manage risk and to plan for/respond to emergencies.
In addition to be above indicators, other changes that could affect the Plan will be monitored. These might include, for example, a major new development such as a new estuary transport crossing or a change in Government Policy.		

Table 5.3 TE2100 Plan Options 1 and 3 compared through the century



Planning for the long term:

To plan effectively to the end of this century, we will be making decisions which affect future generations well into the 22nd century. Table 5.3 illustrates how our generic Options 1 and 3 could both provide a flood risk management system to the end of this century and beyond.

The indicators for change are shown. These must be monitored to ensure the Plan remains flexible and responds appropriately to change. Table 5.3 also shows how Option 1 and Option 3 could be implemented in stages. Some key points to note are:

- the arrows showing implementation date and decision dates;
- both options are identical from 2010 to the year 2070;
- the horizontal bars on the options charts show when each intervention starts and when it ceases to be of value;
- when an intervention ceases to be of value, a new intervention is implemented. But the decision to do this must be made 10, 20 or even more years earlier as shown;
- Table 5.3 shows the timing of interventions based on government's current climate change guidance.

There is no way of knowing exactly what London and the Thames estuary will look like so far in the future. The choice of the "end of the century" option will be made around 2050 during a future review of the TE2100 Plan and will be based on the conditions prevailing at the time of the review.

TE2100 – Fit for Purpose over its 100 year life?

We recommend that the TE2100 Plan is reviewed against the 10 indicators for change every 10 years as a minimum – or more frequently if major change occurs in one or more of the indicators being monitored.

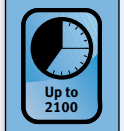
If one or more of the indicators change significantly, this will trigger a movement of the bars on Table 5.3 showing the interventions. This could be likened to the channel volume sliders on a sound mixing desk, the final "mix" being the optimum decisions at each stage throughout the life of the TE2100 Plan.

There are many different ways in which we could respond to changes identified each time the TE2100 Plan is reviewed and updated. Table 5.4 shows the ways in which the TE2100 Plan is adaptable to change.

Table 5.4 How the TE2100 Plan is adaptable

Changes to the timing of new intervention: If rates of change increase, interventions will be brought forward. If the rates of change are slower, then these interventions will be delayed.
Ability to change between options: If the rate of change of a critical factor is significantly different from the expected rate of change, it may be necessary to switch to an alternative option which can cope more efficiently with these new conditions.
Adaptation of engineering responses: Structures should be designed so that they can be adapted to changing circumstances. For example, providing foundations for new defences that can take higher future flood water loadings, or designing barriers and other control structures that can be modified in the future. The initial cost will be higher than responses that do not allow for subsequent adaptation, but this can result in significant savings over the whole life of the structure.
Safeguarding land for future options: Each flood risk management option will require land for new defences, enlarged defences, new barriers, new areas of habitat creation, and in some cases flood storage. Land allocations through the spatial planning system must be guided and informed by the requirements of the TE2100 options to ensure they remain possible.
Adaptation to new infrastructure: New infrastructure on the Thames estuary could have a major impact on flood risk management arrangements. For example, ports such as the proposed London Gateway Port at Shell Haven will require free access for navigation. Also, new transport links could provide the opportunity to combine a new crossing of the estuary with a new barrier. This could be brought forward in the TE2100 Plan if this is justified by the synergies and funding from different groups.

Three time horizons – three themes for flood risk management

	**The first 25 years** from 2010 to 2034 **"Maintaining confidence and planning together"**	• Continuing maintenance, operation and essential improvements. • Creating new habitats, safeguarding the spaces for future flood management and working in partnership with others to reduce flood risk. • TE2100 will have a real influence in the preparation of, and updating of local strategic and spatial plans.
	**The middle 15 years** from 2035 to 2049 **"Renewal and reshaping the riverside"**	• Many of the existing walls, embankments and smaller barriers will need raising and major refurbishment or replacement in this period. • These major projects provide an opportunity to reshape our riverside environment through working with spatial planners, designers, environmental groups and those who live and work in the Estuary area.
	**To the end of the century** from 2050 **"Preparing for, and moving into the 22nd century"**	• From 2070 (based on government's current climate change guidance) a major change will be needed. • The decision on the "end of the century" option to be adopted must be made at the start of this period followed by planning and preparation for implementation • By 2070, flood risk management arrangements must be in place to take us to the end of the century – and beyond.

The supporting evidence

We have built up a comprehensive evidence base of data and results with over 300 studies and investigations. This evidence provides a firm foundation to our TE2100 Plan. It is also a valuable resource for us to share with implementation partners.

To find out more see chapter 10.

Deciding on the Plan

In order to decide on our Plan, we have had to understand the impacts of all combinations of our estuary-wide options. We have used two key methods – economic appraisal and strategic environmental assessment, to undertake this work which is described in chapter 7 "Deciding on the Plan".

For more information on appraisal and assessment, see chapter 7.

Planning the implementation

Three phases have emerged for implementation of our TE2100 Plan, each having a different objective and theme representing the developing needs of flood risk management in the Thames estuary over the life of the TE2100 Plan:

- "Maintaining confidence and planning together" (2010 to 2034);
- "Renewal and reshaping the riverside" (2035 to 2049);
- "Preparing for, and moving into the 22nd Century" (from 2050).

Our action plan (chapters 8 and 9) shows the location of activities – by zone, and the time horizon – showing the short, medium or long term of the TE2100 Plan. As an aid to navigation through the action plan, we have colour coded the text according to the relevant time horizon and position in the Estuary.

A programme of works has been developed. The nature of the works proposed is described in our action plan chapters 8 and 9 and the detail is described in our Technical report and supporting documents. We have a high degree of confidence in the short- and medium-term programmes which take us up to the end of 2049.

From 2070 – based on government's current climate change guidance – a major change in the flood risk management system will be required. This will be planned, designed and constructed during our long-term programme, which takes us from 2050 into the 22nd century. Our programme is based on the options which come out best from our appraisal process measured against today's conditions. Significant changes in climate and other factors over the next 40 to 50 years may point to a different recommended option for the end of the century. This will be decided on during the 2050 review of the TE2100 Plan.

Building the partnerships

The overall responsibility for tidal flood risk management lies with the Environment Agency through our strategic overview role, but we cannot implement the TE2100 Plan alone. It will require a multi-agency approach. For instance, local authorities will play a key part in delivering our recommendations for spatial and emergency planning procedures. Bodies such as Natural England and English Heritage will provide essential guidance on how our detailed designs incorporate the needs of the important habitats and heritage landscape of the Thames estuary.

Responses to our public consultation have strengthened existing partnerships and identified new ones which we must create.

The action plan

Our action plan (chapters 8 and 9) describes the actions required at local and estuary-wide level by the different people and organisations involved. This is central to the implementation of the TE2100 Plan. It is important that all partners know the actions they are responsible for, where they are located in the estuary and at what time in the century they will be required. All partners need to be know about the arrangements being made to form the partnerships for implementation.

Taking ownership of the actions. For successful implementation, each partner must take ownership of their actions. As an essential step in transition to implementation of the TE2100 Plan, we will work with our partners to agree how the actions are taken forward. Where terms of reference are needed for partnership working, we will ensure that these are established. Where more detailed understanding of local issues is required, or design frameworks need to be agreed, we will ensure that this preparation work is put in place and seen through to successful conclusion.

Starting work on the TE2100 Plan. Once the transition to implementation agreements are in place and the TE2100 Plan has been approved by Government, work on the actions can commence. The first actions and investments are scheduled to start immediately the plan is agreed. Our programme indicates major expenditure of £1.5 bn in the first 25 years alone. Much of this represents a continuation of what we are doing now in terms of looking after our flood defence assets. But in addition to our inter tidal habitat creation programme, there is a significant increase in

proactive floodplain management activities – an anticipated expenditure of some £300 million in the first 25 years of the Plan will be required, with a large range of partners involved. The middle 15 years of our Plan has an estimated cost of £1.8 bn and the final years, to the end of the century, £6 to 7 bn (depending on the final option selected). Note that all these figures are present-day cost estimates and exclude inflation and contingency. More information about the estimated costs of the options we are recommending and the proposed expenditure is contained within our TE2100 Technical Report.

For more information see chapter 10.

Undertaking the TE2100 project has been a major investment. We are confident that our decisions are based on the best possible science and we have worked with and listened to many groups and individuals throughout the development of this Plan. But the launch of our consultation Plan in March 2009 was the first time that all the elements of our Plan had been presented together. This initiated a lively and constructive response from stakeholders. The Plan and action plan presented in this document reflects the feedback we received during our public consultation, and it provides a starting point for a successful implementation of the TE2100 Plan.

The Thames Barrier – visitors on a technical tour

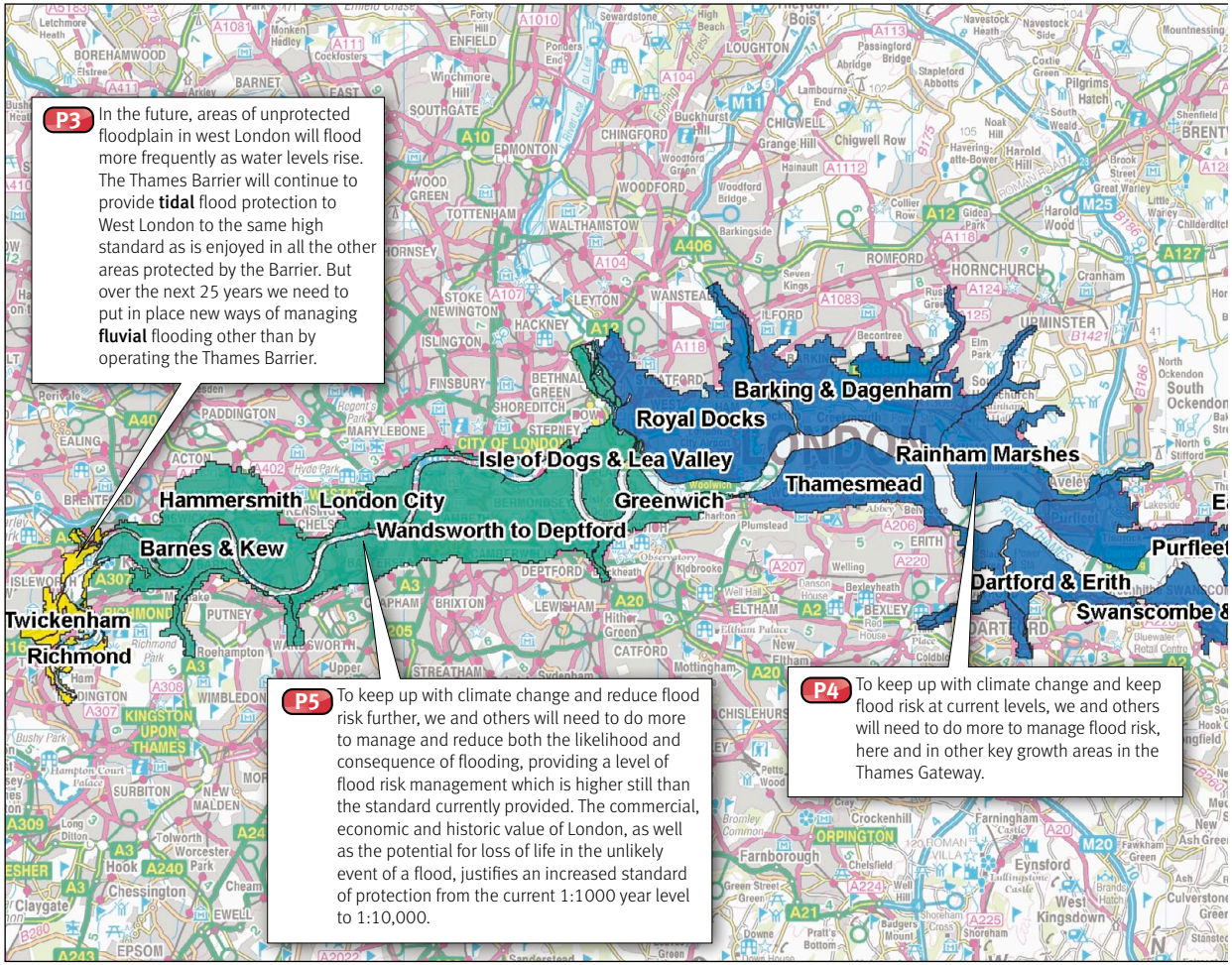
Introducing the TE2100 policies

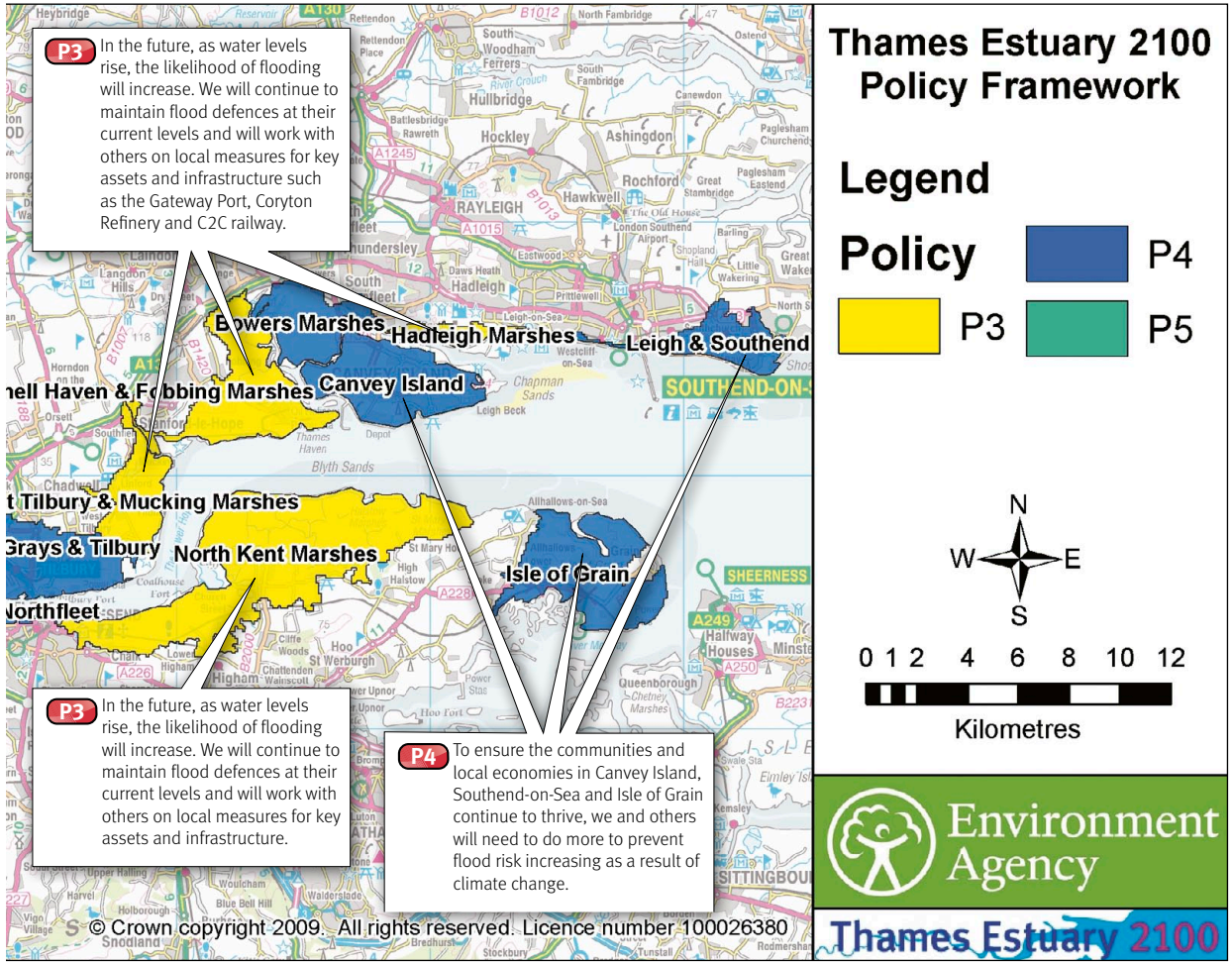
What are the policies?

- **P1** No active intervention (including flood warning and maintenance). Continue to monitor and advise.
- **P2** Reduce existing flood risk management actions (accepting that flood risk will increase over time).
- **P3** Continue with existing or alternative actions to manage flood risk. We will continue to maintain flood defences at their current level accepting that the likelihood and/or consequences of a flood will increase because of climate change.
- **P4** Take further action to keep up with climate and land use change so that flood risk does not increase.
- **P5** Take further action to reduce the risk of flooding (now or in the future).

What do the policies mean for the Thames estuary:

This map shows the strategic flood risk management approach for the Thames estuary recommended in the TE2100 Plan. We have divided the Estuary into 23 geographical areas, known as the policy units. Each policy unit has been assessed to determine the appropriate level of flood risk management.





Moving from vision to reality: The first stage of our assessment was to assess the level of flood risk management activity we can justify in different parts of the TE2100 Plan area. This is described by the policies which are the starting point for developing the TE2100 programme of activities at estuary-wide and local scale. The policies also provide us with a single framework for considering different options and assist with prioritisation of flood risk management activities.

The policies indicate the level of flood risk management which is justified by the people, the value of property and the other assets being protected in that area. The policies set the strategic direction of flood risk management in each part of the Estuary. This is defined by one of five available policies P1 to P5 as shown in the key box on the opposite page.

Policy appraisal: The social, economic and environmental value of each policy unit has been assessed through a formal process to allocate a flood risk management policy. The same process is used throughout England and Wales to ensure a nationally consistent approach to flood risk – and a level playing field when it comes to allocation of scarce resources for flood risk management. Policy P1 was used as one of the baselines for the appraisal but has not been selected for any of the TE2100 policy units. This is explained in our TE2100 Technical Report.

Understanding impacts and making decisions

To help make decisions on which are the best flood risk management options and policies for the estuary communities and environment we have used a number of assessment and appraisal methodologies. These are designed to:

- assess what strategic flood management approach, or policy, can be justified in a local area;
- assess the impacts any individual future flood management option might have;
- appraise how potential impacts of any flood management option compare with other options.

The results of the policy assessment and appraisal can be found in chapter 6. The assessment and appraisal of flood management options used the following methods:

- **Economic appraisal** (also known as cost-benefit analysis) attempts to estimate the costs and benefits to society (the nation) of options using monetary terms;
- **Strategic Environmental Assessment (SEA)** assesses the environmental and social impacts of flood management options and how they conform to environmental legislation.

Our Plan brings the two processes together to determine the best course of action, based on current information.

Economic appraisal (cost-benefit analysis)

This is accepted best practice within flood risk management planning, and the approach is consistent with Defra's[12] Flood and Coastal Defence Project Appraisal Guidance series and the Policy Statement on Appraisal (July 2008) issued as a result of the Making Space for Water strategy. A key aspect of this approach is the need for greater consideration of social and environmental impacts within appraisal. TE2100 has been at the cutting edge of emerging new methods (Multi-Criteria Analysis) to factor in society and the environment in flood risk management appraisal, in addition to the traditional focus on protecting against property damage from flooding. Table 7.1 shows the impact categories used in the TE2100 appraisal.


For more information, see the TE2100 Technical Report.

Although called "economic appraisal", our approach also seeks to place value on the environmental and social impacts and benefits of

[12] Government's Department for Environment, Food and Rural Affairs (Defra)

Table 7.1 Impact categories assessed in the appraisal

Economic
Property
Key infrastructure
Agricultural land use
Navigation
Transport
Indirect impacts on business
Environmental
Physical habitats and biodiversity
Water quality and quantity
Natural processes
Other environmental
Landscape
Historical environment
Social
Recreation
Safety and security
Sense of community
Technical
Technical risk

our flood risk management options. It remains an economic approach however to the extent that these wider impacts are evaluated in terms of the "worth to society" as expressed in monetary terms.

Through this process, we have demonstrated that factoring in social and environmental outcomes can change the view of which options have the biggest benefits compared to the more traditional cost-benefit analysis.

The results of the flood risk management options economic appraisal are presented in Appendix H to the TE2100 Technical Report.

Assessing the ratio of benefits to costs for all of the options considered in the final stage of the Plan development, led to two "front runners" being determined for the period from 2070. These are:

- Option 1.4 – Optimised maintenance and enhancement of the existing system with modifications made to the Thames Barrier by 2070, and further adapting the structure to become a barrier with locks after 2135.
- Option 3.2 – Optimised maintenance and enhancement of the existing system to 2070 and building a new barrier at Long Reach by 2070; (converting to a barrier with locks or "open" barrage after 2135).

For the period up to 2070, maintaining and enhancing the current system is strongly preferred, regardless of the "end-of century" approach selected thereafter. This is the key recommendation of the TE2100 Plan. Uncertainty in the assessment post-2070, and the absence of an immediate need to decide on the preferred strategy beyond that point, mean that a single preferred "end of century" option is not being promoted at this time.

Strategic environmental assessment

Strategic environmental assessment (SEA) is a systematic process of evaluating the potential consequences of a plan before it is approved, and it is legally required for TE2100. SEA involves collecting and presenting baseline information relating to the Plan; identifying alternatives to the Plan and their effects; predicting the significant environmental effects of the Plan and proposing mitigation measures for these effects. This work has been documented in an Environmental Report which has been used for consulting the public and authorities with environmental responsibilities. Thereafter, there is a requirement to monitor significant environmental effects of implementing the Plan.

We have carried out the SEA at the same time as developing and drafting our TE2100 Plan. It has helped us develop and assess strategic alternatives and identify opportunities for policy amendments and environmental mitigation, while shaping our early thoughts on the content of the Plan.

We have considered the impacts of our various TE2100 Plan options.

This is reported in the supporting SEA Environmental Report.

Impact mitigation and enhancement

We have identified in our Environmental Report several ways in which we can minimise adverse effects of the flood risk management options and enhance positive ones. Some are relevant to all of the options and some to specific options only.

Examples of these mitigation actions relevant to all options include:

- **Construction** – during the construction of any options, every effort should be made to transport construction materials by river where possible, and residents should be consulted and warned in advance of planned works.
- **Floodplain management** – we need to consider flood warning, emergency planning, spatial planning and building design, including

secondary defences, as appropriate. Vulnerable populations may require extra assistance to improve the effectiveness of flood warning or emergency planning.

- **Environmental enhancement** – in terms of environmental mitigation, by managing realignment areas and enhancing existing habitat on the floodplain we can provide an important habitat for fish, birds and invertebrates. Economic benefits to the estuary could be provided from improving both recreational and commercial fisheries.

There are more details of mitigating the effects of specific options in our Environmental Report.

Habitats Regulations Assessment (Appropriate Assessment)

Under the Habitats Directive we need to make an Appropriate Assessment to determine whether the TE2100 Plan will impact upon the integrity of designated habitat sites in the Thames Estuary. Our four-stage process is outlined below:

Stage 1: Clarify whether the Plan is 'necessary' for the site management
The TE2100 Plan is not necessary for managing the designated sites in the Thames.

Stage 2: Assessment of likely significant effect
Sea level rise could cause the loss of up to 1200 ha of designated intertidal habitat in the Thames Estuary Plan area over the next century.

This has been identified through the Greater Thames Coastal Habitat Management Plan (CHaMP). In recommending maintenance and improvement of the fixed defences, the TE2100 Plan is likely to have significant negative effect alone, and in combination, on the:

- Medway Estuary and Marshes SPA/Ramsar site
- Thames Estuary and Marshes SPA/Ramsar site
- Holehaven Creek proposed SPA
- Benfleet and Southend SPA/Ramsar site
- Foulness (Mid-Essex Coast Phase 5) SPA/ Ramsar/SAC

The primary reason for this is that continuing with the current line of defences will mean that these sites are likely to suffer from coastal squeeze – where the inter-tidal habitat is squeezed out between the line of defences and rising sea levels.

Stage 3: Adverse effect assessment procedure
Discussions with Natural England on the results of our investigations, suggest there is likely to be an adverse effect on site integrity as a result of the Plan on the following sites:

- Medway Estuary and Marshes SPA/Ramsar site
- Benfleet and Southend SPA/Ramsar site
- Thames Estuary and Marshes SPA/Ramsar site
- Holehaven Creek proposed SPA

Stage 4: Alternatives
We have considered and consulted on a wide range of alternatives before arriving at the range of options contained in the TE2100 Plan. No alternative solutions having been identified, Imperative Reasons for Overriding Public Interest (IROPI) tests have been applied and a Statement of Case from the Environment Agency supported by Natural England will be submitted to the Secretary of State.

In anticipation that the Appropriate Assessment would conclude the TE2100 Plan would have an adverse effect, we have identified in the TE2100 Plan, opportunities for up to 1000 ha for potential intertidal habitat creation and 800 ha for potential freshwater habitat creation. These are identified within our action plan (Chapters 8 & 9). Following EC guidance and in agreement with Natural England, the new habitat areas are as near as possible to those adversely affected; are suitable in terms of ecological features; and should be ready in time to provide the functions they are intended to compensate for.

SEA and HRA: Conclusions

The conclusion of the SEA and HRA (Appropriate Assessment) is that the environmentally-preferred option is to upgrade and maintain the existing system of defences (Option 1.4). New barrier options are likely to infringe environmental legislation.

Bringing the economic appraisal and SEA together

In summary, the economic appraisal has identified **Improving the existing defences** (Option 1.4) and a **New barrier at Long Reach** (Option 3.2) as "front runners" for the period beyond 2070, with Improving the existing system (Option 1.4) being recommended until that time.

The SEA/HRA process has concluded that Improving the existing system – optimising repair and replacement (Option 1.4) is the environmentally preferred option both pre- and post-2070.

This suggests that the overall preference would be for Improving the existing system (Option 1.4). Current information suggests that a new Barrier at Long Reach (Option 3.2) might be the better economic option by a small margin post-2070. But uncertainty in the assessment post-2070 and the absence of an immediate need for a decision on the "end of the century" option, mean that this will be deferred until a future review of the TE2100 Plan in 2050.

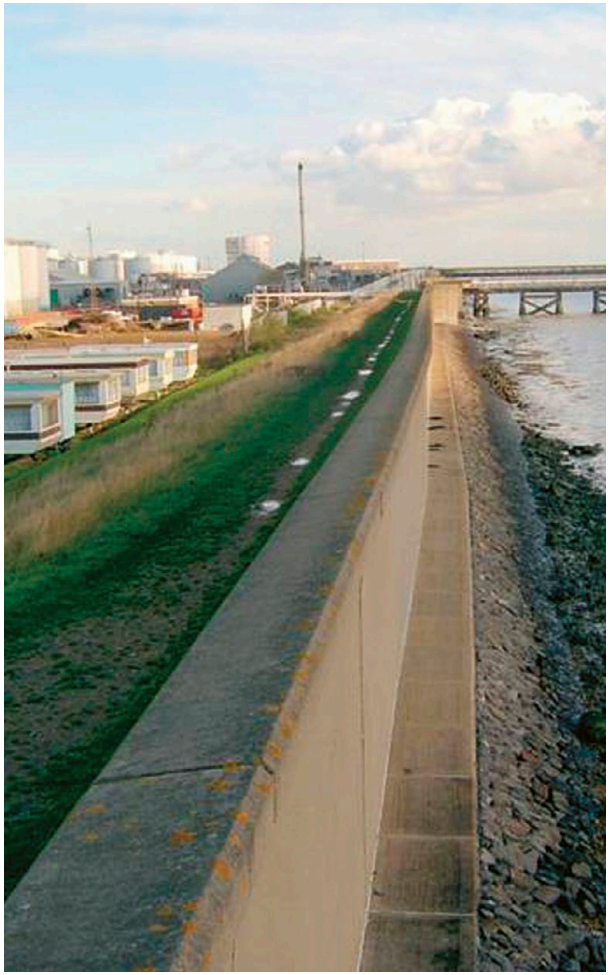
The TE2100 action zones

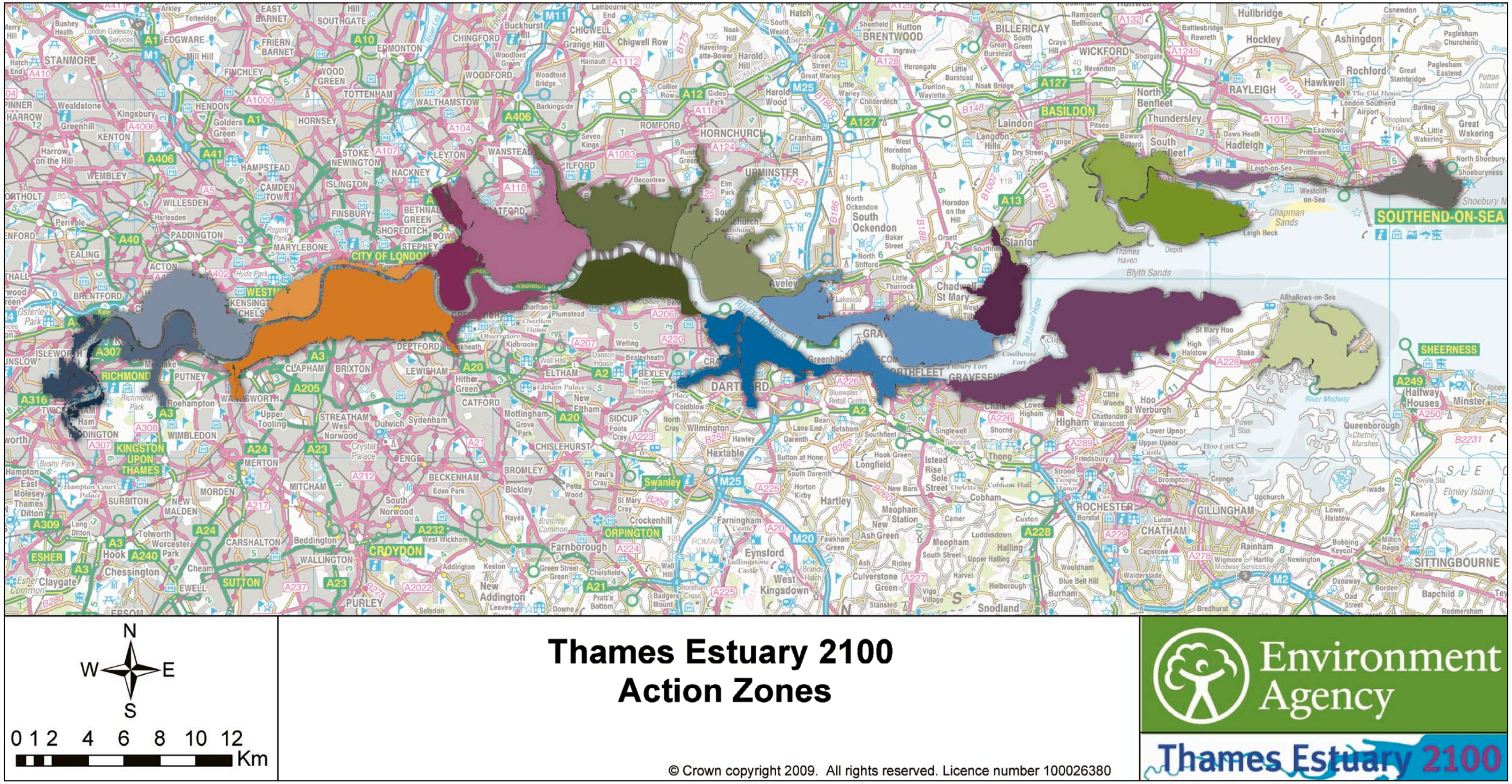
Our action plan sets out our recommendations estuary-wide and in each of the TE2100 policy units. There are 23 policy units in our Plan area, so to avoid repetition we have grouped together those with similar characteristics and requiring a similar type and range of actions. There are eight of these local action zones and an estuary-wide zone:

Action zone 0 – estuary-wide
Action zone 1 – west London
Action zone 2 – central London
Action zone 3 – east London
Action zone 4 – east London downstream of Thames Barrier
Action zone 5 – middle Estuary
Action zone 6 – lower Estuary Marshes
Action zone 7 – lower Estuary, urban/industrial and marshland
Action zone 8 – Seaside/fishermen's frontage

For each action zone there is a description explaining the features of each policy unit and our action plan for each zone which shows:

- what actions are required;
- who will undertake these actions;
- how this will be done.

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© Crown copyright 2009. All rights reserved. Licence number 100026380
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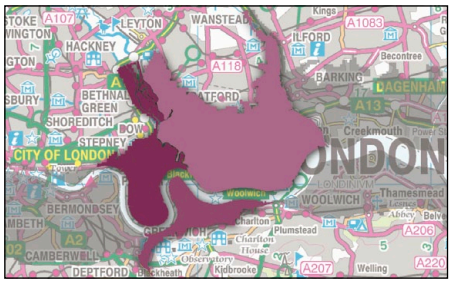
CITY OF LONDON
RICHMOND
KINGSTON UPON THAMES
CROYDON
BASILDON
ROCHESTER
CHATHAM
GILLINGHAM
SITTINGBOURNE
GRAVESEND
DARTFORD
HORNCHURCH
ROMFORD
BILLERICAY
WICKFORD
RAYLEIGH
BRENTWOOD

An overview of the action zones

Action zone 1

Action zone 2

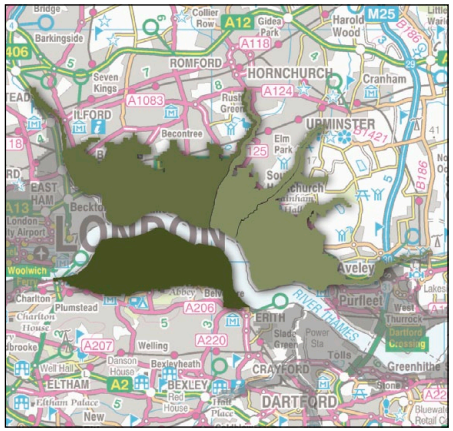


Action zone 3

Action zone 0 – estuary-wide

(This action zone covers the estuary-wide options which affect to a greater or lesser degree, all 23 of the policy units)

This action zone covers the whole Estuary and our estuary-wide options are presented here. These estuary-wide options provide the strategic framework for flood risk management for the TE2100 Plan area for 100 years. Further information on what this means at local level is described in the action plan tables for zones 1 to 8 in Chapter 9.



Action zone 4

Action zone 1 – west London

(Richmond, Twickenham, Barnes & Kew and Hammersmith)

These four policy units are in west London. Whilst the area is heavily urbanised, they all have large open spaces and important recreation and amenity areas. Richmond and Twickenham both have a significant fluvial flood risk from the Thames. Richmond and Twickenham policy units have been given by TE2100 a P3 flood risk management policy and we recommend a P5 policy for Barnes & Kew and Hammersmith policy units. These policies are further described in the action plan and are outlined in chapter 6.

Action zone 2 – central London

(Wandsworth to Deptford and London City)

These two policy units cover the section of the Thames that passes through central London. TE2100 gives both policy units a P5 flood risk management policy.

Action zone 3 – east London

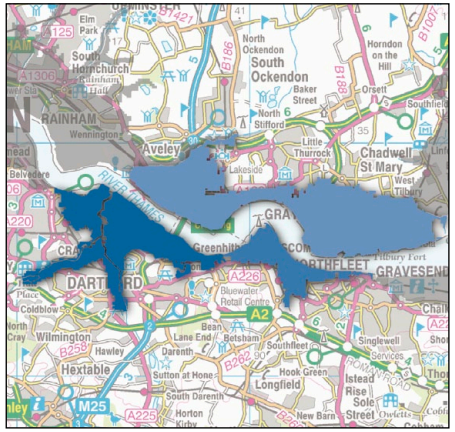
(Greenwich, Isle of Dogs & Lea Valley and Royal Docks)

These three policy units cover much of the regeneration area in east London. Development at Canary Wharf on the Isle of Dogs continues, and there are major developments planned in the Greenwich and Royal Docks policy units. TE2100 gives Greenwich and Isle of Dogs & Lea Valley a P5 flood risk management policy and Royal Docks a P4.

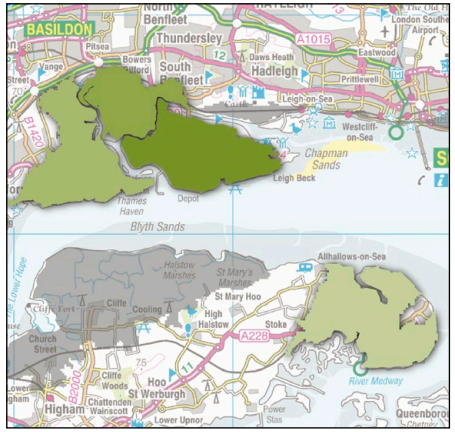
Action zone 4 – east London downstream of Thames Barrier

(Barking & Dagenham, Rainham Marshes and Thamesmead)

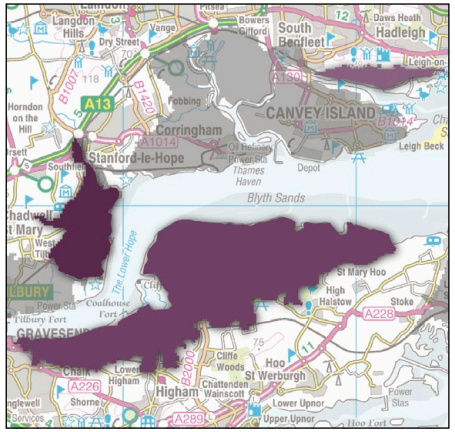
These three policy units cover the Estuary from Woolwich to Erith. Common features include new residential development, major industrial areas and open marshes. TE2100 gives all these policy units a P4 flood risk management policy.



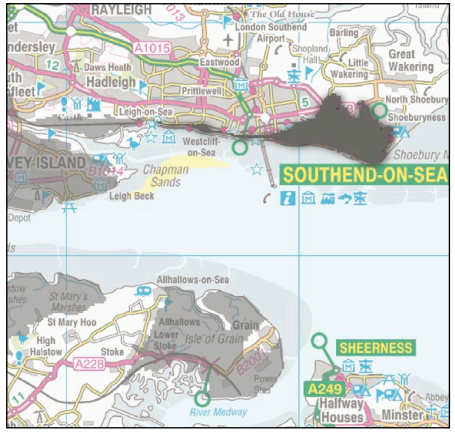
Action zone 5



Action zone 7



Action zone 6



Action zone 8

Action zone 5 – middle Estuary

(Dartford & Erith, Swanscombe & Northfleet and Purfleet, Grays & Tilbury)

These three policy units cover the Estuary from Erith to Gravesend. Common features include port activity, residential areas, new development sites, industry and open marshes. TE2100 gives all these policy units a P4 flood risk management policy.

Action zone 6 – lower Estuary Marshes

(East Tilbury & Mucking Marshes, North Kent Marshes and Hadleigh Marshes)

These three policy units are all in the lower Estuary. They are predominantly areas of open grazing marshes. TE2100 gives East Tilbury, North Kent Marshes and Hadleigh Marshes a P3 flood risk management policy. This means that with climate change, flood risk is likely to increase in these policy units.

Action zone 7 – lower Estuary, urban/industrial and marshland

(Canvey Island, Bowers Marshes, Shell Haven & Fobbing Marshes and Isle of Grain)

These four policy units cover a wide range of land uses, including a major residential area (Canvey Island), major industrial areas (Shell Haven/ Coryton and Isle of Grain East), and areas of freshwater marsh. Canvey Island, Bowers Marshes and Shell Haven & Fobbing Marshes are linked together because they have a common flood risk management system. TE2100 gives Canvey Island, the Isle of Grain and Bowers Marshes a P4 flood risk management policy and Shell Haven & Fobbing Marshes a P3 with secondary defence arrangements at key sites.

Action zone 8 – Seaside/fishermen's frontage

(Leigh Old Town and Southend-on-Sea)

This single policy unit has a very different character to the rest of the Estuary and is therefore treated separately. Southend-on-Sea is a seaside resort and Leigh has a strong fishing tradition. The policy unit has a long frontage and a narrow floodplain. TE2100 gives it a P4 flood risk management policy.

Action zones

Action plan for zone 0

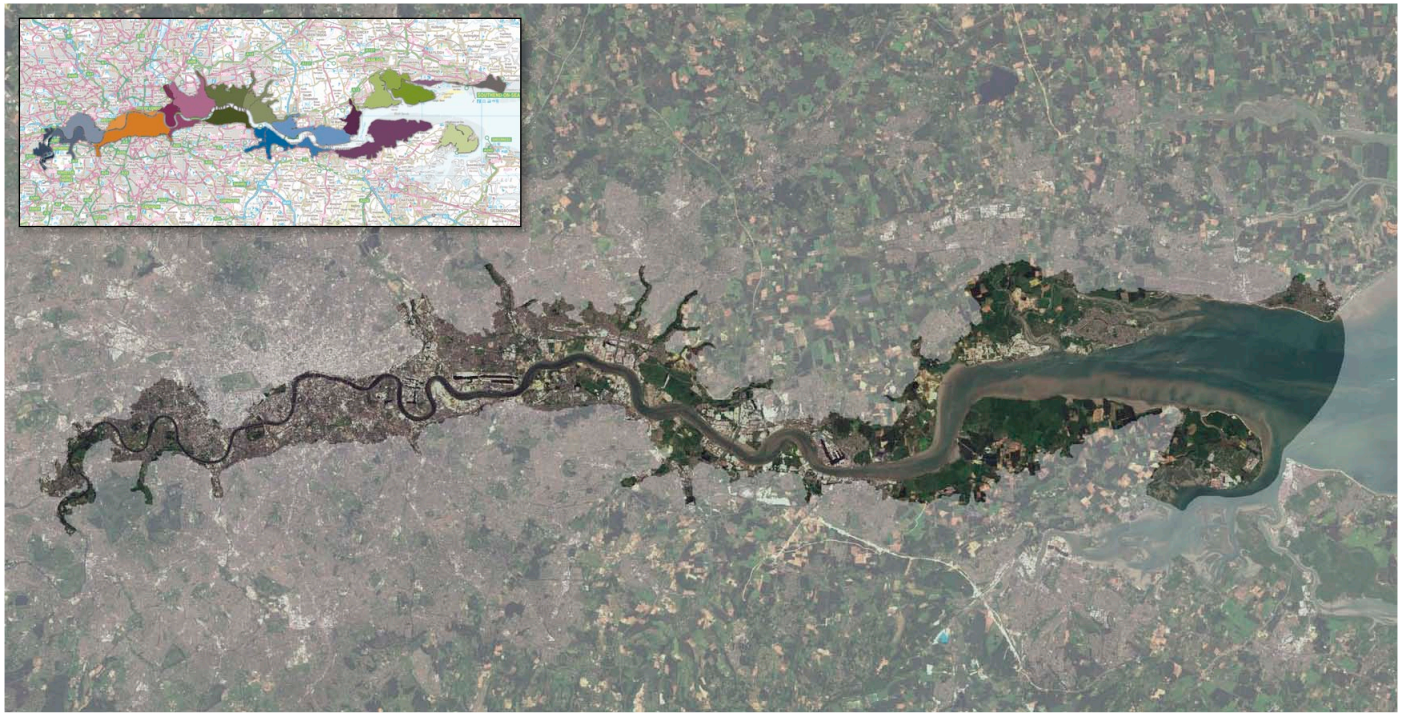
15 actions identified

The estuary-wide options

- Estuary-wide option 1 (improve existing system)
- Estuary-wide option 2 (tidal flood storage)
- Estuary-wide option 3 (new barrier)
- Estuary-wide option 4 (new barrier with locks)

This section of the action plan describes the 15 actions for zone 0 – (estuary-wide) which have been identified through the TE2100 plan. The actions are described under the following headings:

- TE2100 recommended actions (and whether or not costs for this have been included in the TE2100 plan)
- Implementation partners
- How this will be achieved



"A long-term plan such as the TE2100 strategy needs to be flexible enough to incorporate changes to climate projections and the scientific evidence base, while at the same time provide decision makers with the evidence needed to take important investment decisions now."

Association of British Insurers

Chapter 9: TE2100 action plan: **action zone 0** – estuary-wide

The TE2100 estuary-wide options

We have developed four generic estuary-wide options to deliver our strategic vision for flood risk management in the Thames estuary. Each option has variations in the way it could be delivered. These are described in the table on the opposite page.

The TE2100 recommended Plan is as follows:

For the first 60 years of the plan period (from 2010 to 2069), improving the existing defence system **(Option 1.4)** is our recommended way to manage flood risk on the Thames estuary.

From 2070, rising sea levels will require a different approach to be taken. Our appraisal identifies two 'front runner' options: **Option 1.4** – a continuation of defence improvements including major improvements to the Thames Barrier, or **Option 3.2** – a new downstream barrier at Long Reach.

A decision will need to be made in approximately 2050 (based on government's current climate change guidance) so that changes to the flood risk management system can be planned and be commissioned ready for use by 2070. Climate and other conditions may change by the time of our 2050 review but we have a fair degree of certainty about flood risk management requirements for the next 40 years. We have therefore prepared a detailed investment programme up to 2049, with a high level programme to the end of the century.

Our 2009 appraisal does not favour tidal flood storage **(Option 2)** or a barrier with locks **(Option 4)**. Current sea level rise predictions do not justify the cost of building a barrier with locks, which could close more frequently than a barrier like the Thames Barrier. However, such a structure would be needed if water levels in the estuary rise above current predictions. Our further investigations of flood storage indicated that there were some serious issues regarding its reliability using current forecasting technology and that it posed significant risks to health and safety. It was also more expensive than either of the two 'front runner' options.

However, because of the uncertainties in the assessment post-2070, all four of our generic options will remain as candidates for future appraisal post-2050. Detailed planning for the next 40 years will be based on our Option 1.4.

The four TE2100 estuary-wide options and their sub options are summarised in the table below

The estuary-wide option	What it means
Option 1: Improve the existing defences 1.1 Raise defences when needed 1.2 Allow for future adaptation of defences 1.3 Optimise the balance between defence replacement and repair 1.4 Optimise defence repair & replacement and allow for adaptation to future change	Four different sub-options were considered, involving different maintenance schedules, and different ways of deciding when and by how much walls should be raised. Our appraisal indicates that option 1.4 is the preferred option until 2070.
Option 2: Tidal flood storage Four potential sites have been identified which are in the right location to store tidal waters and reduce the level of storm surges. The sites identified are at Erith Marshes, Aveley and Wennington Marshes, Dartford and Crayford Marshes, and Shorne and Higham Marshes.	Storing tidal waters during very large surge tides would help to reduce extreme water levels at the Thames Barrier. This could delay by several decades the date when the Thames Barrier would have to be replaced or improved. Our appraisal and technical investigations do not favour this option at present but it remains as one of our choices of end of the century options for future review.
Option 3: New barrier 3.1 Tilbury location 3.2 Long Reach location Barriers would be designed to resist the highest surge tides predicted under government's current climate change guidance.	Both options assume that the barrier can be closed only a certain number of times per year, so there would still be a need for defence raising upstream.

(continued)

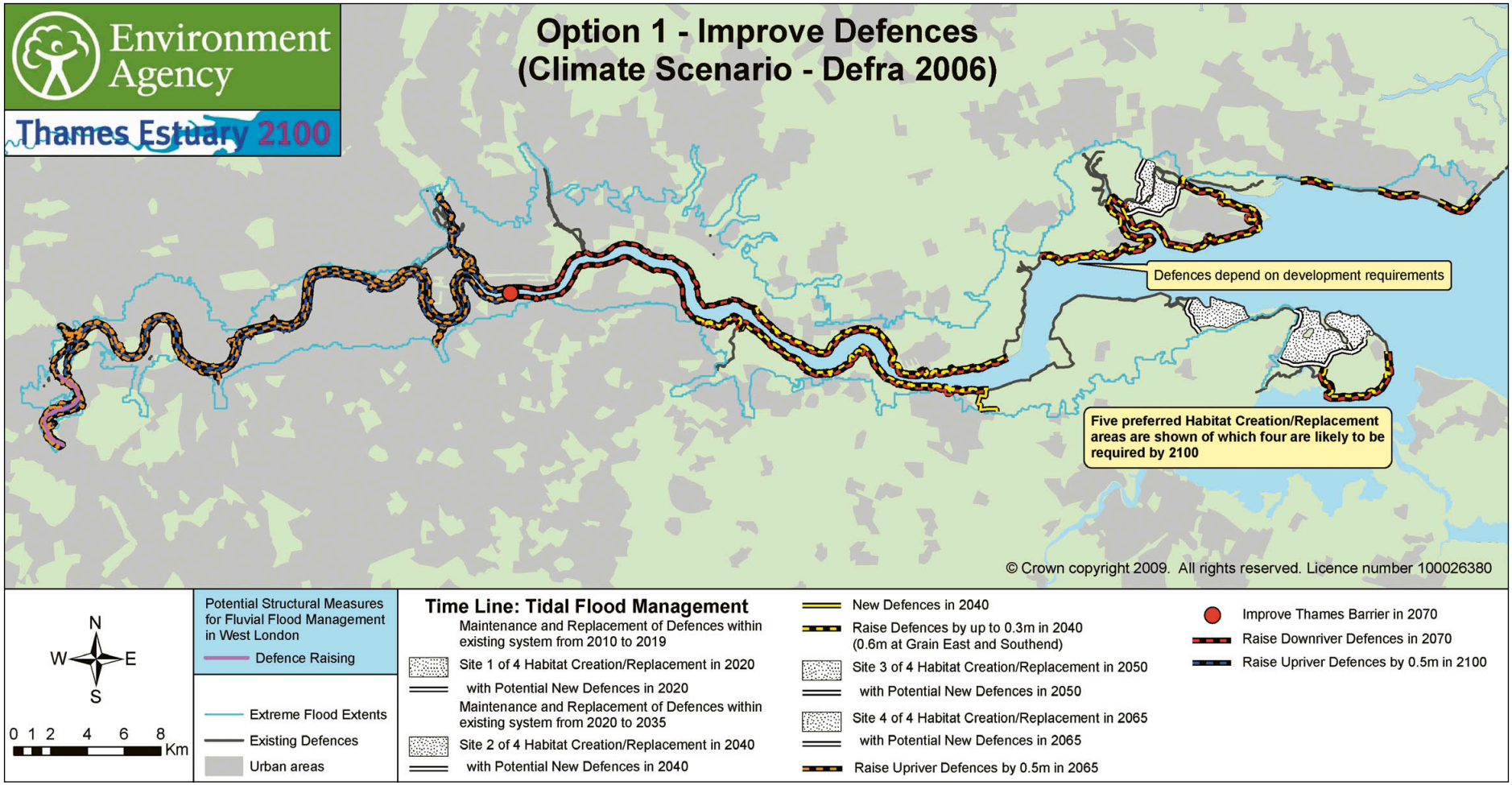
Chapter 9: TE2100 action plan: **action zone 0** – estuary-wide

The estuary-wide option	What it means
Option 4: Barrier with locks 4.1 Tilbury location 4.2 Long Reach location 4.3 Barrier with locks at Thames Barrier (when closures/year approach their limit)	A barrier with locks allows ships to pass through large openings in the same way as a barrier during periods when the barrier is open. Ship locks and small craft locks would also allow vessels to pass through the structure when the barrier is closed. A barrier with locks would be designed to be 'fail-safe' and can be closed as frequently as necessary without losing its reliability. This is the most expensive option. It is also the most damaging to the natural environment and to river commerce.

A summary of our options Appraisal

Our appraisal shows that Option 1.4 is the optimum approach for the first 60 years of the Plan under government's current guidance on climate change.

From the year 2070, our appraisal shows that Options 1.4 and 3.2 are the two front-runners, for managing tidal flood risk up to the end of this century and into the 22nd century. But with the uncertainties of long-term assessment, all four of our generic estuary-wide options will remain as candidates for appraisal post-2050.


Environment Agency
Thames Estuary 2100
Option 1 - Improve Defences
(Climate Scenario - Defra 2006)
Defences depend on development requirements
Five preferred Habitat Creation/Replacement areas are shown of which four are likely to be required by 2100
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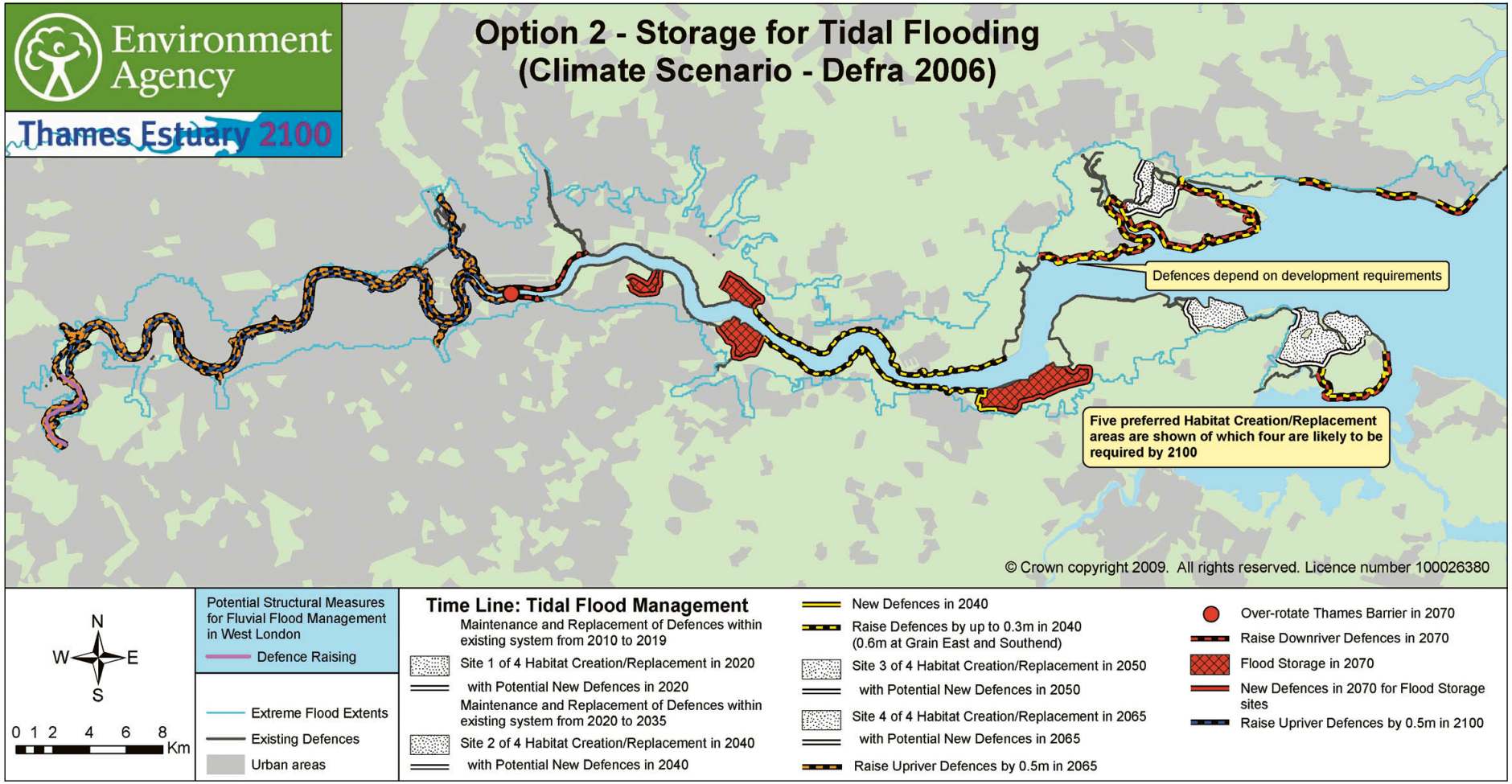
Potential Structural Measures for Fluvial Flood Management in West London
Defence Raising
Extreme Flood Extents
Existing Defences
Urban areas
Time Line: Tidal Flood Management
Maintenance and Replacement of Defences within existing system from 2010 to 2019
Site 1 of 4 Habitat Creation/Replacement in 2020
with Potential New Defences in 2020
Maintenance and Replacement of Defences within existing system from 2020 to 2035
Site 2 of 4 Habitat Creation/Replacement in 2040
with Potential New Defences in 2040
New Defences in 2040
Raise Defences by up to 0.3m in 2040 (0.6m at Grain East and Southend)
Site 3 of 4 Habitat Creation/Replacement in 2050
with Potential New Defences in 2050
Site 4 of 4 Habitat Creation/Replacement in 2065
with Potential New Defences in 2065
Raise Upriver Defences by 0.5m in 2065
Improve Thames Barrier in 2070
Raise Downriver Defences in 2070
Raise Upriver Defences by 0.5m in 2100


Environment Agency
Thames Estuary 2100
Option 2 - Storage for Tidal Flooding
(Climate Scenario - Defra 2006)
Defences depend on development requirements
Five preferred Habitat Creation/Replacement areas are shown of which four are likely to be required by 2100
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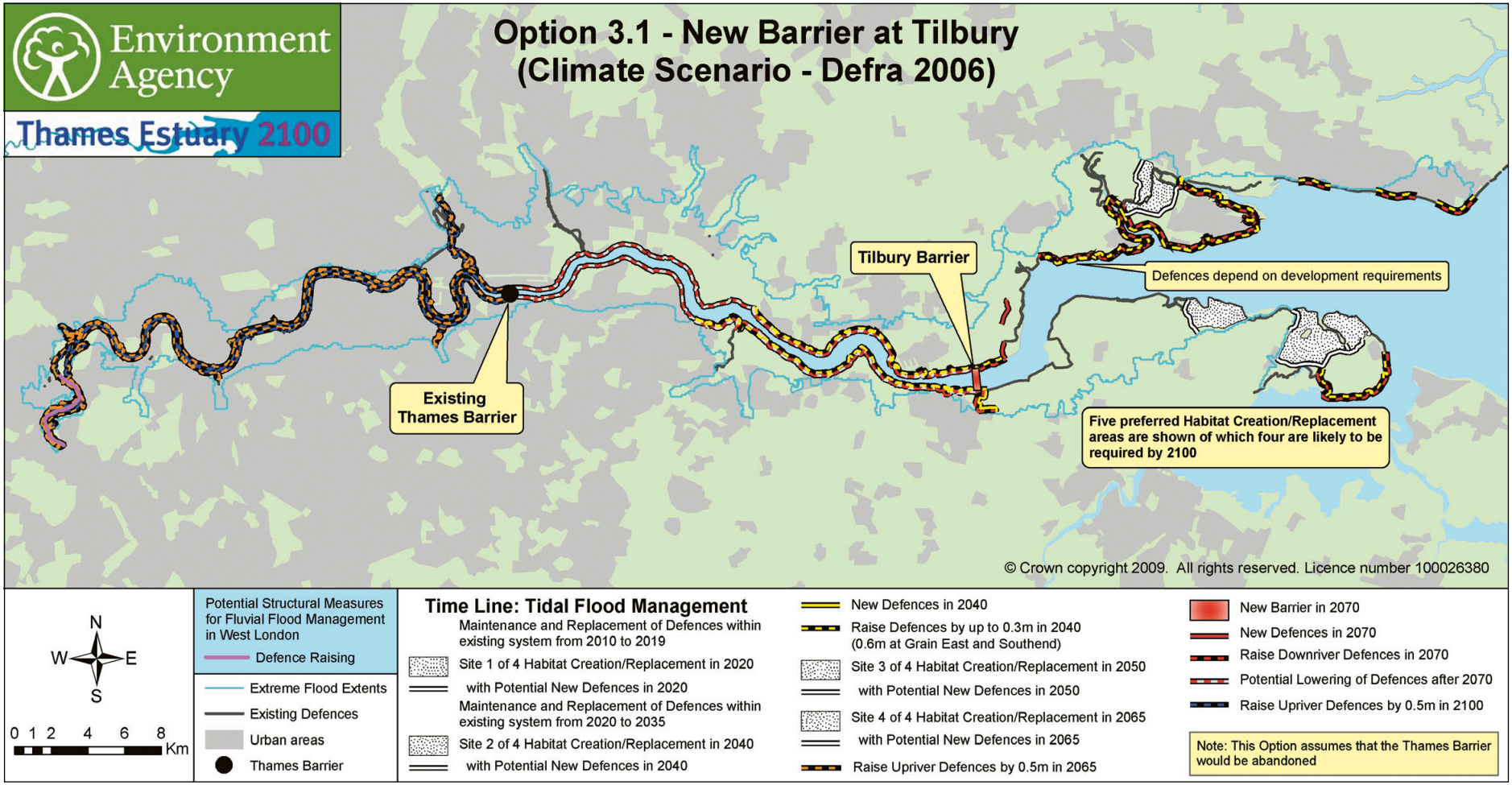
Site 2 of 4 Habitat Creation/Replacement in 2040
with Potential New Defences in 2040
New Defences in 2040
Raise Defences by up to 0.3m in 2040 (0.6m at Grain East and Southend)
Site 3 of 4 Habitat Creation/Replacement in 2050
with Potential New Defences in 2050
Site 4 of 4 Habitat Creation/Replacement in 2065
with Potential New Defences in 2065
Raise Upriver Defences by 0.5m in 2065
Over-rotate Thames Barrier in 2070
Raise Downriver Defences in 2070
Flood Storage in 2070
New Defences in 2070 for Flood Storage sites
Raise Upriver Defences by 0.5m in 2100


Environment Agency
Thames Estuary 2100
Option 3.1 - New Barrier at Tilbury
(Climate Scenario - Defra 2006)
Tilbury Barrier
Defences depend on development requirements
Existing Thames Barrier
Five preferred Habitat Creation/Replacement areas are shown of which four are likely to be required by 2100
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Potential Structural Measures for Fluvial Flood Management in West London
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Urban areas
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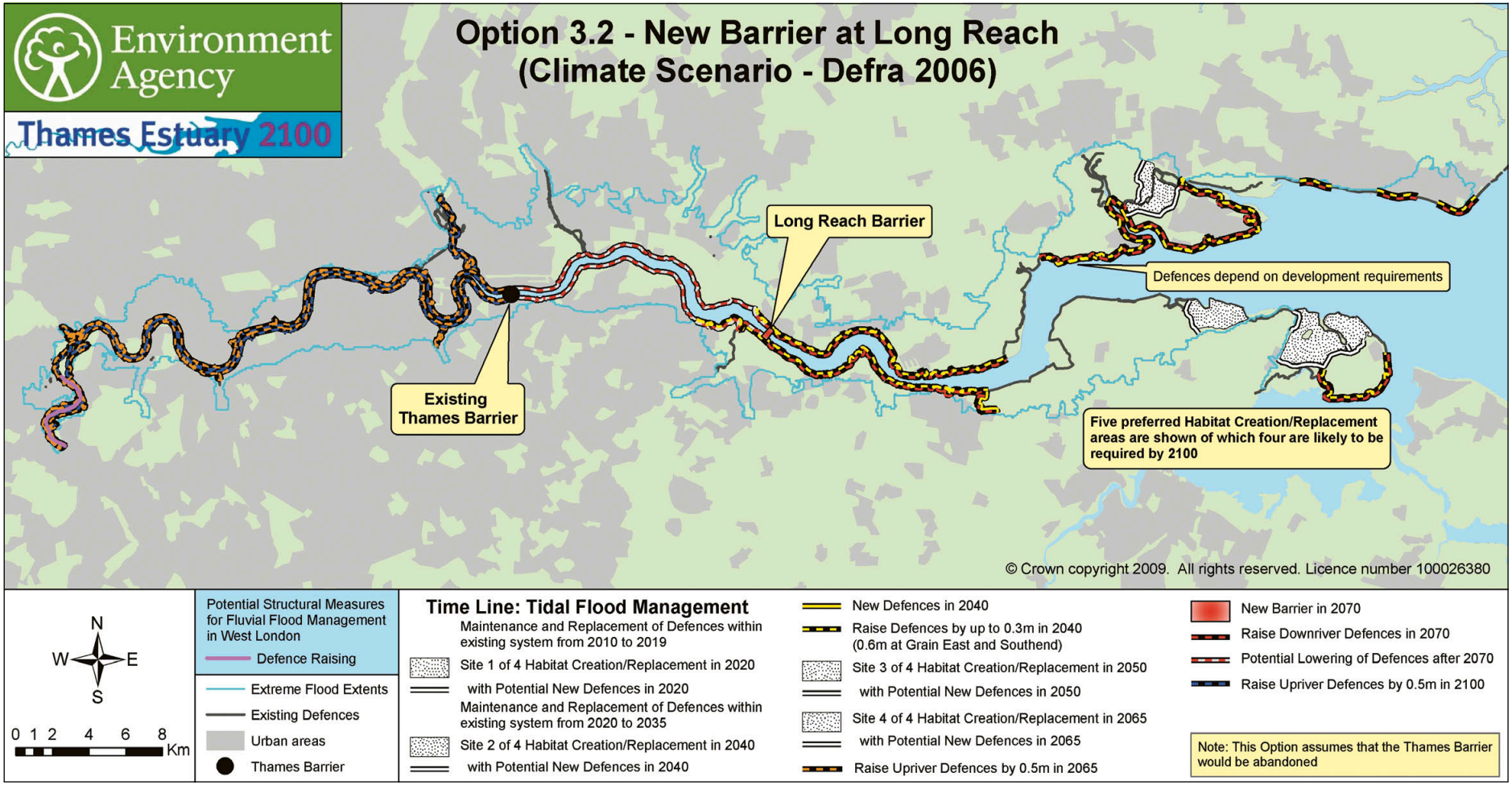
Maintenance and Replacement of Defences within existing system from 2020 to 2035
Site 2 of 4 Habitat Creation/Replacement in 2040
with Potential New Defences in 2040
New Defences in 2040
Raise Defences by up to 0.3m in 2040 (0.6m at Grain East and Southend)
Site 3 of 4 Habitat Creation/Replacement in 2050
with Potential New Defences in 2050
Site 4 of 4 Habitat Creation/Replacement in 2065
with Potential New Defences in 2065
Raise Upriver Defences by 0.5m in 2065
New Barrier in 2070
New Defences in 2070
Raise Downriver Defences in 2070
Potential Lowering of Defences after 2070
Raise Upriver Defences by 0.5m in 2100
Note: This Option assumes that the Thames Barrier would be abandoned


Environment Agency
Thames Estuary 2100
Option 3.2 - New Barrier at Long Reach
(Climate Scenario - Defra 2006)
Long Reach Barrier
Existing Thames Barrier
Defences depend on development requirements
Five preferred Habitat Creation/Replacement areas are shown of which four are likely to be required by 2100
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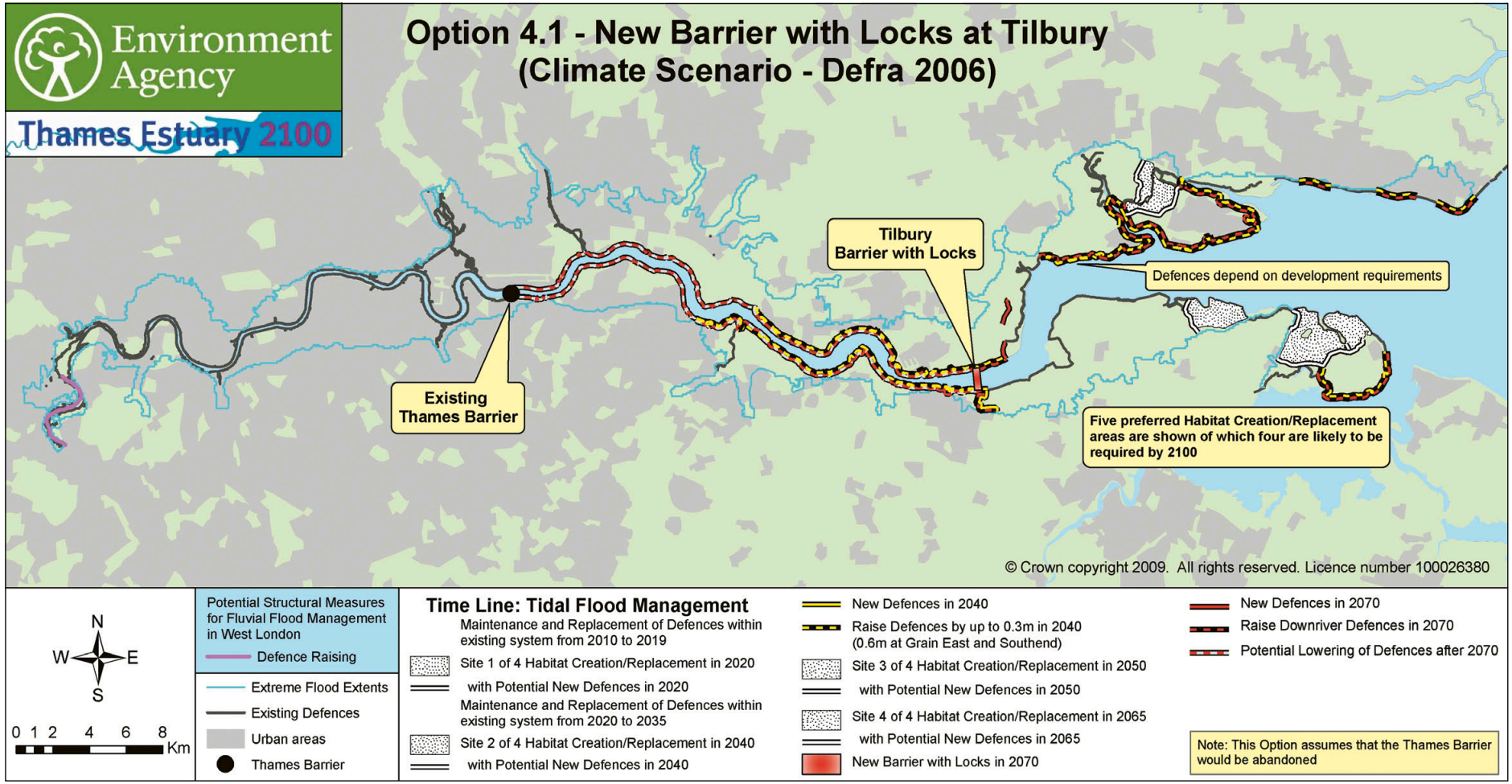
Site 2 of 4 Habitat Creation/Replacement in 2040
with Potential New Defences in 2040
New Defences in 2040
Raise Defences by up to 0.3m in 2040 (0.6m at Grain East and Southend)
Site 3 of 4 Habitat Creation/Replacement in 2050
with Potential New Defences in 2050
Site 4 of 4 Habitat Creation/Replacement in 2065
with Potential New Defences in 2065
Raise Upriver Defences by 0.5m in 2065
New Barrier in 2070
Raise Downriver Defences in 2070
Potential Lowering of Defences after 2070
Raise Upriver Defences by 0.5m in 2100
Note: This Option assumes that the Thames Barrier would be abandoned


Environment Agency
Thames Estuary 2100
Option 4.1 - New Barrier with Locks at Tilbury
(Climate Scenario - Defra 2006)
Tilbury Barrier with Locks
Defences depend on development requirements
Existing Thames Barrier
Five preferred Habitat Creation/Replacement areas are shown of which four are likely to be required by 2100
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Potential Structural Measures for Fluvial Flood Management in West London
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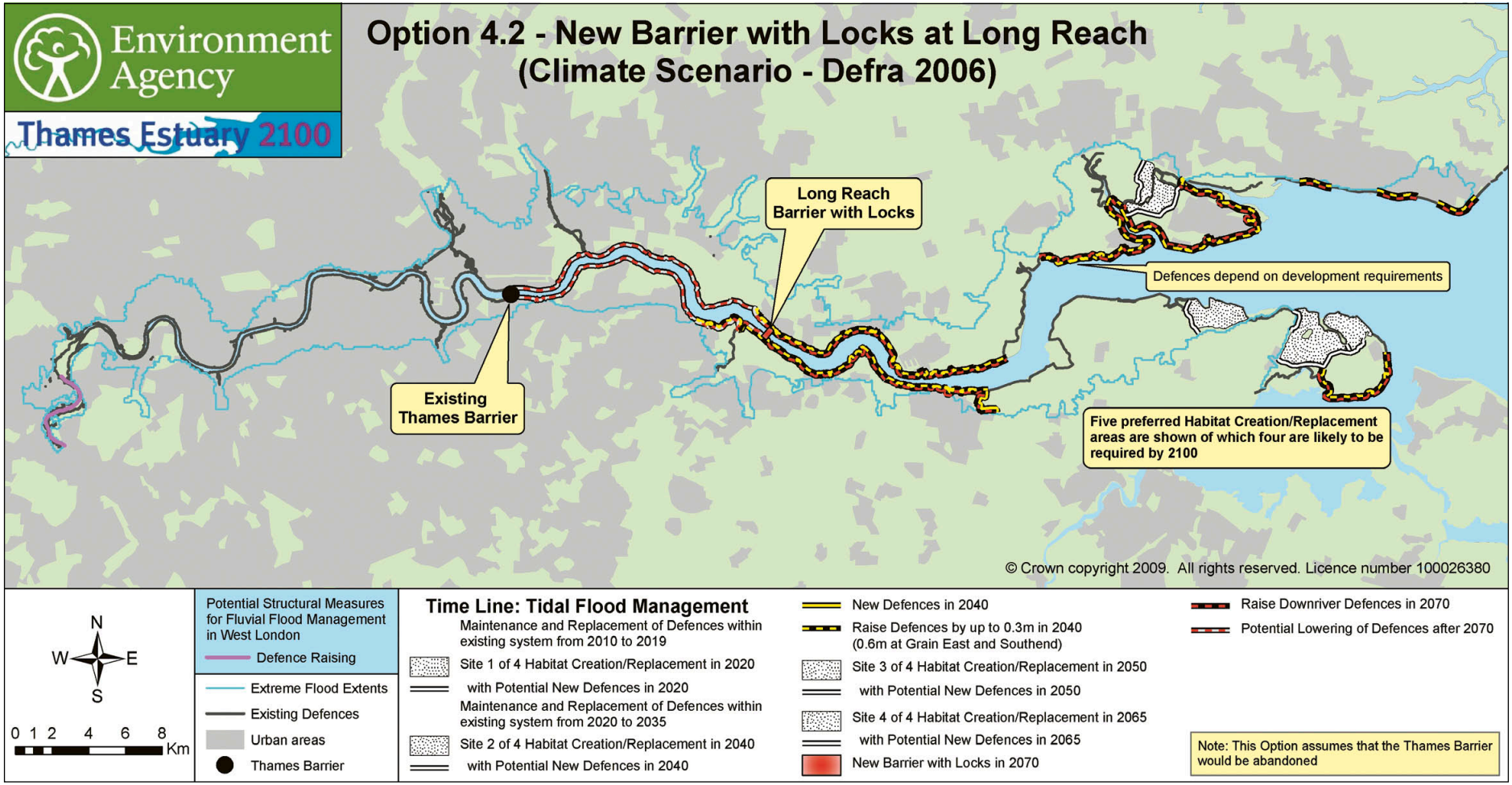
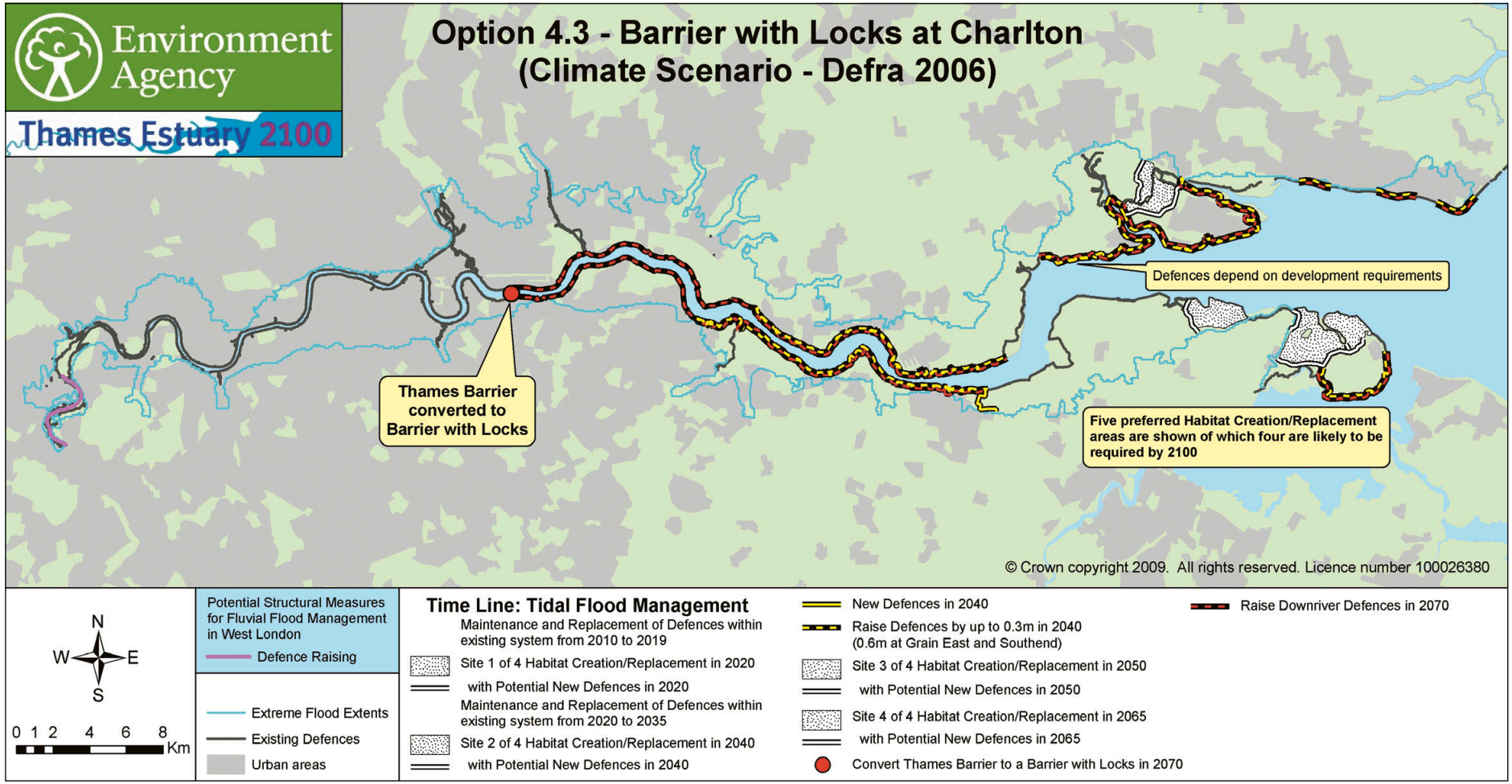
Site 2 of 4 Habitat Creation/Replacement in 2040
with Potential New Defences in 2040
New Defences in 2040
Raise Defences by up to 0.3m in 2040 (0.6m at Grain East and Southend)
Site 3 of 4 Habitat Creation/Replacement in 2050
with Potential New Defences in 2050
Site 4 of 4 Habitat Creation/Replacement in 2065
with Potential New Defences in 2065
New Barrier with Locks in 2070
New Defences in 2070
Raise Downriver Defences in 2070
Potential Lowering of Defences after 2070
Note: This Option assumes that the Thames Barrier would be abandoned



Estuary-wide option 4
(new barrier with locks)


Environment Agency
Thames Estuary 2100
Option 4.3 - Barrier with Locks at Charlton
(Climate Scenario - Defra 2006)
Defences depend on development requirements
Thames Barrier converted to Barrier with Locks
Five preferred Habitat Creation/Replacement areas are shown of which four are likely to be required by 2100
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New Defences in 2040
Raise Defences by up to 0.3m in 2040 (0.6m at Grain East and Southend)
Site 3 of 4 Habitat Creation/Replacement in 2050
with Potential New Defences in 2050
Site 4 of 4 Habitat Creation/Replacement in 2065
with Potential New Defences in 2065
Convert Thames Barrier to a Barrier with Locks in 2070
Raise Downriver Defences in 2070

Action Zone 0 – estuary-wide options

Option 1 Improve existing system
Option 2 Tidal flood storage
Option 3 New barrier (two locations)
Option 4 New barrier with locks (three locations)

[Note that all dates are based on government's current guidance on climate change – the TE2100 plan will be reviewed and updated if these predictions change]

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 0 – Recommendation 1** **Maintain and improve or replace defences (Option 1.4).** Our appraisal shows this is the optimum approach for the first 25 years of the Plan from 2010 to 2034. It will involve continued maintenance and improvement of the defences. Option 1.4 (Optimise defence repair & replacement) is shown to be 10% to 20% less expensive than the other sub-options: 1.1 Raise defences when needed 1.2 Allow for future adaptation of defences 1.3 Optimise the balance between defence replacement and repair	Environment Agency RFCCs (Regional Flood and Coastal Committees) Riparian owners with responsibility for their defences Landowners adjacent to the defences GLA and local authorities English Heritage Transport infrastructure, operators and utility providers	The Environment Agency's teams responsible for spatial planning will promote these works in partnership with landowners and Local Authority planning teams as part of ongoing development applications. The Environment Agency's teams responsible for management of the flood defence assets will promote these schemes. However, the method of managing the defences is different from the present day approach. It involves greater maintenance and repair work in addition to essential replacement. Promotion of schemes through the Environment Agency's capital replacement programme may not be appropriate for optimising maintenance and repair, and the Environment Agency will need to develop new ways of planning and implementing these works. As well as looking for ways of working better with limited resources, we will need to seek opportunities for environmental and recreational enhancements which will create a better place, and for partnerships which will help achieve this. As Operating Authority for its own defences, Southend on Sea Borough Council will promote schemes supported by the TE2100 Plan and the Essex SMP2 in the Southend area. **(continued)**

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 0 – Recommendation 1** **(continued)** 1.4 Optimise defence repair & replacement and adaptation to future change *(Cost is included in TE2100 Plan)*		Working with other initiatives will be a key element of this action. When works to flood defence structures are planned, it is important to take opportunities to integrate flood defence into developments – and ensure that the developments are designed with a proper understanding of the flood risk they face. Alignment of programmes may be required. Many of the defences are adjacent to or part of important heritage assets, habitats and landscapes. All defence works need to be sensitive to coastal and riverine features, and opportunities must be taken wherever possible to improve the river environment through these works and to integrate flood defence arrangements into the design of new riverside developments. Our recommended Option 1.4 assumes that defence structures will be raised when this additional height is required and not when the structures are replaced. This differs from the present practice of raising at replacement. If defences are not raised at replacement, the foundations for new defences should be strong enough to take future raising. This will mean larger initial constructions, which have built in adaptability for future raising.
	**Action Zone 0 – Recommendation 2** To maintain, operate, modify and improve the Thames Barrier and other active defences for the first 25 years of the Plan from 2010 to 2034. *(Cost is included in TE2100 Plan)*	Environment Agency RFCCs Riparian owners with responsibility for their defences Landowners adjacent to the defences Local authorities	This is the work which the Environment Agency does now. We will continue with our programme of operations, maintenance and replacement but we are looking for ways of working better and more effectively. We are also seeking opportunities and partnerships to deliver environmental and recreational enhancements which will create a better place. The Environment Agency will continue to undertake works or oversee the work of others to operate, maintain, modify and improve the active defences. In addition to the Thames barrier, this includes: • KGV dock gate and Gallions sluice • Barking Barrier • Dartford Barrier • Tilbury Docks Flood Gate • Fobbing Horse Barrier • East Haven Barrier • Benfleet Barrier **(continued)**

Chapter 9: TE2100 action plan: **action zone 0** – estuary-wide

	TE2100 recommended actions	Implementation partners	How this will be achieved
	Action Zone 0 – Recommendation 2 **(continued)**		• 36 major industrial floodgates • 700+ minor structures including frontage gates, outfalls, pumping stations, floodgates on locks etc For active defences owned and operated by others we will oversee their operation and maintenance. We will promote schemes through the capital programme and they will form part of strategic investment plans. As Operating Authority for its own defences, Southend on Sea Borough Council will promote schemes supported by the TE2100 Plan and the Essex SMP2 in the Southend area.
	Action Zone 0 – Recommendation 3 Habitat Creation site 1 of 4 In 2020 the first of four intertidal habitat creation sites will be implemented. Valuable habitat is being lost because our defences are preventing it from migrating landwards as sea level rises and over the 100-year life of our Plan, 876 hectares of new intertidal habitat will be needed. We have identified five sites which have the right characteristics for habitat creation. The location of the sites are shown on the estuary-wide option maps. The sites are: • Grain Marshes • All Hallows Marshes • St Mary's Marsh (with possible further expansion to the west)	Environment Agency RFCCs Natural England Landowners Local authorities Public and local interest groups RSPB Wildlife Trusts Kent County Council Essex County Council English Heritage Friend of North Kent Marshes	Planning and groundworks for intertidal habitats will commence 10 years before implementation of the managed realignment. This preliminary work includes construction of a new line of defence to protect people and properties from the risk of flooding from the new intertidal zone. It also includes, in some cases, recharging the land levels so that the correct habitat develops. It may take up to 10 years after the realignment is implemented before the habitat is fully established at the site. We will be looking for partnership arrangements to manage these sites and get the best for the natural environment, for the local population and for visitors. Some of the sites identified have designated coastal grazing marshes. If these sites are selected, new freshwater habitat will be needed to compensate for the loss of these designated areas as a result of intertidal habitat creation. The following sites have been identified as having the potential to support the interest features that could be lost, either through enhancement of existing features or creation of new habitat features: • Dartford Marshes East • Crayford Marshes • Ingrebourne River valley • Shorne Marshes West **(continued)**

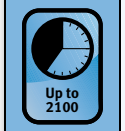
	TE2100 recommended actions	Implementation partners	How this will be achieved
	## Action Zone 0 – Recommendation 3 **(continued)** • West Canvey Marshes • Bowers Marsh The Environment Agency sees habitat creation as a positive step towards the goal of sustainability and supporting the habitats and species that make the Thames estuary internationally important. As managers of flood defences we also have an obligation to maintain the ecological integrity of internationally designated habitats where it is determined our defences are having a detrimental effect. This habitat must be replaced. Intertidal habitat can form a valuable function of absorbing wave and surge energy thus protecting the land and the defence structures behind. *(Cost of new intertidal habitat is included in TE2100 Plan, cost of new freshwater habitat not included in TE2100 Plan)*		• Cooling Marshes • Tilbury Marshes and West Tilbury Marshes • Hadleigh Marsh East • High Halstow For compensatory grazing marsh enhancements, the following sites have been identified: • Dartford Marsh • Crayford Marshes • Fobbing Marshes • Vange Marshes • Erith Marshes In addition to these legislative requirements for habitat creation measures, other opportunities for habitat enhancement have been identified. These are detailed in the relevant action zone discussions. There will be no increased tidal flood risk to the public as a result of the intertidal habitat creation schemes as they will always include a new defence construction on the landward side of the new habitat to protect people and property. This provides major opportunities for improving the reliability of the defence system. It also provides opportunities for enhancements for recreation, key infrastructure, visitors centres and other facilities. Early indications are that of the five sites identified, a possible extension to the west of St Marys Marsh and Bowers Marsh are the most likely to come on stream in the short and medium term of our Plan. The needs of Natura 2000 sites are recognised and the approach is to utilise sites of lowest inherent environmental value first.

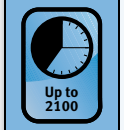
Chapter 9: TE2100 action plan: **action zone 0** – estuary-wide

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 0 – Recommendation 4** To maintain and improve or replace defences (Option 1.4). Our appraisal shows this is the optimum approach for the 15 years of the Plan from 2035 to 2049. It will involve continued maintenance, operation and improvement of the defences. Option 1.4 (Optimise defence repair & replacement) is shown to be 10% to 20% less expensive than the other sub-options (see Recommendation 1 above). *(Cost is included in TE2100 Plan)*	Environment Agency RFCCs Riparian owners with responsibility for their defences Landowners adjacent to the defences Local authorities	The period 2035 to 2049 includes raising of both upriver and downriver defences. There will also be a major programme of rebuilding and refurbishment of the defences as they come to the end of their useful lives. This provides many opportunities for creating a better place and planning for a better riverside environment. These opportunities can be planned through the Riverside Strategies (Action zone 0 – recommendation 16). The Environment Agency and other Operating Authorities (Southend on Sea Borough Council) will promote schemes to undertake these works in partnership with other agencies to maximise multifunctional spaces and uses of the flood risk management infrastructure. The Environment Agency's staff responsible for dealing with proposed development in areas at risk of flooding will promote these works as part of ongoing development applications. Working with other initiatives will be a key element of this action and the Riverside Strategies will enable multi partner planning for short, medium and long term activities. When works to flood defence structures are planned, it is important to take opportunities to integrate flood defence into developments – and ensure that the developments are designed with a proper understanding of the flood risk they face. Alignment of programmes may be required. Many of the defences are adjacent to or part of important heritage assets, habitats and landscapes. All defence works need to be sensitive to coastal and riverine features, and opportunities must be taken wherever possible to improve the river environment through these works and to integrate flood defence arrangements into the design of new riverside developments.
	**Action Zone 0 – Recommendation 5** To maintain, operate, modify and improve the Thames Barrier and other active defences during the 15 year period of the Plan from 2035 to 2049. *(Cost is included in TE2100 Plan)*	Environment Agency RFCCs Riparian owners with responsibility for their defences	This is the work which the Environment Agency does now. We will continue with our programme of operations, maintenance and replacement but we are looking for ways of working better and more effectively. We are also seeking opportunities and partnerships to deliver environmental and recreational enhancements which will create a better place. The Environment Agency will continue to undertake works or oversee the work of others to operate, maintain, modify and improve the active defences. **(continued)**

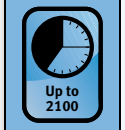
	TE2100 recommended actions	Implementation partners	How this will be achieved
	Action Zone 0 – Recommendation 5 **(continued)**	Landowners adjacent to the defences Local authorities	In addition to the Thames barrier, the active structures include: • KGV dock gate and Gallions sluice • Barking Barrier • Dartford Barrier • Tilbury Docks Flood Gate • Fobbing Horse Barrier • East Haven Barrier • Benfleet Barrier • 36 major industrial floodgates • 700+ minor structures including frontage gates, outfalls, pumping stations, floodgates on locks etc As Operating Authority for its own defences, Southend on Sea Borough Council will promote schemes supported by the TE2100 Plan and the Essex SMP2 in the Southend area. The "weak links" in the tidal defence system are often the active structures which are in multiple ownerships and operating regimes. Where necessary fixed defences could be put in place to replace active structures to provide an appropriate level of risk management to property at risk. Restoring natural function to the floodplain by removing structures supports the provision of an appropriate and sustainable flood risk management system and aligns with the Government's Making Space for Water strategy.
	Action Zone 0 – Recommendation 6 Habitat Creation – site 2, 3, and 4.	Environment Agency RFCCs Natural England Landowners	Monitoring and review will be undertaken to confirm actual loss of intertidal habitat compared to that which was projected. Adjustment may need to be made to planned replacement activities. Intertidal Habitat creation will require compensatory freshwater habitat creation. See Action zone 0 – Recommendation 3 for additional details and considerations. **(continued)**

Chapter 9: TE2100 action plan: **action zone 0** – estuary-wide

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 0 – Recommendation 6** **(continued)** In this period the remaining habitat creation sites will be implemented in 2040, 2050 and 2065. Further sites will be realigned to make up the necessary 876 hectares of intertidal habitat creation required this century. Site options shown on the estuary-wide option maps are: • Grain Marshes • All Hallows Marshes • St Mary's Marsh (with possible further expansion to the west) • West Canvey Marshes • Bowers Marsh *(Cost is included in TE2100 Plan)*	Local authorities Public and local interest groups RSPB Wildlife Trusts Kent County Council Essex County Council English Heritage Friend of North Kent Marshes	
	**Action Zone 0 – Recommendation 7** **To Implement our "end of the century" option between 2050 and 2070.** Although the decision on the "end of the century" generic estuary-wide option will not be made until 2050, two 'front runners' have emerged at this stage. Option 1.4 – Improve Existing system	Environment Agency RFCCs Defra/CLG Landowners Local authorities Developers The public	This will be a major multi billion pound construction project and the arrangements for implementation are likely to differ from our normal defence construction projects. 2070 is a long way ahead but the potential TE2100 "end of the century" options must always be known as part of a recognised TE2100 Plan for planning purposes – even if later preference is shown for one the other generic estuary wide options in a subsequent Plan review. **(continued)**

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 0 – Recommendation 7** **(continued)** Option 3.2 – New Barrier at Long Reach The Long Reach barrier site is within this zone. If a new barrier is constructed between 2050 and 2070 (Option 3.2), further defence raising upstream of the barrier site will not be needed and there will be an opportunity to lower the defences by up to a metre. For the purposes of costing the final epoch (2050–2100) of the Plan, Option 3.2 (New Barrier at Long Reach) has been used as this performed marginally better in our economic appraisal. Our strategic environmental assessment (SEA) indicated that there was little between the options but barriers were less preferable because they caused more damage to natural processes and habitat. *(Cost of option 3.2 included in TE2100 Plan)*	Kent County Council Essex County Council English Heritage GLA Floodplain users	Our recommendations in the TE2100 Plan presented here are based on conditions now, in 2009, but the final decision on the end of the century options will not be taken until the Plan review of 2050 (based on government's current climate change guidance). Intermediate reviews will be undertaken a minimum of 10 yearly intervals – or more frequently if there are significant changes to one or more of the TE2100 indicators for change. There will be further consultation each time the Plan is reviewed. Our 2009 consultation has provided a "snapshot" of Estuary stakeholder views and this will form a starting point for measurement of public attitudes in the future. We will promote the schemes which make up our end of the century options in consultation with Government, and other partners. There are major opportunities for reshaping the Estuary landscape and character as part of these works. The TE2100 10-yearly update will include a review of Action Zone 0 – Recommendation 7 against the 10 TE2100 indicators for change and will recommend whether the end of the century chosen option has changed. [Note that although cost of Option 3.2 has been included in the TE2100 Plan for long term investment planning purposes, there is no recommended option beyond 2070 at this stage in the TE2100 Plan.]

Chapter 9: TE2100 action plan: **action zone 0** – estuary-wide

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 0 – Recommendation 8** To maintain, operate, modify and improve the Thames Barrier or new Barrier and other active defences from the year 2070. *(Cost of Option 3.2 included in TE2100 Plan – although there is no recommended option beyond 2070 at this stage)*	Environment Agency RFCCs Riparian owners with responsibility for their defences Landowners adjacent to the defences	The nature of these works will depend on options adopted following the 2050 review. We cannot know now what institutional arrangements there will be as we approach the 22nd century, but our TE2100 vision imagines an environment where the Thames estuary riverside continues to thrive, is increasingly enjoyed and respected by the people who live, work and visit there. This means that the actions established in action zone 0 will be continued by whoever is looking after our environment at that time. The detailed programmes will be developed following the 2050 review and there will be further consultation at that time. Meanwhile the TE2100 10-yearly review will update the long-term programme with the latest recommendations.
	**Action Zone 0 – Recommendation 10** Development of a land strategy for the Thames estuary. We recommend the development of a Land strategy for the Thames estuary to support the TE2100 Plan. This land strategy will have four purposes: • To safeguard land which may be needed for future flood risk management purposes (future tidal flood storage and/or additional capacity to contain other sources of flooding). • To co-ordinate the planning and ensure that we get the best out of the habitat creation schemes.	Environment Agency RFCCs Defra, Natural England English Heritage National Farmers' Union (NFU)	The Environment Agency will lead the development of the Thames estuary land strategy and details will be included the TE2100 implementation blueprint currently under preparation. The document will recognise the following strategic plans and vision statements: Parklands Vision The GLA London Plan's Blue Ribbon Network The Thames Landscape Strategies Thames Estuary Partnership's Thames Strategy East The Thames Estuary Path Our flood and coastal risk management plans for the Thames estuary Other strategic plans The TE2100 Thames estuary land strategy will be prepared and owned by the Environment Agency. It will be a multi agency document which will support and complement the Riverside strategies (Action Zone 0 – Recommendation 16) which we recommend are prepared and owned by local authorities. **(continued)**

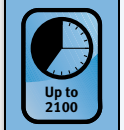
	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 0 – Recommendation 10** **(continued)** • Many of our defences are needed to prevent contaminant from leaching into the river and these areas are not useful for other purposes. There is a need to establish a programme of investigations and remedial works with the key objective of removing the constraints to flood risk management (and other uses) caused by the contamination. • To bring together the various strategic plans and vision statements in the Estuary. This will promote better communication and collaboration between partners. It will also assist in ensuring that opportunities to enhance resilience and landscape/biodiversity inform planning within the floodplain of the River Thames. *(Cost of preparing land strategy is not included in TE2100 Plan as this is the work we do now and the TE2100 Plan will assist in further directing our efforts)*	Greater London Authority (GLA) The Thames Landscape Strategies Thames Estuary Partnership Other strategic planners Landowners and other interest groups	The Land Strategy brief will include further historic landscape assessment and dialogue with English Heritage to ensure that the Land Strategy includes: • A consideration of the potential impact of archaeological finds on the areas proposed for replacement habitat or other works. • Design frameworks to guide the development of local schemes. We cannot know what institutional arrangements there will be as we approach the 22nd century, but our TE2100 vision imagines an environment where the Thames estuary is increasingly enjoyed and respected by the people who live and work there and those who visit. We believe that this land strategy will communicate this vision for the Estuary and assist in its integration into existing and future plans and programmes.

Chapter 9: TE2100 action plan: **action zone 0** – estuary-wide

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 0 – Recommendation 11** **Agree partnership arrangements for floodplain management – now to the end of the century.** Many floodplain management actions are already taken by Government, emergency services, utility providers and others. Our studies show how stronger partnerships, improved co-ordination and additional investment in priority areas can significantly improve safety and reduce damages. We have tested new actions and identified potential investment in specific policy units to inform local delivery plans. Costs for this action are included in the TE2100 Plan. The costs estimated are the extra costs associated with TE2100 proposals, over and above existing "business as usual" expenditures (although the TE2100 Plan will focus and inform our collective efforts). So the costs of standing Environment Agency and local authority planners, and the emergency services, are not included.	Environment Agency RFCCs Defra/CLG/HCA Local authorities Development Agencies and Partnerships Emergency services Transport for London Utility and transport providers Key landowners and developers Natural England English Heritage	The Environment Agency will discuss with implementation partners to agree strategic scope of measures and future funding requirements. A working group will be established to ensure agreement between implementation partners on the strategic approach, and roles and responsibilities for achieving it. The objectives of this action are that local floodplain management measures are in place or planned within 25 years and all site owners supportive of approach and confidence maintained. We will be looking for ways of working more effectively and improving efficiency by strengthening our partnerships. The Environment Agency will support community engagement programmes to ensure the public, businesses and other groups understand, are involved in and supportive of the flood plans. In particular it is important that individuals understand their own level of risk, and the required level of self-preparedness. An Important action during the preparation phase of this action is to undertake an audit of resilience to flooding of key sites. The Environment Agency will ensure that businesses and communities at risk are informed of the risks, particularly for vulnerable communities (e.g. those in care homes and mobile homes) and what action has been taken or is required – and who is responsible as the risk owner. In addition, this action recommends the maintenance and improvement of flood forecasting and warning systems, particularly for tidal flood warning on the Thames. Tidal forecasting and flood warning is a rapidly developing and improving area of flood risk management and the system is operated to a high standard. Of necessity, a precautionary approach is taken and in cases of doubt, the barrier closure rules will trigger a closure. Our Plan development has shown that with further improvement, decision making for barrier closures can be improved. This will become increasingly important as increasing climate change impacts put pressure on the decision-making process. In the future there will be an increasing number of "close call" closure decisions and a strategy is needed to avoid burdening the system with precautionary closures. **(continued)**

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 0 – Recommendation 11** **(continued)** An early estimate for the cost of a range of floodplain management activities is around £2bn to 2100. These additional costs include: • pre-event measures; • enhanced forecasting and warning; • secondary defences for key infrastructure (a series of large one-off investments, with the first programme in 2020); • flood resistance and resilience measures for property (assumed to be only taken up in the longer term, after 2050); • lost development benefit (opportunity cost) to the property sector because of increased land-use planning restrictions (it was assumed these start to be implemented from 2020 taking a century to build up to full "strength"); • preparation of riverside strategies and other activities to promote partnership in floodplain management (Action Zone 0 – Recommendation 16).		Note that the floodplain management costs listed are the financial and economic costs relating to additional floodplain management activities. These are high level costs and an early task for the TE2100 Legacy team will be to investigate how these costs are applied at local scale.

Chapter 9: TE2100 action plan: **action zone 0** – estuary-wide

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 0 – Recommendation 12** To monitor and maintain the TE2100 plan for the first 25 years from 2010 to 2034. This includes the key task of monitoring the 10 TE2100 indicators for change through the monitoring programme established by the TE2100 Legacy arrangements (Action zone 0 – Recommendation 15). *(Standing Environment Agency costs not included in the TE2100 Plan)*	Environment Agency RFCCs Met office and as Action Zone 0 – Recommendation 11	The Environment Agency will undertake the following activities: • Monitor key indicators from 2010 to 2034; • Oversee strategic implementation of actions to ensure a "line of sight" back to the Plan; • Undertake an annual audit of the action plan, identifying blockages to progress and facilitating their resolution; • Maintain and develop the stakeholder relationships and partnerships required for the successful implementation of TE2100 Plan; • Maintain the TE2100 catalogue of information and data sets, ensuring that these are updated as appropriate to inform Plan review and to disseminate the learning of TE2100 to the wider flood risk management industry; and, • Review and update TE2100 Plan in 2020 and 2030 or more frequently if this is required and ensure that any changes are reflected in revised action plans.
	**Action Zone 0 – Recommendation 13** To monitor and maintain the TE2100 Plan for the middle 15 years from 2035 to 2049.	Environment Agency RFCCs Met office and as Action Zone 0 – Recommendation 11	Oversee strategic implementation of actions including annual audit of action plan, maintain and manage TE2100 catalogue. Maintain and develop stakeholder relationships and partnerships. Monitor key indicators from 2035 to 2049. Review and update TE2100 Plan in 2040.
	**Action Zone 0 – Recommendation 14** To monitor and maintain the TE2100 Plan from 2050 to the end of the century.	Environment Agency RFCCs Met office and as Action Zone 0 – Recommendation 11	Oversee strategic implementation of actions including annual audit of action plan, maintain and manage TE2100 catalogue. Maintain and develop stakeholder relationships and partnerships. Monitor key indicators from 2050 to the end of the life of the Plan. Review and update TE2100 Plan every 10 years from 2050 to the end of the life of the TE2100 Plan.

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 0 – Recommendation 15** To formalise TE2100 Legacy handover arrangements. Stakeholder responses have indicated the need for greater support to and clarity on roles and responsibilities as implementation partners. There is also need for simpler documentation and guidance notes. Concern has been expressed that the knowledge of the TE2100 team will be lost and that with the end of the TE2100 project there will be a break in continuity in stakeholder relationships and developing partnerships. *(Standing Environment Agency costs, not included)*	Environment Agency RFCCs	The Environment Agency will establish a Migration Plan to ensure that the TE2100 Plan is embedded in the Environment Agency's business and that of our implementation partners. Specific tasks will include: • establishment of a monitoring programme; • preparation of a User Manual for use by colleagues and others using the TE2100 Plan; • development of tools and materials including guidance for design and appraisal of investments and local risk-based decision making tools. Training plus technical workshops as required will be provided to ensure the TE2100 Plan is fully embedded in the programmes of Environment Agency teams and other implementation partners; • support to those preparing business cases for the investments which will flow from the TE2100 Plan and support to governance and assurance arrangements for TE2100 implementation; • management of the TE2100 catalogue of data and information; • establish the systems which will be needed to oversee strategic implementation of actions, to ensure a "line of sight" back to the Plan and to use monitoring information to review and update the Plan; • ensure that arrangements for third party contributions and funding are understood and aligned with national and local contributions and funding policies.
	**Action Zone 0 – Recommendation 16** To prepare Riverside Strategies for each local authority. *(Cost to the spatial planning sector for this action is included in the TE2100 Plan)*	Environment Agency RFCCs Local authorities, neighbourhood groups and as Action Zone 0 – Recommendation 11	The purpose of these Riverside strategies is to provide a framework for sharing plans for the riverside which takes into account the strategic changes to the flood defences over the life of the TE2100 Plan. A key purpose of the riverside strategies is to improve floodplain management in the vicinity of the river, to create better access to the riverside and improve the riverside environment as a result of planned interventions. Many of the defences are adjacent to or part of important heritage assets, habitats and landscapes. All riverside works need to be sensitive to coastal and riverine features, and opportunities must be taken wherever possible to improve the river environment through these works and to integrate flood defence arrangements into the design of new riverside developments. **(continued)**

Chapter 9: TE2100 action plan: **action zone 0** – estuary-wide

	TE2100 recommended actions	Implementation partners	How this will be achieved
	Action Zone 0 – Recommendation 16 **(continued)**		We recommend that the Riverside Strategies are prepared and owned by the Local Authorities or neighbourhood groups. They will be multi agency documents which will support and complement the TE2100 Thames estuary land strategy (Action zone 0 – Recommendation 10) which will be prepared and owned by the Environment Agency.

Action plan for zone 1

11 actions identified

Description of the policy units

- Richmond
- Twickenham
- Barnes & Kew
- Hammersmith

This section describes the 11 actions for zone 1 – west London which have been identified through the TE2100 Plan. The actions are described under the following headings:

- TE2100 recommended actions (and whether or not costs for this have been included in the TE2100 Plan)
- Implementation partners
- How this will be achieved.

"I appreciate your policies are for the long-term but I do feel that those of us who own properties, that will be affected, need to plan well in advance. It is vital that the right programme, help and advice is available to us."

Local resident

Policy unit – Richmond

Richmond riverside

Policy: Our recommended flood risk management policy for Richmond policy unit is policy P3 to continue with existing or alternative actions to manage flood risk. We will continue to maintain flood defences at their current level, accepting that the likelihood and/or consequences of a flood will increase because of climate change.

Description

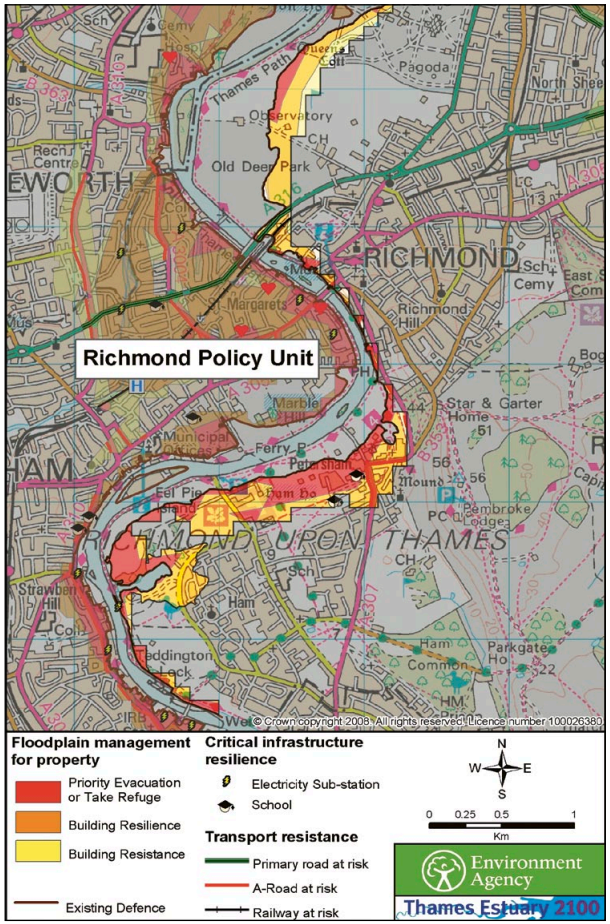
The Richmond policy unit consists of a relatively narrow floodplain along the Thames, much of which floods regularly and is occupied by parks and gardens. The amount of property at risk is small but there are some historic and important sites including Ham House and part of Kew Gardens. There are two schools and three electricity substations in the flood risk area, as well as the Richmond lock and weir. The developed floodplain is narrow and therefore the benefits of improving defences are limited. This policy unit is a very environmentally sensitive area, where defence improvements should enhance the landscape and not have adverse impacts. The area is covered by the Thames Landscape Strategy Hampton to Kew, which includes a vision for managing and improving the landscape including better public access to the river. There is public access along the riverside for the full length of the frontage, much of which is in the park areas.

Sources of flooding

- Tidal from the Thames upriver of the Thames Barrier (probability of 0.1% per annum, barrier controlled); flood depths up to 2 m if the Thames Barrier failed.
- Fluvial and tidal/fluvial from the Thames (probability ›1% per annum; flood depths up to 3 m).
- Local drainage.

Existing flood risk management system

- The Thames Barrier, to control tidal water levels.
- The Thames Barrier is also used to reduce fluvial flood levels.
- Secondary tidal defences along the Thames frontage.
- Flood forecasting and warning.



At risk in Richmond policy unit

There are no fluvial flood defences but existing tidal defences provide some protection against fluvial flooding downriver of Teddington. There are some undefended areas between the defences and the Estuary.

Policy context

This policy unit lies within the Thames CFMP area, and also the area covered by the Thames Landscape Strategy (Hampton to Kew). Some development is planned in Richmond but the impact on the floodplain would be small.

Vision

Our vision for the Richmond policy unit is to provide flood risk management within the constraints of a P3 policy, that enhances the landscape and amenity of the area, and involves local communities, businesses and agencies in flood risk management. Suggested requirements are for targeted improvements and new defences where public access and views of the Estuary are maintained and enhanced.

Local issues and choices

The Richmond policy unit is the narrow strip of floodplain running along the eastern bank of the Thames from Teddington, past the Old Deer Park to the edge of Kew Gardens. There is a risk of fluvial flooding in Richmond from the tidal Thames.

At present, the Thames Barrier can be closed to reduce fluvial flood risk. But climate change will increase the number of closures required to protect against rising tides. With increased and more intense rainfall, fluvial flood risk will also increase. The Thames Barrier will be less and less available to assist with managing this fluvial flood risk as it will need to be conserved for tidal flood risk management – the purpose for which it was designed. (The particular constraint is the annual number of closures for the Barrier, as this must be limited to reduce the risk of failure and ensure readiness of the Thames Barrier for tidal surge flood conditions.)

The Thames Barrier will continue to provide a high standard of protection against tidal flood conditions, but over the next 25 years its use for fluvial flood risk management will be gradually reduced. Choices for managing this risk are given in action plan table for zone 1.

For the Richmond policy unit this means that we have 25 years to plan and put in place alternative measures for managing freshwater flood risk. This means that vulnerable areas, such as undefended islands, will have to rely upon floodplain management measures in the future with localised defences to protect specific properties where this can be justified. Floodplain management measures include resistance and resilience of properties and increased reliance on flood warning and community flood management strategies. An opportunity for wetland habitat restoration has been identified in action plan table for zone 1.

Policy unit – Twickenham

Policy: Our recommended flood risk management policy for Twickenham is policy P3 to continue with existing or alternative actions to manage flood risk. We will continue to maintain flood defences at their current level accepting that the likelihood and/or consequences of a flood will increase because of climate change.

Description

The Twickenham policy unit has a relatively narrow floodplain along the Thames, although there is a large tidal/fluvial floodplain area on the River Crane and a smaller area on the River Brent. The flood risk areas are mainly residential but also contain parks and gardens including Syon House and Marble Hill Park. There are six schools, four care homes, 12 electricity substations, a hospital and major arterial routes and railway lines in the flood risk area. This is an environmentally sensitive area, where flood defence improvements should be designed to enhance the landscape and minimise adverse impacts. The area is covered by the Thames Landscape Strategy Hampton to Kew, which includes a vision for managing and improving the landscape including better public access to the river. There is public access to the riverside in parts of the policy unit, but other areas are privately owned.

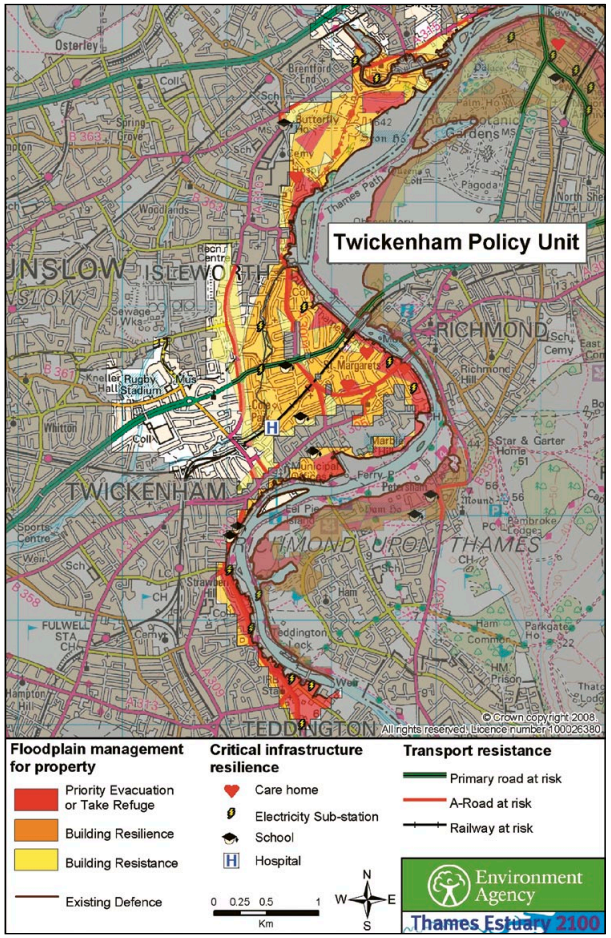
Sources of flooding

These are the same as for the Richmond policy unit, but in addition there are the following sources of flood risk:

- Fluvial from the River Crane, exacerbated by backing up from the Thames (probability >1% per annum, flood depths up to 2 m). The River Crane has an extensive floodplain in the tidal/fluvial interaction zone.
- Fluvial and tidal/fluvial from the River Brent (probability 1% per annum, flood depths up to 2 m).
- Fluvial and tidal/fluvial from the Duke of Northumberland's River. The flood risk is believed to be small.
- Local drainage.
- Groundwater flooding from superficial strata, possibly connected to Thames levels.

Existing flood risk management system

- The Thames Barrier, to control tidal water levels.
- The Thames Barrier is also used to reduce fluvial flood levels.
- Secondary tidal flood defences along the Thames frontage and the lower Brent.



At risk in Twickenham policy unit

- The Crane gates that prevent high water levels in the Thames entering the River Crane. They are only effective when Crane flows are relatively low. When fluvial flows on the River Crane are high, the gates open even if the Thames water level is high.
- Local fluvial defences on the River Crane.
- Flood forecasting and warning.

Teddington

There are no formal fluvial flood defences on the Thames. The existing tidal defences do however provide some protection against fluvial flooding downriver of Teddington. The current estimated standard of protection provided by these defences at Teddington is 3% per annum (1:30). There are some poorly defended areas including areas between the defences and the Estuary, and Eel Pie Island. Flood warning arrangements for these areas include warning signs and lights.

Policy context

The Twickenham policy unit lies within the Thames CFMP area. It is also in the area covered by the Thames Landscape Strategy (Hampton to Kew). Some development is planned in Twickenham but the impact on the floodplain would be small.

Vision

Our vision for this policy unit is to provide flood risk management within the constraints of a P3 policy, that enhances the landscape and amenity of the area, and involves local communities, businesses and agencies in flood risk management.

Local issues and choices

There is a risk of fluvial flooding in Twickenham from the tidal Thames. Choices for managing this risk are given in the action plan for Action Zone 1. As for the Richmond policy unit, at present, the Thames Barrier is closed to reduce fluvial flood risk. However, this use will be significantly reduced in order to conserve the barrier for tidal flood risk management. This means that vulnerable areas, for example undefended islands such as Eel Pie Island, will increasingly have to rely upon floodplain management and localised defence measures in the future.

Measures will also be required for tributary flooding, particularly from the River Crane which has an extensive fluvial floodplain in the fluvial/tidal interaction zone (Action Zone 1 – Recommendation 4). This will be affected by lack of space for new defences.

Floodplain management may also be required for groundwater flooding. This has not been considered in detail by TE2100 and further investigation will be needed in the future.

Policy unit – Barnes & Kew

Policy: The recommended flood risk management policy for Barnes & Kew is policy P5 to take further action to reduce flood risk beyond that required to keep pace with climate change.

Description

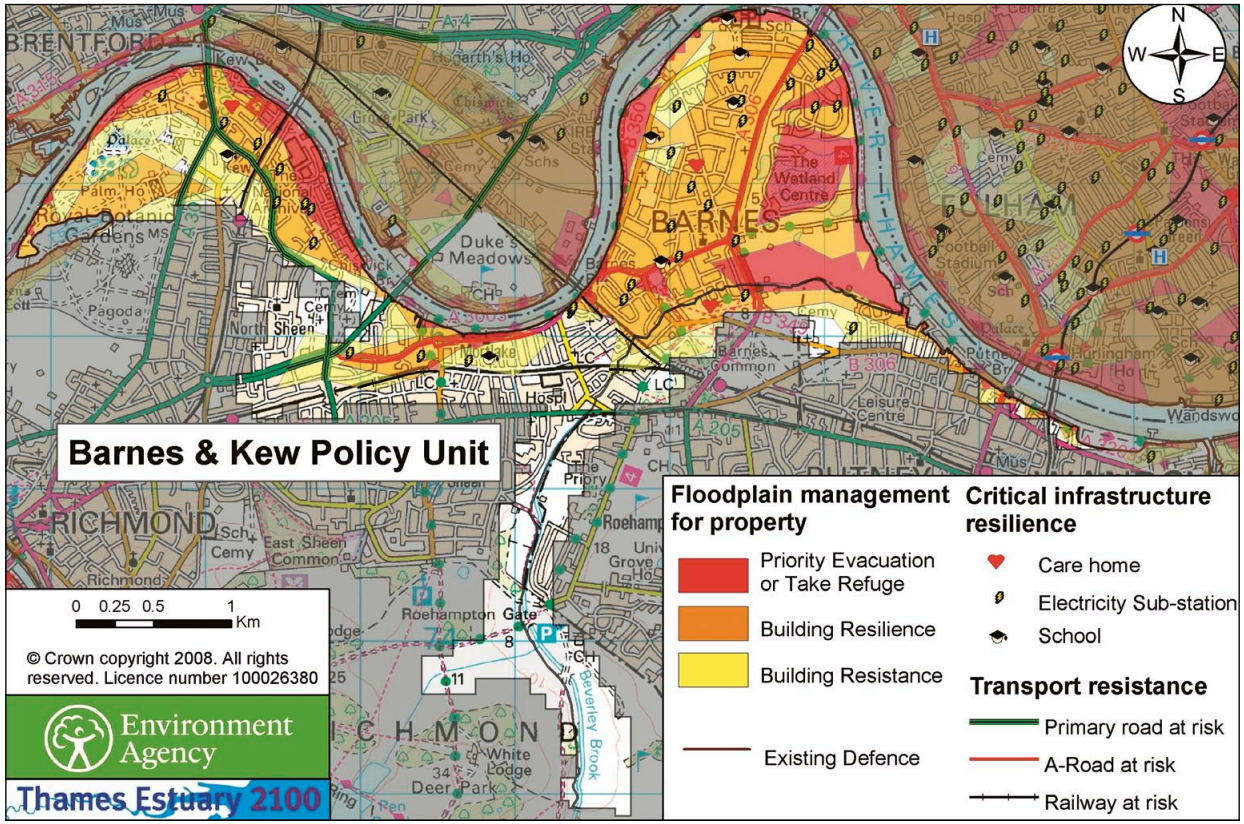
The Barnes & Kew policy unit contains large residential areas, schools and offices. It also has several large open areas including the Kew Gardens World Heritage Site, Barnes Wetlands Centre and playing fields. There is public access to the whole frontage. There are two care homes, seven schools and 29 electricity substations in the flood risk area which also has the major arterial routes leading to three Thames bridges.

Sources of flooding

These are the same as for Richmond plus fluvial flooding from Beverley Brook (probability about 10% per annum) and a risk of groundwater flooding from superficial strata, possibly connected to high water levels in the Thames.

Existing flood risk management system

- The Thames Barrier, to control tidal water levels.
- Secondary tidal flood defences along the Thames frontage.
- Beverley Brook flapped outfall.



At risk in the Barnes & Kew policy unit

- Beverley Brook bypass culverts, that provide relief from fluvial flooding.
- Combined sewer overflows (CSOs) for urban drainage flood mitigation.
- Flood forecasting and warning.

Mortlake. Downstream of Chiswick Bridge

Policy context

The Barnes & Kew policy unit lies within the Thames CFMP area. It is also in the reach covered by the Thames Strategy Kew to Chelsea, which gives clear guidance on where and how the Estuary frontage could be improved. Some development is planned but the sites are generally small, and the impact on the floodplain would also be small.

Vision

Our vision for this policy unit is to enhance the already attractive environment in this area by providing defence improvements that are designed in a sensitive way and blend with the surroundings. Where defences are raised, it will be important to ensure that the impacts on views are minimised. The vision also includes greater local and institutional awareness of the flood risk, and this should influence emergency planning, land use planning and new development.

Local issues and choices

There is a possibility that defence raising for tidal flood risk management may not be acceptable in all areas because of the adverse impact on the riverside. An alternative approach would be a combination of defence realignment and floodplain management to reduce the impacts of flooding to existing properties and other assets located between the realigned defence and the Estuary. However, when considering this approach it must be remembered that flooding could occur several times per year and the annual frequency will increase. It should only be adopted when there is a good local appreciation and acceptance of the risk of living with flooding. In this policy unit, a P5 policy is recommended. This means that there is justification to improve the level of flood risk management beyond that required to keep pace with climate change.

Accretion of the river bed is occurring at Barnes and Putney. This may provide opportunities to improve the ecological capacity and appearance of these frontages. There is a risk of fluvial flooding from Beverley Brook which is exacerbated by high water levels in the Thames. There are two diversion culverts, although these are also affected by tide lock from high levels in the Thames. Floodplain management may also be required for groundwater flooding. This has not been considered in detail by TE2100 and further investigation will be needed in the future.

Policy unit – Hammersmith

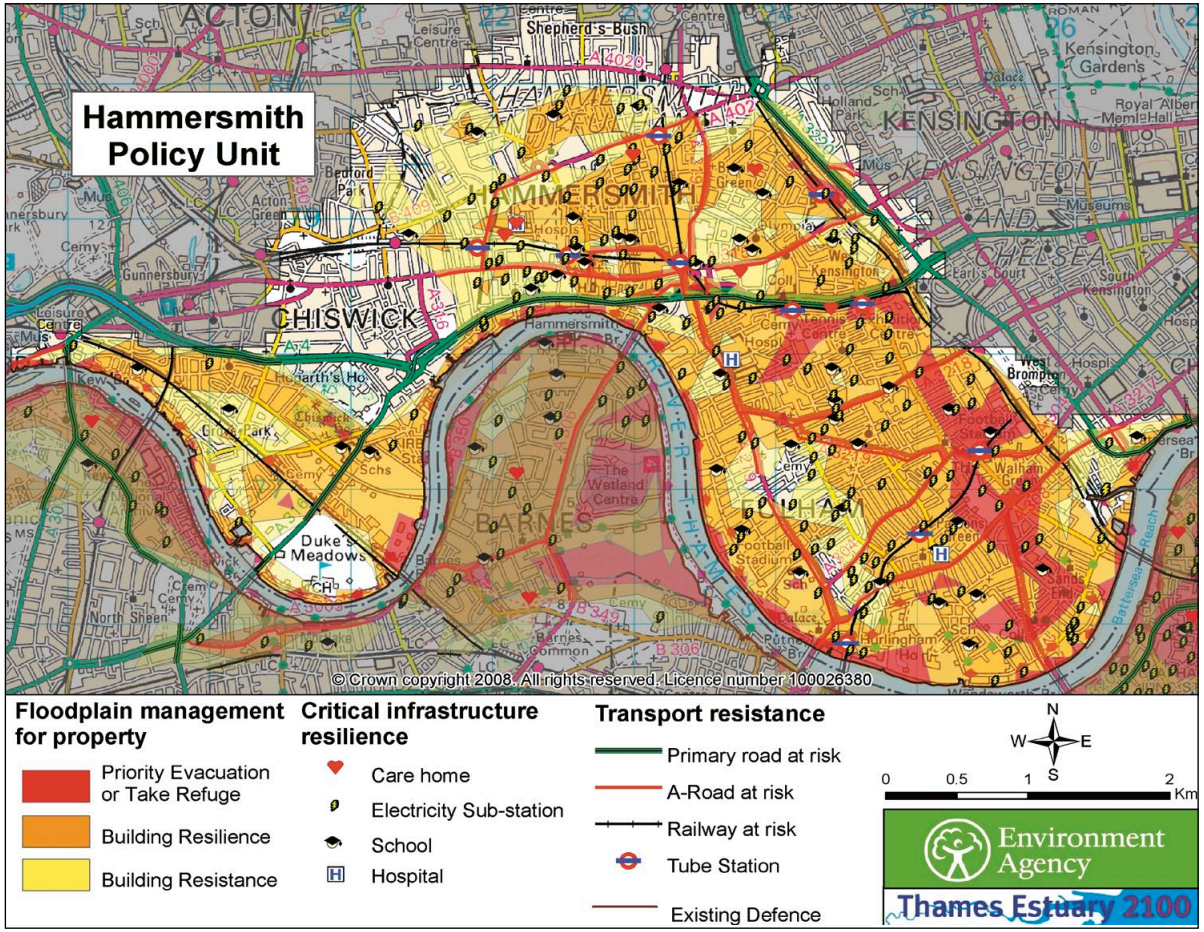
Policy: The selected policy for Hammersmith policy unit is policy P5 to take further action to reduce flood risk beyond that required to keep pace with climate change.

Description

Hammersmith is a large and highly developed policy unit with extensive and established residential areas. The estuary frontage is a mixture of public parks, public walkways, roads and private areas. Thus access to the Estuary is currently not continuous. The underground network at Hammersmith and environs is particularly vulnerable with 10 underground stations in the flood risk zone. There are also 34 schools, six care homes, over 100 electricity substations and two major hospitals in the flood risk area.

Sources of flooding

- Tidal from the Thames upriver of the Thames Barrier (probability 0.1% per annum or less frequent, barrier controlled), flood depths up to 2 m if the Thames Barrier failed.
- Fluvial from the Thames upriver of the Thames Barrier (probability 0.1% per annum or less frequent).
- There is a risk of flooding from pluvial and urban drainage sources.



At risk in Hammersmith policy unit

- There is a potential for groundwater flooding from superficial strata when levels in the Thames are high, particularly in the future when defence levels have been raised in line with our P5 policy.

Existing flood risk management system

- The Thames Barrier, to control tidal water levels.
- Secondary tidal flood defences along the Thames frontage.
- Eight CSOs for urban drainage flood mitigation.
- Flood forecasting and warning.

Hammersmith Bridge

Policy context

The Hammersmith policy unit lies within the Thames CFMP area. It is also in the reach covered by the Thames Strategy Kew to Chelsea, which gives clear guidance on where and how the Estuary frontage could be improved. There are locations where development is planned on or near the Estuary frontage. These provide opportunities to enhance the frontage and the defences.

Vision

Our vision for the Hammersmith policy unit is to enhance the already attractive environment in this area by providing defence improvements that are designed in a sensitive way and blend with the surroundings whilst achieving our recommended policy P5. The vision also includes greater local and institutional awareness of the flood risk, and this should influence emergency planning, land use planning and new development.

Local issues and choices

Where policy P5 applies, a higher standard of protection is needed. This will be provided by the Thames Barrier for tidal flood risk for the foreseeable future. There is a possibility that defence raising for tidal flood risk management may not be acceptable in all areas because of the adverse impact on the riverside. An alternative approach would be a combination of defence realignment and floodplain management to reduce the impacts of flooding to existing properties and other assets located between the realigned defence and the Estuary. However, when considering this approach it must be remembered that flooding could occur several times per year and that the annual frequency will increase.

View from Hammersmith Bridge

Fluvial flooding from the Thames is unlikely to be a problem for the Hammersmith policy unit because fluvial flood levels would not overtop the defences. There is a risk of flooding from pluvial (rainfall) and urban drainage sources. These have only been investigated at a high level, and mitigation measures have not been developed in detail. Further investigation into this local flood risk forms part of our action plan (Action Zone 1 – Recommendation 4). Mitigation measures could include improvement of drainage outfalls and flood resilience in affected areas.

There is a potential for groundwater flooding from superficial strata when levels in the Thames are high, particularly in the future when defences are raised. This has not been investigated by TE2100 and investigation and development of mitigation measures is included as an action in our action plan (Action Zone 1 – Recommendation 4).

Accretion of the river bed is occurring at Fulham. This may provide opportunities to improve the ecological capacity and appearance of this frontage. Erosion of the river bed is occurring on the frontage at Chiswick, and it may be necessary to improve the defences to avoid erosion damage.

Action Zone 1 – Policy units

Richmond P3 | Twickenham P3 | Barnes & Kew P5 | Hammersmith P5

[Note that all dates are based on government's current guidance on climate change – the TE2100 Plan will be reviewed and updated if these predictions change]

	TE2100 recommended actions	Implementation partners	How this will be achieved
First 25 years	**Action Zone 1 – Recommendation 1** **To agree a programme for planning and putting in place within 25 years, alternative measures for managing fluvial flood risk in the west London tidal area.** [The Thames Barrier will continue to provide tidal flood protection to the same high standard as the rest of London. The Thames Barrier will also continue to be deployed for fluvial floods which trigger barrier closure but within 25 years it will no longer be sustainable to use the Thames Barrier to assist with lower order (i.e. more frequent) fluvial flood events – particularly for protection of islands and other undefended areas]	Environment Agency RFCCs (Regional Flood and Coastal Committees) Greater London Authority (GLA) West London Boroughs: • LB Richmond on Thames • LB Hammersmith & Fulham • LB Hounslow • LB Wandsworth • LB Kensington & Chelsea	The Environment Agency will discuss with implementation partners to agree strategic scope of measures and future funding requirements. A working group will be established to ensure agreement between implementation partners on the strategic approach, and roles and responsibilities for achieving it. We will discuss with London Boroughs to agree the strategic scope of measures required. We will promote projects to achieve the agreed measures in partnership with local authority emergency and spatial planners and the GLA. Engagement of public, business and interests groups to raise awareness and increase support for adaptation. In line with the findings of the Thames CFMP, we recommend long-term adaptation of the urban environment in these floodplains. **(continued)**

TE2100 action plan: **action zone 1** – west London

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 1 – Recommendation 1** **(continued)** *(Standing Environment Agency costs, not included in the TE2100 Plan but technical support from the Environment Agency will be provided to promote this action together with the availability of TE2100 data and information. Requirements for future funding relating to implementation of this action will have to be agreed in concert with related actions in the TE2100 Plan – specifically Recommendations 3, 5 and 6 in Action Zone 1)*	Local Resilience Forum The public and businesses	By the year 2034, we may no longer be able to use the Thames Barrier for the frequent, but lower order, fluvial flood events although it will continue to provide a good level of protection against tidal and higher order fluvial flood events. Alternative ways of managing fluvial flood risk will be needed. This will mean adapting some buildings and public spaces which currently have a low standard of protection against fluvial flood. It is important that the public and businesses have confidence in, and are supportive of this approach. This will be very challenging, will require a high degree of partnership and commitment – and will be more difficult than simply maintaining what is already in place. Each area in west London has different requirements so it is important that the right programme is developed for each area.
	**Action Zone 1 – Recommendation 2** TE2100 Plan informs the development and revision of local authority strategic flood risk assessments (SFRAs) and flood plans. *(Cost of implementing this action not included in TE2100 Plan, but TE2100 data and information will be available to assist)*	Environment Agency RFCCs West London Boroughs: • LB Richmond on Thames • LB Hammersmith & Fulham • LB Hounslow • LB Wandsworth • LB Kensington & Chelsea Local Resilience Forum	TE2100 data and information will be provided to local authorities preparing SFRAs, flood plans and emergency capability testing. The Environment Agency will support local authorities with interpretation of TE2100 data and information as required to ensure SFRAs and flood plans are developed with an understanding of TE2100 analysis and recommendations. TE2100 data and information will be provided to Local Resilience Forum (LRF) to inform Community Risk Registers and support exercises. The Thames tidal defences are robust and well managed. But should there be a failure of a defence or an extreme event which overtops the defences, large areas of west London would be at risk. The flood plans will set out arrangements for managing this sort of emergency. Feedback from stakeholders indicates interest in greater collaborative working supported by technical workshops to share best practice and support the development of these key documents and plans – and ensure the links to related CFMPs are properly understood. The Environment Agency will scope this activity, and prepare a proposal for the ways in which we can promote this collaborative working.

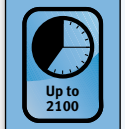
	TE2100 recommended actions	Implementation partners	How this will be achieved
	## Action Zone 1 – Recommendation 3 **To agree a programme of floodplain management including emergency planning, and localised flood protection and resilience for vulnerable key sites in west London zone – particularly in the Hammersmith policy unit.** [Note: In Hammersmith policy unit there are ten Underground stations in the flood risk zone. There are also 34 schools, six care homes, over 100 electricity sub stations and two major hospitals. Underground areas including basements are particularly vulnerable and will require evacuation plans] *(Standing Environment Agency costs, not included in the TE2100 Plan but TE2100 data and information will be available to assist. Future roles, responsibilities and funding requirements for this action to be agreed during preparation phase)*	Environment Agency • LB Richmond on Thames • LB Hammersmith & Fulham • LB Hounslow • LB Wandsworth • LB Kensington & Chelsea RFCCs Local Resilience Forum Transport for London London Underground NHS Trusts EDF Energy Other site owners	The Environment Agency will discuss with implementation partners to agree strategic scope of measures and future funding requirements. A working group will be established to ensure agreement between implementation partners on the strategic approach, and roles and responsibilities for achieving it. The objectives of this action are that local floodplain management measures in place or planned within 25 years and all site owners supportive of approach and confidence maintained.

TE2100 action plan: **action zone 1** – west London

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 1 – Recommendation 4** **To agree a programme of managing flooding from other sources in the defended tidal floodplain.** In the west London zone there is potentially a high risk of pluvial and urban drainage flooding, particularly in areas where the urban drainage system has relatively low capacity and/or is prone to tide locking. There is also fluvial flood risk from the Beverley Brook, the Duke of Northumberland's River, the River Brent and the River Crane. Choices for local flood risk management have not been designed or addressed in detail in TE2100 but this is identified as an action in the Plan. The programme must take account of the viability of potential actions to reduce flood risk from other sources. *(Cost of implementing this action is not included in TE2100 Plan, but TE2100 data, information and recommendations are available to support the successful implementation of the action)*	Environment Agency RFCCs Local authority spatial and emergency planning GLA Landowners Thames Landscape Strategy Hampton to Kew Thames Strategy Kew to Chelsea	These works will be the responsibility of local Environment Agency teams and those responsible for surface water and other drainage systems. The planning and agreement on what is needed should happen in the short term and this will be supported by the TE2100 Legacy team. Implementation may be a medium term action, depending on local scheme justification based on agreement between implementation partners on the strategic approach, and roles and responsibilities for achieving it. Our TE2100 Technical Plan and local choices documents for the policy units provide further information on these matters and the choices which are available to assist with problems. Local measures for management of flooding from other sources to be in place or planned within 25 years. This action will form part of an updated local delivery plan which is linked to our Thames CFMP and long-term investment strategy (LTIS). This includes pluvial and urban drainage and fluvial flooding from the River Crane, the Duke of Northumberland's River and the Beverley Brook.

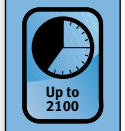
	TE2100 recommended actions	Implementation partners	How this will be achieved
First 25 years	**Action Zone 1 – Recommendation 5** **To agree a programme for floodplain restoration and management.** Work with Thames Landscape Strategy – Hampton to Kew on the development and feasibility of the London's lost floodplains project to restore and manage floodplains to reduce flood risk and benefit the use of floodplains for people and wildlife. *(Standing Environment Agency costs, not included in the TE2100 Plan but TE2100 data and information will be available to assist)*	Environment Agency RFCCs Richmond Borough Council National Trust GLA Thames Landscape Strategy Hampton to Kew Thames Strategy Kew to Chelsea	TE2100 and the Lower Thames Strategy to inform the development of the London's lost floodplains project managed by the Thames Landscape Strategy – Hampton to Kew. The TE2100 plan ensures that an appropriate level of flood risk management for people and property will continue to be provided.
First 25 years	**Action Zone 1 – Recommendation 6** **To agree partnership arrangements and principles to ensure that new development in west London tidal risk area is safe, and flood risk management is factored into the planning process at all levels for the first 25 years from 2010 to 2034.** There is need for greater clarity over methods and procedures for safety in new development behind defences.	Environment Agency RFCCs GLA Local authority spatial and emergency planning • LB Richmond on Thames • LB Hammersmith & Fulham • LB Hounslow • LB Wandsworth	The Environment Agency will provide data, information and technical support to ensure the TE2100 Plan and associated information is able to inform Local Development Frameworks (LDF) and future updates of existing LDFs. These LDFs to be supported by sustainability appraisals that include local tidal flood risk and the implications of climate change. The Environment Agency will encourage application of the National Planning Policy Framework (NPPF) for new development and encourage adoption of property-level protection and resilience. The Environment Agency will assist local authorities to develop guidance for development in the west London defended tidal floodplain. These activities will be aimed at promoting partnerships with a wide range of interested parties – recognising the pressures and different timetables and complexities that partners are working within. **(continued)**

TE2100 action plan: **action zone 1** – west London

	TE2100 recommended actions	Implementation partners	How this will be achieved
	Action Zone 1 – Recommendation 6 **(continued)** Environment Agency and local authority staff are providing advice to developers and responding to difficult planning applications. *(Cost of implementing this action not included in TE2100 Plan, but TE2100 data and information will be available to assist)*	• LB Kensington & Chelsea Developers	
	**Action Zone 1 – Recommendation 7** To review and maintain partnership arrangements and principles from 2035 to 2049. As Action Zone 1 – Recommendation 6 above	As Action Zone 1 – Recommendation 6 above	Guidance updated to reflect changing needs. The TE2100 10-yearly update to include review of Action Zone 1 – Recommendation 6 and recommend further action. We cannot know what institutional arrangements will be in place during this period or what pressures there will be on the environment. We do know that for west London to continue to thrive, flood risk management must continue to be integrated into the spatial planning process.
	**Action Zone 1 – Recommendation 8** To review and maintain partnership arrangements and principles from 2050 and into the 22nd century. As Action Zone 1 – Recommendation 7 above	As Action Zone 1 – Recommendation 6 above	TE2100 10-yearly update to include review of Action Zone 1 – Recommendation 6 and recommend further action. Guidance is updated to reflect changing needs. Flood risk management continues to be integrated into the spatial planning process into the 22nd century – see above.

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 1 – Recommendation 9** To maintain, enhance and replace the river defence walls and active structures through west London over the first 25 years of the Plan from 2010 to 2034. [Note: This is a continuation of our current activities to ensure that confidence in the Thames tidal flood risk management system is maintained and that opportunities for environmental enhancements and partnership through planning are actively sought and carried out] *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency RFCCs Landowners Developers and local authority planning teams Thames Landscape Strategy Hampton to Kew Thames Strategy Kew to Chelsea	The Environment Agency's teams responsible for spatial planning will promote these works in partnership with landowners and local authority planning teams as part of ongoing development applications. The Environment Agency's teams responsible for managing the flood defence assets will promote these schemes. However, the method of managing the defences is different from the present day approach. It involves greater maintenance and repair work in addition to essential replacement. Promotion of schemes through the capital replacement programme may not be appropriate for optimising maintenance and repair, and the Environment Agency will need to develop new ways of planning and implementing these works. As well as looking for ways of working better with limited resources, we will need to seek opportunities for environmental and recreational enhancements which will create a better place, and for partnerships which will help achieve this. Working with other initiatives will be a key element of this action. When works to flood defence structures are planned, it is important to take opportunities to integrate flood defence into developments – and ensure that the developments are designed with a proper understanding of the flood risk they face. Alignment of programmes may be required.
	**Action Zone 1 – Recommendation 10** To operate, maintain and enhance the defence walls and active structures through west London during the 15 year period of the Plan from 2035 to 2049.	Environment Agency RFCCs Landowners Developers and local authority planning teams	Our aims remain as Action Zone 1 – Recommendation 9 above, but during this period, there will be a major programme of rebuilding and refurbishment of the river walls and defences through west London zone. This provides many opportunities for creating a better place and to plan for a better riverside environment. The Environment Agency's staff responsible for dealing with proposed development in areas at risk of flooding will promote these works as part of ongoing development applications. A key issue is how land allocated for development can take account of the need for the raising of flood defences in 2040. The Environment Agency will support local authorities to provide clear and consistent advice to developers in these matters. **(continued)**

TE2100 action plan: **action zone 1** – west London

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 1 – Recommendation 10** **(continued)** [Note: Continuing our activities to ensure that confidence in the Thames tidal flood risk management system is maintained and that opportunities for environmental enhancements and partnership through planning are actively sought and carried out] *(Cost of implementing this action is included in TE2100 Plan)*	Thames Landscape Strategy Hampton to Kew Thames Strategy Kew to Chelsea	The Environment Agency will promote schemes through the capital programme and they will form part of strategic and investment plans subject to replacement/repair working arrangements as Action Zone 1 – Recommendation 9 above. There are major opportunities for reshaping the local landscape as part of these works and a primary purpose of the Riverside Strategies (ref Action Zone 0 – Recommendation 16) is to enable these opportunities to be factored into medium to long term spatial plans. During this period we will be preparing for the "end of the century" any decisions made as part of Action Zone 1 – Recommendation 10 must recognise that there may be major changes during the period 2050 to 2070. New and creative partnership approaches must be sought to make the most of the opportunity to reshape the riverside.
	**Action Zone 1 – Recommendation 12** To maintain and enhance the river defence walls and active structures through west London post-2070 and into the 22nd century. *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency RFCCs Landowners Developers and local authority planning teams Thames Landscape Strategy Hampton to Kew Thames Strategy Kew to Chelsea	There will be a preliminary raising of the walls around 2065. Whether or not defences are raised further, all defences will still require ongoing maintenance, repair and replacement (and hence engineering works) and this has been allowed for in our Plan investment profile. There are major opportunities for reshaping the local landscape as part of these works. We cannot know what institutional arrangements there will be as we approach the 22nd century, but our TE2100 vision imagines an environment where the west London riverside is increasingly enjoyed and respected by the people who live and work there and those who visit. This means that the actions established in Action Zone 1 – Recommendation 9 and 10 will be continued by whoever is looking after our environment at that time.

TE2100 action plan: **action zone 2 – central London**

Action plan for zone 2

10 actions identified

Description of the policy units

- Wandsworth to Deptford
- London City

This section describes the 10 actions for Zone 2 – central London which have been identified through the TE2100 Plan. The actions are described under the following headings:

- TE2100 recommended actions (and whether or not costs for this have been included in the TE2100 Plan)
- Implementation partners
- How this will be achieved.

"The City of London supports the comprehensive, co-ordinated and forward looking approach that the Environment Agency are adopting for the management of flood risk for the Thames estuary..."

City of London

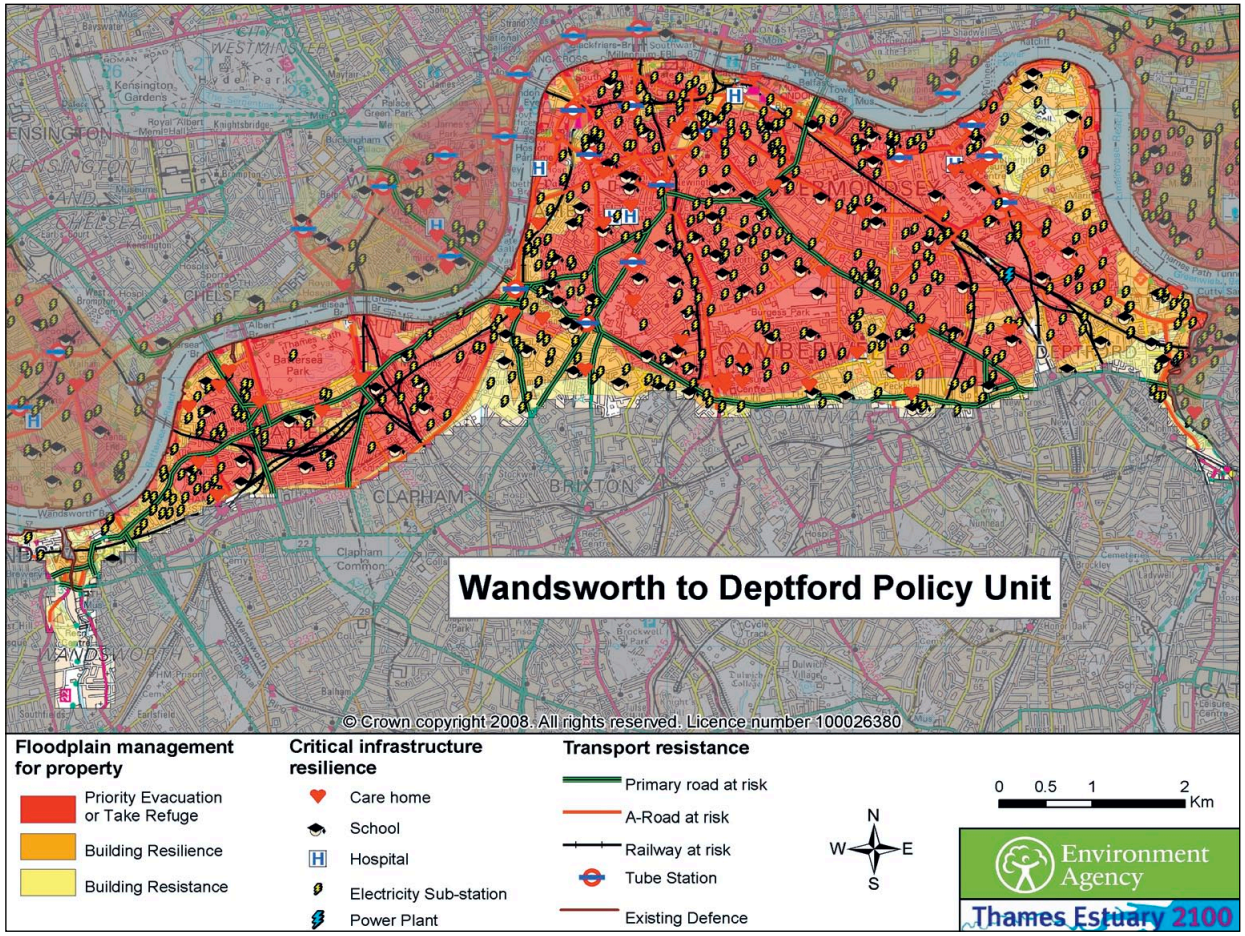
Policy unit – Wandsworth to Deptford

Policy: The selected policy for Wandsworth to Deptford is policy P5 to take further action to reduce flood risk beyond that required to keep pace with climate change.

Description

Wandsworth to Deptford has the largest developed area of any of the TE2100 policy units. It is almost continuously developed and includes major urban centres, residential areas, industry, commerce, and some of London's main transport terminals. It is also a very established area and redevelopments are generally relatively small sites compared with the areas of major regeneration further downriver. It includes a large number of old riverside warehouses, but the redevelopment of these frontages is largely complete. The rich heritage of the area deserves special mention. Important sites that could be vulnerable to changes in the flood defences include Battersea Power Station, the Albert Embankment, Lambeth Palace, the National Theatre and Tower Bridge.

There are 10 underground stations and three major railway termini in the tidal flood risk area. There are also 32 care homes, 93 schools, three hospitals and over 200 electricity substations potentially at risk. This makes the Wandsworth to Deptford policy unit one of the most vulnerable in



At risk in Wandsworth to Deptford policy unit

TE2100 action plan: **action zone 2** – central London

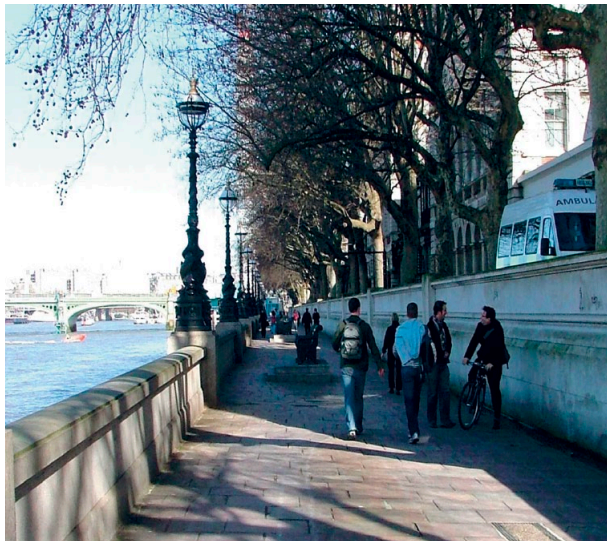
the TE2100 area to flood risk in the event of a failure or overtopping of the defences.

The ground level in much of the policy unit is low at 2 m AOD (above ordnance datum) or less, whereas the level on the Thames frontage is generally higher (typically 3 m AOD or more). Thus there would be great difficulty evacuating floodwater should flooding occur. There is continuous riverside public access from Tower Bridge to Vauxhall.

Many parts of the Wandsworth to Deptford policy unit are particularly vulnerable to flooding because they are low-lying and contain a very large residential and business population. There is also the potential for surface water flooding during periods of heavy and prolonged rainfall.

Sources of flooding

- Tidal from the Thames upriver of the Thames Barrier (probability 0.1% per annum or less frequent, barrier controlled) but potential flood depths up to 4 m if the Thames Barrier failed.
- Fluvial from the River Wandle (probability 3% per annum).



The Embankment

- There is also a risk of flooding from pluvial (heavy rainfall) and urban drainage sources. This could potentially be very serious, bearing in mind the size of the Wandsworth to Deptford policy unit and the fact that there are large low-lying areas that would be difficult to drain.
- Groundwater flooding from superficial strata, possibly connected to Thames levels.

Existing flood risk management system

- The Thames Barrier, to control tidal water levels.
- Secondary tidal flood defences along the Thames frontage and the lower reach of the River Wandle.
- 11 combined sewer overflows (CSOs) for urban drainage flood mitigation.
- Flood forecasting and warning.

Note that the River Ravensbourne which borders this policy unit is covered in the Greenwich policy unit.

Policy context

The Wandsworth to Deptford policy unit lies within the Thames CFMP (Catchment Flood Management Plan) area. The western part of the unit is also in the reach covered by the Thames Strategy Kew to Chelsea, which gives clear guidance on where and how the Estuary frontage could be improved.

There are locations where development is planned on or near the Estuary frontage. These development projects provide opportunities to enhance the frontage and the defences.

Vision

Our vision for the Wandsworth to Deptford policy unit is to provide an environment that has a lower flood risk than now (because of the concentration of people and property at risk) and where flood defences are integrated into the landscape.

TE2100 action plan: **action zone 2** – central London

The policy unit is very diverse and the ways in which the landscape could be enhanced vary. There is also a need to raise awareness of the flood risk as the consequences of flooding would be severe. Flood risk should be taken into account in land use planning and new development.

Local issues and choices

Suggested local choices are essentially the same as for west London except that tidal defences on the lower reach of the River Wandle will require raising for estuary-wide options – and there is ample justification to do this. Local choices to manage local sources of flooding for this policy unit are described below.

Flood risk management Policy P5 applies in this policy unit so a higher standard of protection is justified. This will be provided by the Thames Barrier for tidal flood risk for the foreseeable future. Towards the end of the century major investment will be required and our appraisal demonstrates that a 1:10,000 year standard will be justified for the policy P5 areas. Fluvial flooding from the Thames is unlikely to be a problem for this policy unit because fluvial flood levels would not overtop the defences – although there may be a problem with fluvial and pluvial flooding occurring behind the tidal defences.

The Southbank

There may be opportunities to set back defences and improve the riverside amenity and habitats. A combination of defence realignment and floodplain management could reduce the impacts of flooding to existing properties and other assets located in the floodable areas on the river side of realigned defences, like the approach used around the Tate Modern at Bankside.

However, when considering this approach it must be remembered that although set-back defences

TE2100 action plan: **action zone 2** – central London

Deptford Creek prior to improvements

would improve the riverside environment, flooding could occur several times per year and the annual frequency will increase.

Accretion of the river bed is occurring at Deptford, Rotherhithe and Lambeth. This may provide opportunities to improve the ecological capacity and appearance of these frontages.

Erosion of the river bed is occurring at Southwark and Battersea. It may be necessary to improve the defences to avoid erosion damage.

Measures will also be needed to provide flood protection for the docks if the defences are raised, possibly by incorporating a flood gate into the dock gates.

The Wandsworth to Deptford policy unit is a very large, flat and low-lying area. It has a high potential for surface water flooding during periods of heavy and prolonged rainfall in much of the area. Pluvial flooding will be exacerbated by shortcomings in the urban drainage system.

In addition, there is the potential for groundwater flooding via permeable superficial deposits that connect the Estuary with the floodplain.

These sources of flooding have only been investigated at a strategic level. Further work would be needed to develop mitigation options.

Policy unit – London City

Policy: The selected policy for London City is policy P5 to take further action to reduce flood risk beyond that required to keep pace with climate change.

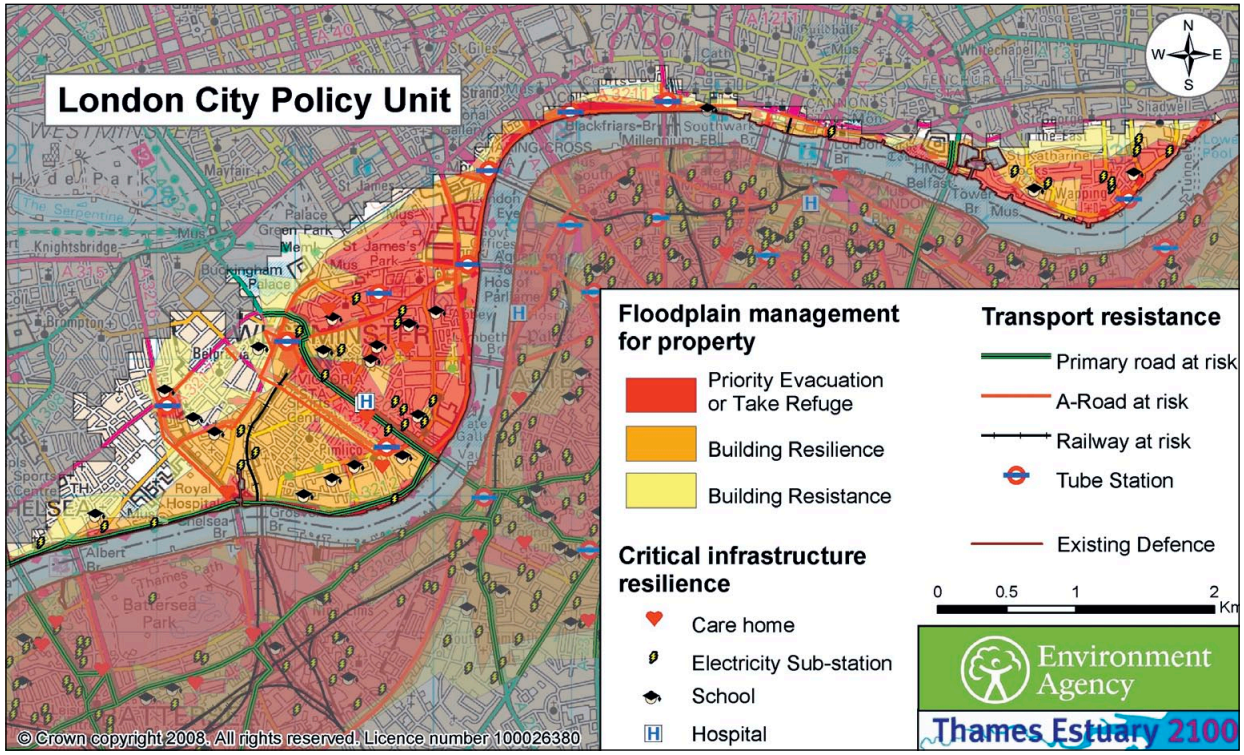
Description

London City policy unit includes much of Westminster, part of Wapping and a narrow strip along the north bank of the Thames between Charing Cross and London Bridge. The policy unit includes two World Heritage Sites (Palace of Westminster and the Tower of London) and many other historic buildings and scheduled ancient monuments such as Queenhithe Dock. It is also a very established area, with limited redevelopment opportunities. Much of the transformation of the old warehouses to new uses is complete and the river frontage already has some established public open spaces.

Although it covers a relatively small area, the London City policy unit contains a high number of vulnerable sites in addition to the seat of government and the heritage sites noted above. Within the policy unit there also are eight underground stations, 19 schools, 29 electricity substations and a hospital.

Public access for much of the frontage is via footpaths adjacent to main roads. Further east in the old warehouse areas, there are buildings on the river frontage and access routes are set back.

There are defences along the river frontage, some of which are incorporated into buildings.



At risk in London City policy unit

Sources of flooding

- Tidal from the Thames upriver of the Thames Barrier (probability 0.1% per annum or less frequent, barrier controlled), flood depths up to 3 m if the Thames Barrier failed.
- There is a risk of flooding from pluvial and urban drainage sources, particularly in the Westminster area.

HMS Belfast

- Groundwater flooding from superficial strata, possibly connected to Thames water levels.

Existing flood risk management system

- The Thames Barrier, to control tidal water levels.
- Secondary tidal flood defences along the Thames frontage.
- 22 combined sewer overflows (CSOs) for urban drainage flood mitigation.
- Flood forecasting and warning.

Policy context

The policy unit lies within the Thames CFMP area.

There are locations where development is planned on or near the Estuary frontage. These provide opportunities to enhance the frontage and the defences.

Vision

Our vision for the London City policy unit is to provide an environment that has low flood risk and where flood defences are integrated into the environment. This policy unit contains some of the most important public areas in London, and the appearance of defences and maintaining views is of paramount importance. There is also a need to raise awareness of the flood risk for residents, commuters and tourists.

Local issues and choices

Flood risk management policy P5 applies in this policy unit, so a higher standard of protection is needed. This will be provided by the Thames Barrier for tidal flood risk for the foreseeable future. Fluvial flooding from the Thames is unlikely to be a problem for this policy unit because fluvial flood levels would not overtop the defences – although there may be fluvial/pluvial flood risk from behind the tidal defences.

There is a possibility that defence raising for tidal flood risk management may not be acceptable in all areas because of the adverse impact on the riverside. Wherever possible, opportunities should be taken to set the defences back into the urban landscape – recognising that the areas to the riverside of the defences would be inundated by the tide from time to time. The Tate Modern on the south bank of the river is an example of where this has been successfully achieved through a development project. The riverside environment is greatly improved, safety is maintained and the defences are easier to maintain.

Accretion of the river bed is occurring at Wapping and Westminster. This may provide opportunities to improve the ecological capacity and appearance of these frontages.

TE2100 action plan: **action zone 2** – central London

There are long lengths of eroding foreshore at Shadwell, Blackfriars, Pimlico and Chelsea. It may be necessary to improve the defences to avoid erosion damage.

Measures will be needed to provide flood protection for the dock entrances if the defences are raised, possibly by incorporating a flood gate into the dock gates.

There is a risk of pluvial and urban drainage in the Westminster part of this policy unit. Flooding from the urban drainage system could potentially result from sewer capacity, pump station failure and tide-locking of outfalls.

Whilst generic mitigation responses have been identified for flooding from local sources, these have not been designed or assessed in any detail.

Southbank

Action Zone 2 – Policy units

Wandsworth to Deptford P5
London City P5

[Note that all dates are based on government's current guidance on climate change – the TE2100 Plan will be reviewed and updated if these predictions change]

	TE2100 recommended actions	Implementation partners	How this will be achieved
First 25 years	**Action Zone 2 – Recommendation 1** TE2100 Plan informs the development and revision of local authority strategic flood risk assessments (SFRAs) and flood plans. *(Cost of implementing this action not included in TE2100 Plan, but TE2100 data and information will be available to assist)*	Environment Agency RFCCs London Boroughs in action zone 2: • LB Wandsworth • LB Southwark • LB Lambeth • LB Lewisham • LB Kensington & Chelsea • LB Tower Hamlets Westminster City Council City of London Central London Local Resilience Forum	The Thames Barrier provides very reliable protection to central London against surge tides and when the Thames Barrier is not closed, the river walls provide protection to low-lying areas. But should there be a failure of a defence or an extreme event which overtops the defences, low-lying areas of central London would flood as shown on the policy unit "at risk" maps. Flood plans will set out arrangements for managing this sort of emergency. TE2100 data and information will be provided to local authorities preparing SFRAs, flood plans and emergency capability testing. The Environment Agency will support local authorities with interpretation of TE2100 data and information as required to ensure SFRAs and flood plans are developed with an understanding of TE2100 analysis and recommendations. TE2100 data and information will be provided to Local Resilience Forums to inform Community Risk Registers and support exercises. Feedback from stakeholders indicates interest in greater collaborative working supported by technical workshops to share best practice and support the development of these key documents and plans – and ensure the links to related CFMPs and SMPs are properly understood. The Environment Agency will scope this activity, and prepare a proposal for the ways in which it can promote this collaborative working.

TE2100 action plan: **action zone 2** – central London

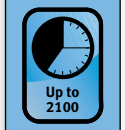
	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 2 – Recommendation 2** To agree a programme of floodplain management including local flood protection, resilience and emergency plans for vulnerable key sites in the action zone 2. *(Environment Agency, Local Authority and other standing costs not included but additional costs included as described in Action Zone 0 – Recommendation 11. In addition, technical support from the Environment Agency will be provided to promote this action together with the availability of TE2100 data and information. Requirements for future funding will have to be agreed)*	Environment Agency • LB Wandsworth • LB Southwark • LB Lambeth • LB Lewisham RFCCs Central London Local Resilience Forum Transport for London Rail Service Providers NHS Trusts Board of Education EDF Energy Thames Water Other site owners	The Environment Agency will discuss with implementation partners to agree strategic scope of measures and future funding requirements. A working group will be established to ensure agreement between implementation partners on the strategic approach, and roles and responsibilities for achieving it. The objectives of this action are that local floodplain management measures in place or planned within 25 years and all site owners supportive of approach and confidence maintained. There are ten underground stations and three major railway termini in the tidal flood risk area. There are also 32 care homes, 93 schools, three hospitals and over 200 electricity sub stations potentially at risk. This makes the Wandsworth to Deptford policy unit one of the most vulnerable in the TE2100 area in the event of a failure or overtopping of the defences. Underground stations are particularly vulnerable in central London as the network will flood and will require evacuation plans and emergency measures.

TE2100 action plan: **action zone 2** – central London

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 2 – Recommendation 3** To agree partnership arrangements and principles to ensure that new development in the central London tidal risk area is safe, and that where possible applies the NPPF to actually reduce the consequence of flooding – particularly in the Wandsworth to Deptford policy unit because of it's vulnerability. It is essential that flood risk management is factored into the planning process at all levels for the first 25 years from 2010 to 2034. *(Cost of implementing this action not included in TE2100 Plan, but TE2100 data and information will be available to assist)*	Environment Agency RFCCs GLA & LDA Spatial and emergency planners • LB Wandsworth • LB Southwark • LB Lambeth • LB Lewisham • LB Kensington & Chelsea • LB Tower Hamlets Westminster City Council City of London Developers & Architects	TE2100 Plan and information informs London Plan and Local Development Frameworks (LDFs) and future revisions. Local authorities and our planning staff require guidance for applying the principles of the NPPF[13] to the complexities of central London's defended tidal floodplain. We will work with implementation partners and Communities and Local Government (CLG) to develop guidance for development in London's defended tidal floodplain. There is need for greater clarity over methods and procedures for safety in new development behind defences. Environment Agency and local authority staff are providing advice to developers and responding to difficult planning applications.
	**Action Zone 2 – Recommendation 4** To review and maintain from 2035 to 2049 the partnership arrangements and principles for development and flood risk management established in the first 25 years of our Plan.	As Action Zone 2 – Recommendation 3	Guidance is updated to reflect changing needs. The TE2100 10-yearly update to include review of Action Zone 2 – Recommendation 3 and recommend any changes or developments. We cannot know what institutional arrangements will be in place during this period or what pressures there will be on the environment. We do know that for central London to continue to thrive, flood risk management must continue to be integrated into the spatial planning process.

[13] National Planning Policy Framework (CLG 2012)

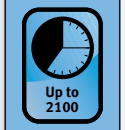
TE2100 action plan: **action zone 2** – central London

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 2 – Recommendation 5** To review and maintain from 2050 and into the 22nd century the partnership arrangements and principles for development and flood risk management established in the middle years of the Plan.	As Action Zone 2 – Recommendation 3	TE2100 10-yearly update to include review of Action Zone 2 – Recommendation 4 and recommend further action. Guidance is updated to reflect changing needs. Flood risk management continues to be integrated into the spatial planning process into the 22nd century.
	**Action Zone 2 – Recommendation 6** To maintain, enhance or replace, the river defence walls and active structures through central London over the first 25 years of the Plan from 2010 to 2034. [Note: This is a continuation of our current activities to ensure that confidence in the Thames tidal flood risk management system is maintained and that opportunities for environmental enhancements and partnership through planning are actively sought and carried out] *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency RFCCs • LB Wandsworth • LB Southwark • LB Lambeth • LB Lewisham • LB Kensington & Chelsea • LB Tower Hamlets Westminster City Council City of London Landowners Developers GLA Thames Estuary Partnership	The Environment Agency's teams responsible for spatial planning will promote these works in partnership with landowners and local authority planning teams as part of ongoing development applications. The Environment Agency's teams responsible for management of the flood defence assets will promote these schemes. However, the method of managing the defences is different from the present day approach. It involves greater maintenance and repair work in addition to essential replacement. Promotion of schemes through the capital replacement programme may not be appropriate for optimising maintenance and repair, and the Environment Agency will need to develop new ways of planning and implementing these works. As well as looking for ways of working better with limited resources, we need to seek opportunities for environmental and recreational enhancements which will create a better place, and for partnerships which will help achieve this. Working with other initiatives will be a key element of this action. When works to flood defence structures are planned, it is important to take opportunities to integrate flood defence into developments – and ensure that the developments are designed with a proper understanding of the flood risk they face. Alignment of programmes may be required. We will promote these schemes. However, the method of improving the defences is different from the present day approach. It involves greater maintenance and repair work in addition to replacement. **(continued)**

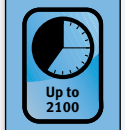
TE2100 action plan: **action zone 2** – central London

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 2 – Recommendation 6** **(continued)**		Our TE2100 Technical Report and local choices documents for the policy units provide our assessment of the choices which are available in central London in the short term.
	**Action Zone 2 – Recommendation 7** **To maintain, enhance or replace the defence walls and active structures through central London during the 15 year period of the Plan from 2035 to 2049.** [Note: Continuing our activities to ensure that confidence in the Thames tidal flood risk management system is maintained and that opportunities for environmental enhancements and partnership through planning are actively sought and carried out] *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency • LB Wandsworth • LB Southwark • LB Lambeth • LB Lewisham • LB Kensington & Chelsea • LB Tower Hamlets RFCCs Westminster City Council City of London Landowners Developers GLA Thames Estuary Partnership	Our aims remain as Action Zone 2 – Recommendation 6 above, but during this period, there will be a major programme of rebuilding and refurbishment of the river walls and defences through central London. This provides many opportunities for creating a better place and to plan for a better riverside environment. During this period we will be preparing for the "end of the century" wall works – see Action Zone 2 – Recommendation 8 below and any decisions made as part of Action Zone 2 – Recommendation 7 must recognise that there may be major changes from 2065. Our TE2100 Technical Report and local choices documents for the policy units provide our assessment of the choices which are available in central London in the medium term (2035 to 2049).

TE2100 action plan: **action zone 2** – central London

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 2 – Recommendation 8** **To implement a programme of defence raising through central London in 2065.** These are the TE2100 "end of the century" measures of raising defence levels in central London to provide continuing tidal flood risk management for all options (except a downriver barrier with locks which will not require defence raising through central London). Combination of defences raised on the existing line and some new defences on a new alignment to enhance sensitive environments would be possible for "end of the century" options 1, 2 and 3. There are areas where the defences could be set back, and periodic flooding of riverside paths and public open space areas could be acceptable as creating a safe, but more natural riverside environment. These enhancements to the city landscape could be incorporated into new developments. Option 4 would not require the defences to be raised in central London. *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency RFCCs Landowners The eight central London local authorities Developers The public Local interest groups GLA Thames Estuary Partnership Floodplain users	The timing of defence raising will depend on the rate of sea level rise, but a maximum raise of 1 m is envisaged. Our staff responsible for dealing with proposed development in areas at risk of flooding will promote these works as part of ongoing development applications. We will promote schemes through capital programme. There are major opportunities for reshaping the local landscape as part of these works. The TE2100 10-yearly update will include a review of Action Zone 2 – Recommendation 8 and will identify whether the end of the century recommendations have changed. The end of the century options (see estuary-wide action plan – action zone 0) affect options required in central London. Options 1, 2, and 3 would mean we would need a wall raising through central London in 2065. Option 4 (a barrier with locks) would mean that the walls could stay at the current levels – although as the most expensive and damaging option, Option 4 is not currently being recommended. Our recommendations in this Plan are based on conditions now, in 2009, but the final decision of "end of the century" option is likely to be made between 2050 and 2060, and the front-runners may or may not change. There will be further public consultation each time we review the Plan. The responses we have received during the 2009 consultation have set the baseline for establishing public attitudes to the central London riverside environment. This "2009 snapshot" of central London stakeholder views will form a starting point for measurement of public attitudes in the future.

TE2100 action plan: **action zone 2** – central London

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 2 – Recommendation 9** **To maintain, improve and enhance the river defence walls and active structures through central London post 2070 and into the 22nd century.** Whether or not defences are raised, all defences will still require ongoing maintenance, repair and replacement (and hence engineering works) and this has been allowed for in our Plan investment profile. *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency RFCCs Landowners Developers The eight central London local authority planning teams	We cannot know what institutional arrangements there will be as we approach the 22nd century, but our TE2100 vision imagines an environment where the central London riverside complements the cityscape and is increasingly enjoyed and respected by the people who live and work there and those who visit. This means that the actions established in Action Zone 2 – Recommendation 6 and 7 will be continued by whoever is looking after our environment at that time.
	**Action Zone 2 – Recommendation 10** **To agree a programme of managing flooding from other sources in the defended tidal floodplain.** Large areas of central London zone are low-lying, and there is potentially a high risk of pluvial and urban drainage flooding, particularly in areas where the urban drainage system has relatively low capacity and/or is prone to tide locking.	Environment Agency RFCCs Landowners GLA London Boroughs in action zone 2: • LB Wandsworth • LB Southwark • LB Lambeth • LB Lewisham • LB Kensington & Chelsea • LB Tower Hamlets	These works will be the responsibility of local Environment Agency teams and those responsible for surface water and other drainage systems. The planning and agreement on what is needed should happen in the short term and this will be supported by the TE2100 Legacy team. Implementation may be a medium term action, depending on local scheme justification based on agreement between implementation partners on the strategic approach, and roles and responsibilities for achieving it. There is also fluvial flood risk from the River Wandle. Choices for local flood risk management have not been designed or addressed in detail in TE2100 but this is identified as an action in the Plan. The programme must take account of the viability of potential actions to reduce flood risk from other sources. Our TE2100 Technical Report and local choices documents for the policy units provide further information on these matters and the choices which are available to assist with problems.

(continued)

TE2100 action plan: **action zone 2** – central London

	TE2100 recommended actions	Implementation partners	How this will be achieved
	Action Zone 2 – Recommendation 10 **(continued)** *(Cost of implementing this action is not included in TE2100 Plan as it is a development of current Environment Agency activities, but TE2100 data, information and recommendations are available to support the successful implementation of the action)*	Westminster City Council City of London	

Action plan for zone 3

10 actions identified

Description of the policy units

- Isle of Dogs & Lea Valley
- Greenwich
- Royal Docks

This section describes the 10 actions for zone 3 – east London which have been identified through the TE2100 Plan. The actions are described under the following headings:

- TE2100 recommended actions (and whether or not costs for this have been included in the TE2100 Plan)
- Implementation partners
- How this will be achieved.

"...we would like to see the adoption of the type of flood defences of a similar design to those around the Greenwich Peninsula which both encourage bio diversity and also recreation throughout Tower Hamlets so making a valuable contribution to the health and well being of our residents."

NHS Tower Hamlets

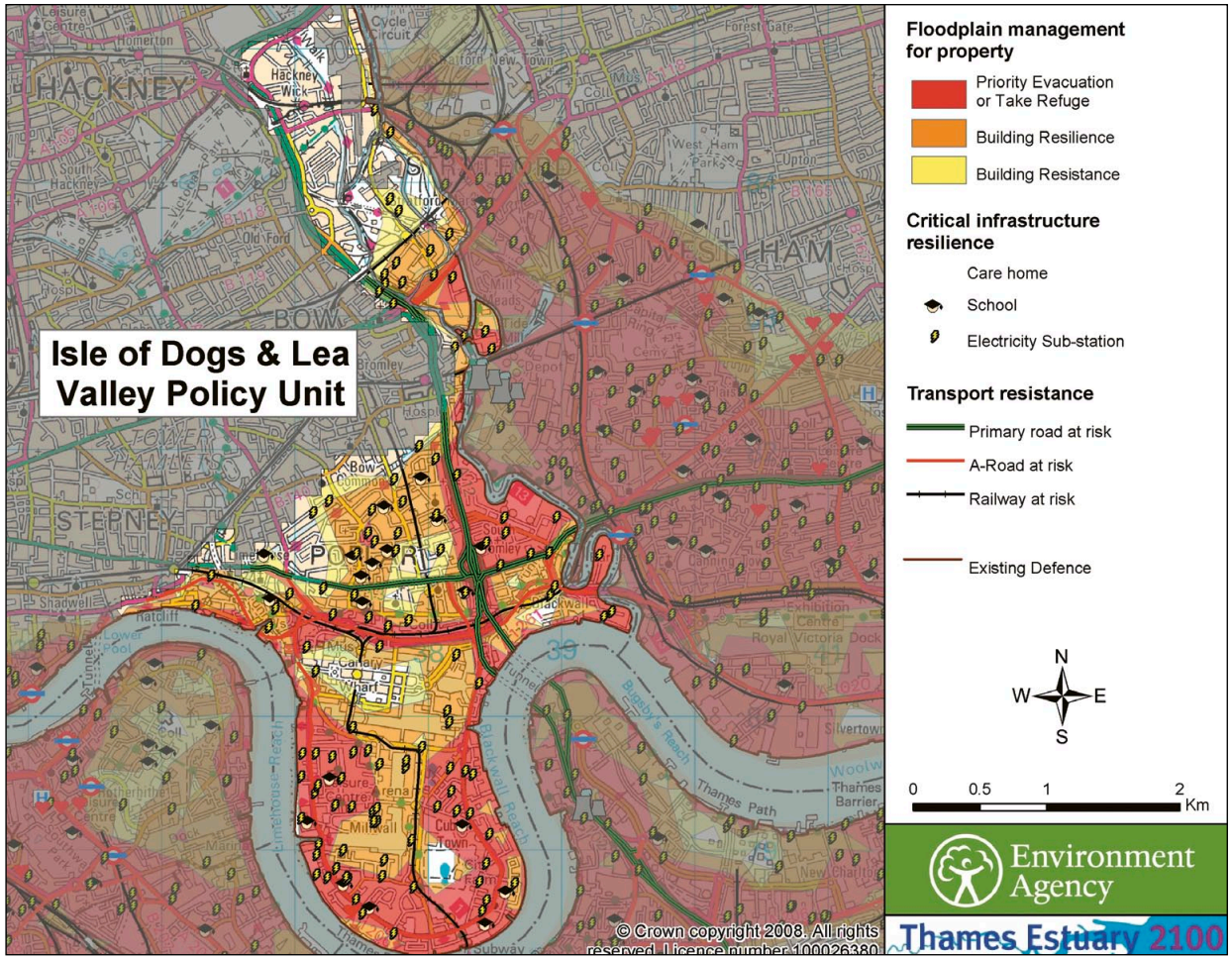
Policy unit – Isle of Dogs & Lea Valley

Policy: The recommended policy for Isle of Dogs is policy P5 to take further action to reduce flood risk beyond that required to keep pace with climate change.

Description

The Isle of Dogs & Lea Valley policy unit has a very high density of development. It includes the Canary Wharf business district and the Olympic Park in the Lea Valley. It also contains extensive residential and industrial areas, and West India and Millwall Docks. Apart from the docks there are few open spaces, and the river frontage is almost continuously developed.

In the flood risk area there are over 100 electricity substations, the Docklands Light Railway, 19 schools and the Canary Wharf underground station. The Blackwall Tunnel with its southbound approach roads and the northern entrance to the Greenwich foot tunnel are also in the flood risk area. There are no major hospitals here. This is former industrial land which has seen major changes in the past 20 years with the development of the Canary Wharf Docklands commercial area. It is anticipated that the investments associated with the Olympic site in the Lea Valley will be the catalyst for regeneration in the northern part of



At risk in Isle of Dogs & Lea Valley policy unit

this unit. This policy unit also includes local choices for the River Lea, which forms the boundary between Isle of Dogs and the adjacent Royal Docks policy unit.

Sources of flooding

- Tidal from the Thames upriver of the Thames Barrier (probability 0.1% per annum or less frequent, Thames Barrier controlled), flood depths up to 3 m if the Thames Barrier failed.
- Tidal from the River Lea (probability 0.1% per annum or greater, Thames Barrier controlled).
- Fluvial from the River Lea (probability 1.5 to 3% per annum).
- There is a medium risk of flooding from pluvial and urban drainage sources in the areas between the docks and the defences.
- The docks provide a potential pathway for tidal flooding (but could also store fluvial floodwater – this has not been investigated by TE2100 but forms part of the local choices for further investigation).

Existing flood risk management system

- The Thames Barrier, to control tidal water levels.
- Secondary tidal flood defences along the Thames frontage and the River Lea.
- Fluvial flood defences on the River Lea (including the Lea Flood Relief Channel).
- The Lea system includes channels which could provide pathways for floodwater, for example the Limehouse Cut.
- Five combined sewer overflows (CSOs) for urban drainage flood mitigation.
- Flood forecasting and warning.

Looking over London Docklands and Canary Wharf

Policy context

The Isle of Dogs & Lea Valley policy unit lies within the Thames CFMP (Catchment Flood Management Plan) area. There is a separate flood risk strategy for the River Lea. There are locations where development is planned on or near the Estuary frontage. These provide opportunities to enhance the frontage and the defences. Like Greenwich on the south bank, this policy unit is the first major area of redevelopment on the north bank when travelling east from the centre of London. It is therefore covered by Thames Strategy East in addition to the Thames Gateway Parklands vision.

Vision

Our vision for the Isle of Dogs & Lea Valley policy unit is for a defence system that can provide an increasing level of protection against climate change. The defences should be integrated with new development wherever possible, blending with the modern and rapidly changing urban environment. There are some opportunities for set-back and environmental enhancement, for example at the old East India Dock site.

TE2100 action plan: **action zone 3** – east London

There is also a need to raise awareness of the flood risk for residents, business groups, commuters and tourists. Frequency of fluvial flooding on the Lea is greater than from tidal flooding, and the Lea should be a priority area for floodplain management. Flood risk should also be taken into account in land use planning and new development.

Local issues and choices

Flood risk management policy P5 applies in this policy unit, so a higher standard of protection is justified. This will be provided by the Thames Barrier for tidal flood risk for the foreseeable future. Fluvial flooding from the Thames is unlikely to be a problem for this policy unit because fluvial flood levels would not overtop the defences.

Some erosion of the river bed is occurring in the south east corner of the Isle of Dogs, and the bend in the river at Limehouse. It may be necessary to improve the defences to avoid erosion damage. Accretion of the river bed is occurring on the east and south sides of the Isle of Dogs.

Measures will be needed for tributary flooding from the River Lea and the associated channels. The flood relief channel and tidal Lower Lea are intended to contain high tidal water levels and fluvial flows, but fluvial flooding may also occur from the Lea navigation and the associated channels (including the Limehouse Cut).

Docklands Commercial area

Work on the Lea was undertaken as part of the Olympics development. This includes the new control structure and lock at Three Mills, and river and floodplain restoration. Further work will also be undertaken as part of the Legacy transformation phase. This should be taken into account when planning flood risk management responses for the River Lea.

There is a risk of tidally influenced fluvial flooding from the River Lea. Choices for managing tidal and fluvial flood risk on the Lea are set out in our zone 3 action plan table.

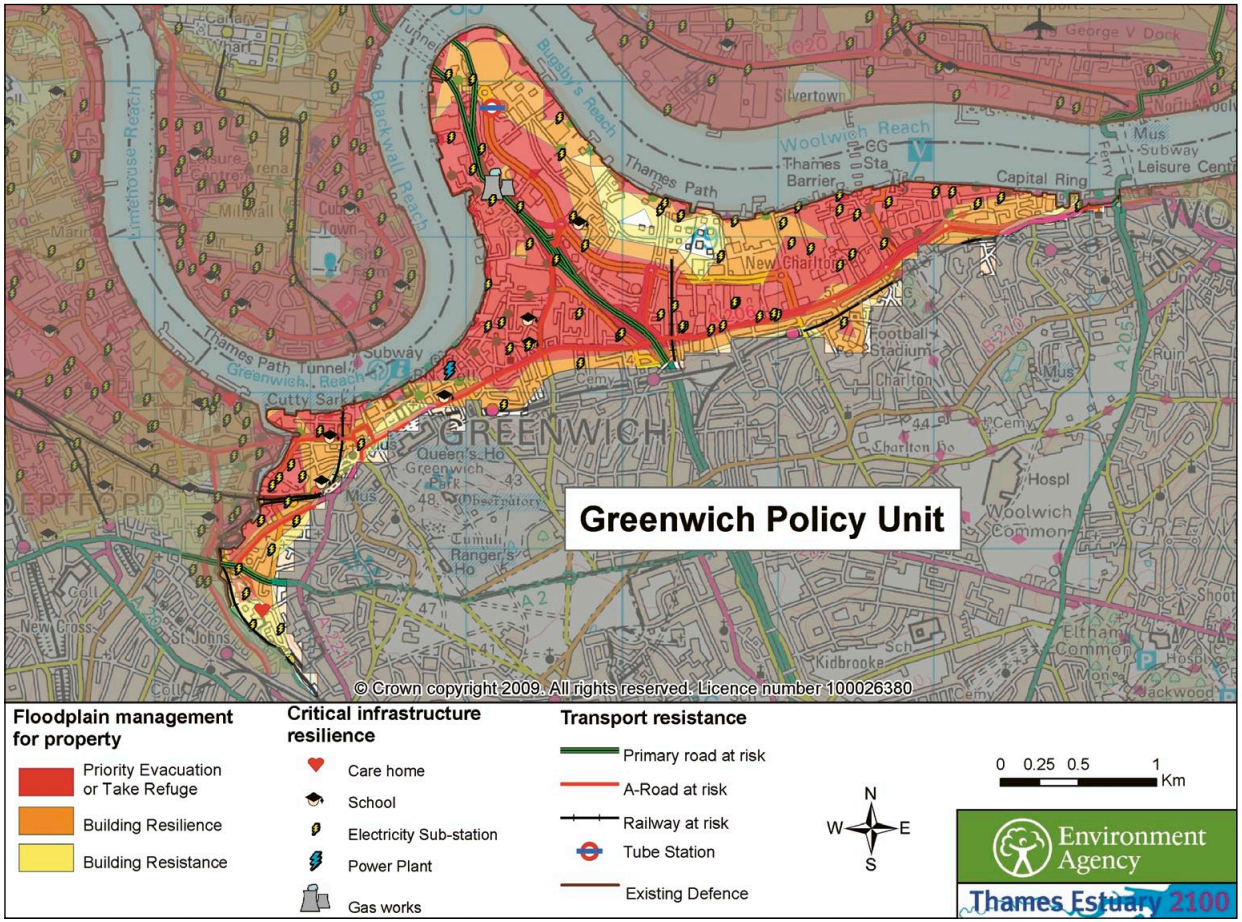
Policy unit – Greenwich

Policy: The selected policy is policy P5 to take further action to reduce flood risk.

Description

The Greenwich policy unit includes the Millennium village and other redevelopment areas on Greenwich peninsula including the O_2 arena, together with North Greenwich underground station and bus terminus. The policy unit is a mixture of residential, urban and industrial areas. It also contains important historic buildings including part of maritime Greenwich, which is a World Heritage Site. The Thames Barrier, including its south bank operational area, is in this policy unit. There are also 70 electricity substations and a power station (currently mothballed), five schools and one care home. The A101(M) is raised but drops down to flood level as it approaches the Blackwall Tunnel. The main road from Greenwich to Woolwich runs along the southern edge of the Greenwich policy unit.

A key feature of this policy unit is that it straddles the Thames Barrier so when the barrier is closed against high tides, there is a difference of up to 2 m either side of the barrier. To accommodate this difference in water levels, the flood defences downstream of the Thames Barrier are up to 2 m higher than those upstream.



At risk in Greenwich policy unit

Sources of flooding

- Tidal from the Thames upriver of the Thames Barrier (probability 0.1% per annum or less frequent, Thames Barrier controlled), flood depths up to 3 m if the Thames Barrier failed.
- Tidal from the Thames downriver of the Thames Barrier (eastern part of the policy unit) (probability 0.1% per annum or greater, flood depths up to 5 m).
- Fluvial and tidal/fluvial from the Ravensbourne River (probability 1–2% per annum).
- There is a risk of urban drainage flooding, particularly where the capacity of the urban drainage system is low. This risk is exacerbated by tide locking of outfalls.

The Greenwich peninsula

Existing flood risk management system

- The Thames Barrier, to manage surge tide water levels.
- River edge flood defences upriver of the Thames Barrier to manage daily tide water levels.
- Tidal flood defences downriver of the Thames Barrier.
- Fluvial flood defences on the Ravensbourne River (enlarged channel).
- Three combined sewer overflows (CSOs) for urban drainage flood discharge.
- Flood forecasting and warning.

Policy context

Like the Isle of Dogs on the north bank, this policy unit is the first major area of redevelopment on the south bank when travelling east from the centre of London. It is covered by Thames Strategy East. Requirements that should be taken into account in the design of flood risk management interventions in order to achieve local planning objectives are based largely on the proposals in these documents.

Terraces at the O_2 – cheaper to build, subsequently increased value of the land and enhanced local ecology

Vision

Our vision for the Greenwich policy unit is to provide a flood risk management system that keeps pace with climate change and improves on the defence standards provided. The defence system is integrated with new development and takes advantage of the space available to achieve a river frontage which is safe and is part of the regenerated cityscape. In some areas the defences could be integrated into the landscape. An example of how this can be done is provided in this policy unit by the defences adjacent to the Greenwich peninsula intertidal habitat terraces.

Redevelopment and the existence of iconic sites such as the Thames Barrier, the O_2, the Cutty Sark historic ship site (now undergoing major refurbishment) and the Greenwich frontage provide opportunities for creative integration of the defences into the urban landscapes.

Flooding remains unlikely in this part of the Thames estuary but there is always a risk. We must engage with the community, local businesses and other groups to raise awareness of the flood risk. Our approach to floodplain management should be used to guide local decisions about i) what's vulnerable and how can it be protected or made resilient, ii) where to prioritise redevelopment and iii) considerations for emergency planning.

Local issues and choices

We are recommending a policy P5 for this policy unit so a higher standard of protection is justified. This will be provided by the Thames Barrier for tidal flood risk upriver of the Thames Barrier. Downriver of the Barrier, policy P5 will be introduced by defence raising in 2070.

Accretion of the river bed is occurring at Greenwich. This may provide opportunities to improve the ecological capacity and appearance of this frontage. Erosion of the river bed is occurring downriver of the Thames Barrier. It may be necessary to improve the defences to avoid erosion damage.

Measures will be needed for tributary, tidal and fluvial flooding on the River Ravensbourne (Action Zone 3 – Recommendation 10).

There is a risk of urban drainage flooding in this policy unit, particularly in areas where the capacity of the urban drainage system is low. This risk is exacerbated by tide locking of outfalls. Measures for managing this source of flooding have not been investigated in detail by TE2100 but this is an action which must be picked up by the teams responsible and is thus included in our action plan for zone 3.

Policy unit – Royal Docks

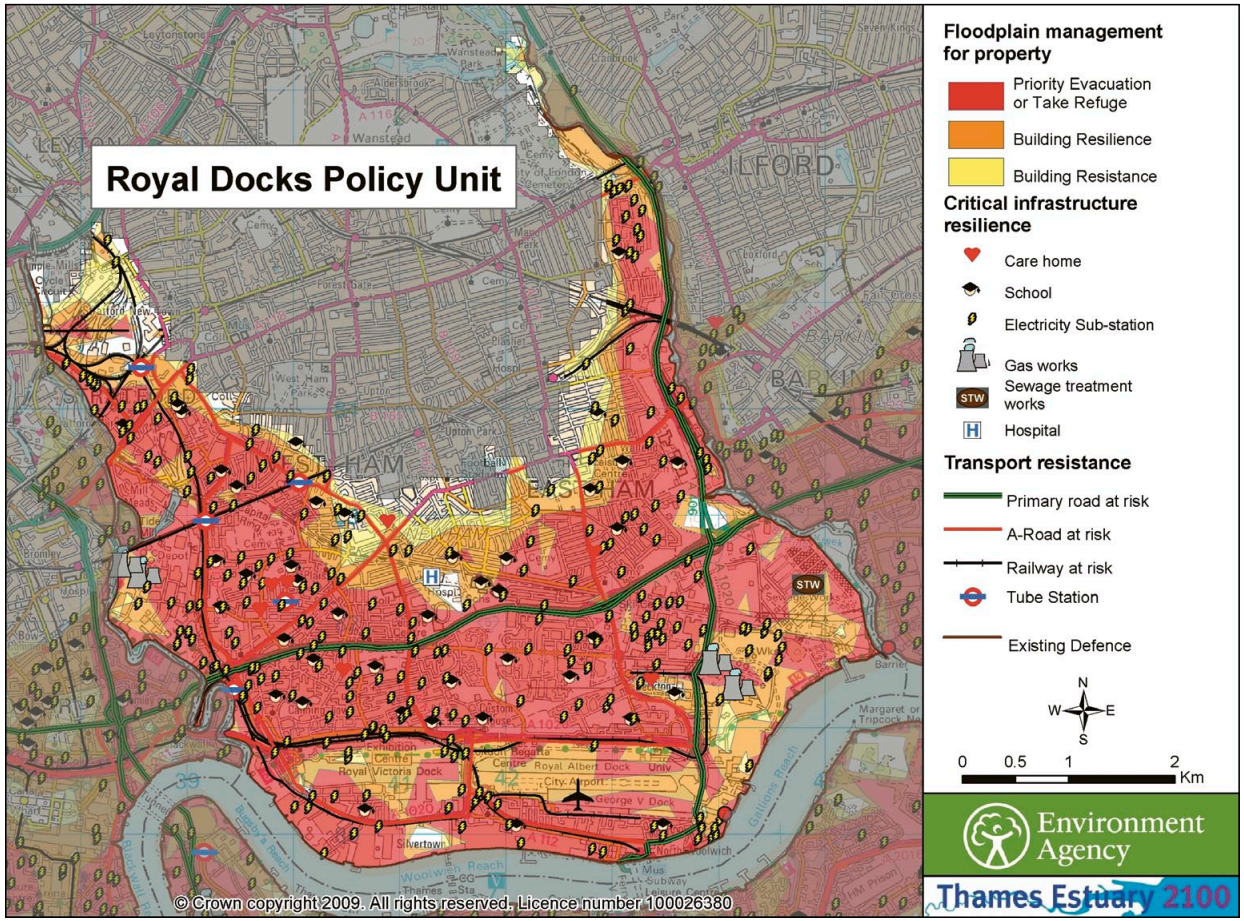
Policy: We recommended flood risk management policy P4 to take further action to keep up with climate change and land use change so that flood risk does not increase.

Description

The Royal Docks policy unit includes extensive and established residential and industrial areas. It also contains the three Royal Docks, which are a focus for redevelopment and which form a raised strip of land parallel to Woolwich Reach on the River Thames. It is anticipated that the investments associated with the Olympic site in the Lea Valley will be the catalyst for regeneration in the north western part of this policy unit.

The unit includes City Airport and associated new developments as well as the north bank of the Thames Barrier. There are five underground stations, 36 schools, seven care homes and a hospital. Two power stations, over 200 electricity substations and the major Beckton sewage treatment works are also in the tidal flood risk area. The A13 arterial route cuts across this policy unit from west to east.

The ground level in much of the Royal Docks policy unit is low (at 1 m AOD or less), whereas the levels



At risk in Royal Docks policy unit

at the docks and the Thames frontage are higher (3 m to 5 m AOD). Thus there would be great difficulty evacuating floodwater should flooding occur. This also means that this area is vulnerable to pluvial (heavy/prolonged rainfall) flooding.

The options for the Royal Docks policy unit do not include the River Lea or the River Roding, which form the west and east boundaries of the unit and are covered in the Isle of Dogs & Lea Valley and Barking & Dagenham policy units respectively. A key feature of this policy unit is that it straddles the Thames Barrier so when the barrier is closed against high tides, there is a difference of up to 2 m either side of the barrier. To accommodate this difference in water levels, the flood defences downstream of the Thames Barrier are up to 2 m higher than those upstream.

The Thames Barrier has remained a constant feature in the rapidly changing urban landscape over the past 25 years

Sources of flooding

- Tidal from the Thames upriver of the Thames Barrier (probability 0.1% per annum or less frequent, barrier controlled), flood depths up to 5 m if the Thames Barrier failed.
- Tidal from the Thames downriver of the Thames Barrier (probability 0.1% per annum or less frequent), flood depths up to 5 m but very variable.
- There is a serious risk of pluvial and urban drainage flooding, particularly in areas where the capacity of the urban drainage system is low. This risk is exacerbated by tide locking of outfalls.
- Flooding on the River Lea is covered by the Isle of Dogs & Lea Valley policy unit.
- Flooding on the River Roding is covered by the Barking & Dagenham policy unit.

Existing flood risk management system

- The Thames Barrier, to manage surge tide water levels.
- River edge flood defences upriver of the Thames Barrier to manage daily tide water levels.
- Tidal flood defences downriver of the Thames Barrier.
- Floodgates on lock entrances to the docks at King George V lock and Gallions locksluice.

- Four combined sewer overflows (CSOs) for urban drainage flood mitigation.
- Flood forecasting and warning.

Policy context

The Royal Docks policy unit forms part of the Thames Gateway regeneration area and is covered by Thames Strategy East.

There are extensive areas of redevelopment planned in this policy unit including much of the area to the south of the Royal Docks. This provides opportunities to improve flood risk management arrangements, including floodplain management, to achieve safer floodplains, and defences that enhance the riverfront environment.

The Thames Barrier has remained a constant feature in the rapidly changing urban landscape for the past 25 years.

Requirements that should be taken into account in the design of flood risk management interventions in order to achieve local planning objectives are based largely on the proposals in Thames Strategy East.

Vision

The extent of expected future development in this policy unit provides opportunities to modify the layout of the flood defences and integrate them into new developments wherever possible, in order to improve the appearance of the river frontage and provide environmental enhancement and amenity opportunities.

New development should be safe, particularly in areas where the ground level is low and flood depths could potentially be high. Public awareness should be raised to facilitate emergency planning and response.

Local issues and choices

Accretion of the river bed is occurring between Silvertown and the River Roding. This may provide opportunities to improve the ecological capacity and appearance of this frontage.

Erosion of the river bed is occurring near the River Lea confluence. It may be necessary to improve the defences to avoid erosion damage.

The docks provide a potentially important pathway for flooding. They are protected using flood control gates that form part of the tidal defences. The King George V flood gate is to be replaced by a new structure in the next 40 years. As the sea level rises, this gate would have to be closed more and more frequently to prevent flooding via the docks.

There may be a practical limit to the number of closures of the dock flood control gates, and other flood mitigation measures may be needed. Possibilities include raising the quay levels or closing the docks (or parts of the docks) to navigation.

The Royal Docks policy unit is large and low-lying, and there is potentially a high risk of pluvial and urban drainage flooding, particularly in areas where the urban drainage system has relatively low capacity and/or is prone to tide locking. Choices for local flood risk management have not been designed or addressed in detail, and will be specified for further investigation in our action plans.

Action Zone 3 – Policy units

Isle of Dogs & Lea Valley P5 | Greenwich P5 | Royal Docks P4

[Note that all dates are based on government's current guidance on climate change – the TE2100 Plan will be reviewed and updated if these predictions change]

	TE2100 recommended actions	Implementation partners	How this will be achieved
First 25 years	**Action Zone 3 – Recommendation 1** TE2100 Plan informs the development and revision of local authority strategic flood risk assessments (SFRAs) and flood plans. *(Cost of implementing this action not included in TE2100 Plan as part of Environment Agency standing costs, but TE2100 data and information will be available to assist)*	Environment Agency RFCCs (Regional Flood and Coastal Committees) London Boroughs in action zone 3: • LB Greenwich • LB Tower Hamlets • LB Newham Local Resilience Fora: • Central London • South East London • North East London	The Thames Barrier and the downstream defences provide highly reliable protection to the east London zone against surge tides and when the Thames Barrier is not closed, the river walls provide protection to low-lying areas. But should there be a failure of a defence or an extreme event which overtops the defences, low-lying areas of this zone would be at risk as shown on the policy unit "at risk" maps. The flood plans will set out arrangements for managing this sort of emergency. TE2100 data and information will be provided to local authorities preparing SFRAs, flood plans and emergency capability testing. The Environment Agency will support local authorities with interpretation of TE2100 data and information as required to ensure SFRAs and flood plans are developed with an understanding of TE2100 analysis and recommendations. TE2100 data and information will be provided to LRF to inform Community Risk Registers and support exercises. Feedback from stakeholders indicates interest in greater collaborative working supported by technical workshops to share best practice and support the development of these key documents and plans – and ensure the links to related CFMPs and SMPs are properly understood. The Environment Agency will scope this activity, and prepare a proposal for the ways in which it can promote this collaborative working. Community engagement programmes should be carried out to ensure the public, businesses and other groups understand, are involved in and supportive of the flood plans.

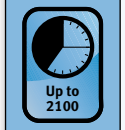
TE2100 action plan: **action zone 3** – east London

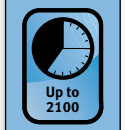
	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 3 – Recommendation 2** To agree a programme of floodplain management including local flood protection, resilience and emergency plans for vulnerable key sites in action zone 3. *(Environment Agency, Local Authority and other standing costs not included but additional costs included as described in Action Zone 0 – Recommendation 11. In addition, technical support from the Environment Agency will be provided to promote this action together with the availability of TE2100 data and information. Requirements for future funding will have to be agreed)*	Environment Agency RFCCs London Boroughs in action zone 3: • LB Greenwich • LB Tower Hamlets • LB Newham Local Resilience Fora: • Central London • South East London • North East London Transport for London Canary Wharf Group EDF Energy Managers/ owners of vulnerable sites	The “at risk” maps show the particular sites and key infrastructure that would be particularly vulnerable in the TE2100 area in the event of a failure or overtopping of the defences. Underground areas and tunnels, particularly those where large numbers of people congregate will require evacuation plans. The Environment Agency will discuss with implementation partners to agree strategic scope of measures and future funding requirements. A working group will be established to ensure agreement between implementation partners on the strategic approach, and roles and responsibilities for achieving it. The objectives of this action are that local floodplain management measures in place or planned within 25 years and all site owners supportive of approach and their confidence maintained.

	TE2100 recommended actions	Implementation partners	How this will be achieved
First 25 years	**Action Zone 3 – Recommendation 3** To agree partnership arrangements and principles to ensure that new development in the east London zone is safe, and that where possible the application of the NPPF reduces the consequence of flood risk – particularly in the areas where large numbers of people congregate or there is aggregation of flood risk. For flood risk management to be factored into the planning process at all levels for the first 25 years from 2010 to 2034. *(Cost of implementing this action not included in TE2100 Plan, but TE2100 data and information will be available to assist)*	Environment Agency RFCCs GLA, Mayor's Development Corporation, Thames Gateway London Partnership and Development Corporations Local authority spatial and emergency planners in action zone 3: • LB Greenwich • LB Tower Hamlets • LB Newham Developers & Architects	TE2100 Plan and information informs London Plan and Local Development Frameworks (LDFs) and future revisions. Local authorities and our planning staff require guidance for applying the principles of the NPPF[14] to the complexities of east London's defended tidal floodplain. We will work with implementation partners and Communities and Local Government (CLG) to develop guidance for development in London's defended tidal floodplain. There is need for greater clarity over methods and procedures for safety in new development behind defences. Environment Agency and local authority staff are providing advice to developers and responding to difficult planning applications.
Middle 15 years	**Action Zone 3 – Recommendation 4** To review and maintain from 2035 to 2049 the partnership arrangements and principles for development and flood risk management established in the first 25 years of our Plan.	As Action Zone 3 – Recommendation 3	Guidance is updated to reflect changing needs. The TE2100 10-yearly update to include review of Action Zone 3 – Recommendation 3 and recommend any changes or developments. We cannot know what institutional arrangements will be in place during this period or what pressures there will be on the environment. We do know that for the east London zone to continue to thrive, flood risk management must continue to be integrated into the spatial planning process.

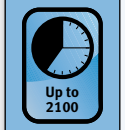
[14] National Planning Policy Framework (CLG 2012)

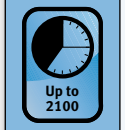
TE2100 action plan: **action zone 3** – east London

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 3 – Recommendation 5** To review and maintain from 2050 and into the 22nd century the partnership arrangements and principles for development and flood risk management established in the middle years of the Plan.	As Action Zone 3 – Recommendation 3	TE2100 10-yearly update will include review of Action Zone 3 – Recommendation 4 and recommend further action. Guidance will be updated to reflect changing needs. Flood risk management will continue to be integrated into the spatial planning process into the 22nd century.
	**Action Zone 3 – Recommendation 6** To maintain, enhance, improve or replace the river defence walls and active structures through east London over the first 25 years of the Plan from 2010 to 2034. [Note: This is a continuation of our current activities to ensure that confidence in the Thames tidal flood risk management system is maintained and that opportunities for environmental enhancements and partnership through planning are actively sought and carried out] *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency RFCCs Local authority spatial planners in action zone 3: • LB Greenwich • LB Tower Hamlets • LB Newham Landowners Developers	The Environment Agency's teams responsible for spatial planning will promote these works in partnership with landowners and local authority planning teams as part of ongoing development applications. The Environment Agency's teams responsible for management of the flood defence assets will promote these schemes. However, the method of managing the defences is different from the present day approach. It involves greater maintenance and repair work in addition to essential replacement. Promotion of schemes through the capital replacement programme may not be appropriate for optimising maintenance and repair, and the Environment Agency will need to develop new ways of planning and implementing these works. As well as looking for ways of working better with limited resources, we will need to seek opportunities for environmental and recreational enhancements which will create a better place, and for partnerships which will help achieve this. Working with other initiatives will be a key element of this action. When works to flood defence structures are planned, it is important to take opportunities to integrate flood defence into developments – and ensure that the developments are designed with a proper understanding of the flood risk they face. Alignment of programmes may be required. Our TE2100 Technical Report and local choices documents provide our assessment of the choices which are available in east London in the short term.

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 3 – Recommendation 7** To maintain, enhance and improve or replace the defence walls and active structures through east London during the 15 year period of the Plan from 2035 to 2049. [Note: Continuing our activities to ensure that confidence in the Thames tidal flood risk management system is maintained and that opportunities for environmental enhancements and partnership through planning are actively sought and carried out] *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency RFCCs Local authority spatial and emergency planners in action zone 3: • LB Greenwich • LB Tower Hamlets • LB Newham Landowners Developers GLA	Our aims remain as Action Zone 3 – Recommendation 6 above, but during this period, there will be a major programme of rebuilding and refurbishment of the river walls and defences through central London. This provides many opportunities for creating a better place and to plan for a better riverside environment. During this period we will be preparing for the "end of the century" wall works – see Action Zone 3 – Recommendation 8 below and any decisions made as part of Action Zone 3 – Recommendation 7 must recognise that there may be major changes from 2065. Defence improvements are likely to include a new flood control gate at the KGV lock entrance to the Royal Docks. Our TE2100 Technical Report and local choices documents for the policy units provide our assessment of the choices which are available in central London in the medium term (2035 to 2049).
	**Action Zone 3 – Recommendation 8** To implement a programme of defence raising through east London from 2065 to 2070 (with defences upriver of the Thames Barrier being raised by 2065 and downriver in 2070). *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency RFCCs Landowners London Boroughs in action zone 3: • LB Greenwich • LB Tower Hamlets • LB Newham Developers	These are the TE2100 "end of the century" raising of defence levels in east London to provide continuing tidal flood risk management against rising sea level. In this action zone, the raisings are in two sections, upriver and downriver of the Thames Barrier. **Upriver of the Thames Barrier:** The defences upriver of the Thames Barrier will require raising for tidal flood risk management for all estuary wide options except Option 4 (a downriver barrier with locks). This action includes the tidal defences on the River Lea. The timing of defence raising will depend on the rate of sea level rise, but a maximum raise of 1 m is envisaged for landscape reasons. **(continued)**

TE2100 action plan: **action zone 3** – east London

	TE2100 recommended actions	Implementation partners	How this will be achieved
	Action Zone 3 – Recommendation 8 **(continued)**	The public Local interest groups GLA Floodplain users Thames Estuary Partnership	There will be opportunities to realign defences along the River Lea to create space for the river and enhance the river frontage. This is because much of the Lower Lea valley is likely to be redeveloped as part of the Legacy transformation of the Olympic Park. A flood control gate may also be needed on the entrance to the West India and Millwall Docks. **Downriver of the Thames Barrier:** The defences downriver of the Thames Barrier will require raising during the period covered by the Plan for options that continue to rely on the Thames Barrier. The amount of raising will depend on the rate of sea level rise. If a new downriver barrier is constructed, this defence raising will not be needed and there will be an opportunity to lower the defences. The TE2100 10-yearly update will include a review of Action Zone 3 – Recommendation 8 and will identify whether the end of the century recommendations have changed. The end of the century options (see estuary-wide action plan – action zone 0) affect options required in east London. Options 1, 2 and 3 would mean we would need a wall raising through central London in 2065. Option 4 (a barrier with locks) would mean that the walls could stay at the current levels – although as the most expensive and damaging option, Option 4 is not currently being recommended. Our recommendations in this Plan are based on conditions now, in 2009, but the final decision of "end of the century" option is likely to be made between 2050 and 2060, and the front-runners may or may not change. There will be further public consultation each time we review the Plan. The responses we have received during the 2009 consultation have set the baseline for establishing public attitudes to the east London riverside environment. This "2009 snapshot" of east London stakeholder views will form a starting point for measurement of public attitudes in the future.

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 3 – Recommendation 9** To maintain, improve, enhance or replace the river defence walls and active structures through central London post 2070 and into the 22nd century. *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency RFCCs Landowners Developers London Boroughs in action zone 3: • LB Greenwich • LB Tower Hamlets • LB Newham GLA Thames Estuary Partnership	We cannot know what institutional arrangements there will be as we approach the 22nd century, but our TE2100 vision imagines an environment where the east London riverside complements the cityscape and is increasingly enjoyed and respected by the people who live and work there and those who visit. This means that the actions established in Action Zone 3 – Recommendation 6 and 7 will be continued by whoever is looking after our environment at that time. Whether or not defences are raised further, all defences will still require ongoing maintenance, repair and replacement (and hence engineering works) and this has been allowed for in our Plan investment profile.
	**Action Zone 3 – Recommendation 10** To agree a programme of managing flooding from other sources in the defended tidal floodplain. *(Cost of implementing this action is not included in TE2100 Plan as Environment Agency standing costs not included, but TE2100 data, information and recommendations are available to support the successful implementation of the action)*	Environment Agency RFCCs London Boroughs in action zone 3: • LB Greenwich • LB Tower Hamlets • LB Newham Sewage and water undertakers	Large areas of east London zone are low-lying, and there is potentially a high risk of pluvial and urban drainage flooding, particularly in areas where the urban drainage system has relatively low capacity and/or is prone to tide locking. These works will be the responsibility of local Environment Agency teams and those responsible for surface water and other drainage systems. The planning and agreement on what is needed should happen in the short term and this will be supported by the TE2100 Legacy team. Implementation may be a medium term action, depending on local scheme justification based on agreement between implementation partners on the strategic approach, and roles and responsibilities for achieving it. There is also fluvial flood risk from the River Lea and the Ravensbourne River. Choices for local flood risk management have not been designed or addressed in detail in TE2100 but this is identified as an action in the Plan. **(continued)**

TE2100 action plan: **action zone 3** – east London

	TE2100 recommended actions	Implementation partners	How this will be achieved
	Action Zone 3 – Recommendation 10 **(continued)**	Landowners Developers & Architects	The programme must take account of the viability of potential actions to reduce flood risk from other sources. Our TE2100 Technical Report and local choices documents for the policy units provide further information on these matters and the choices which are available to assist with problems

Action plan for zone 4

11 actions identified

Description of the policy units

- Thamesmead
- Barking & Dagenham
- Rainham Marshes

This section describes the 11 actions for zone 4 – east London downstream of Thames Barrier which have been identified through the TE2100 Plan. The actions are described under the following headings:

- TE2100 recommended actions (and whether or not costs for this have been included in the TE2100 Plan)
- Implementation partners
- How this will be achieved.

"the Thames is a great feature of Bexley which is not made the most of and I would like to see more public spaces along the river so that residents and visitors could appreciate this asset..."

Cllr John Davey, London Borough of Bexley

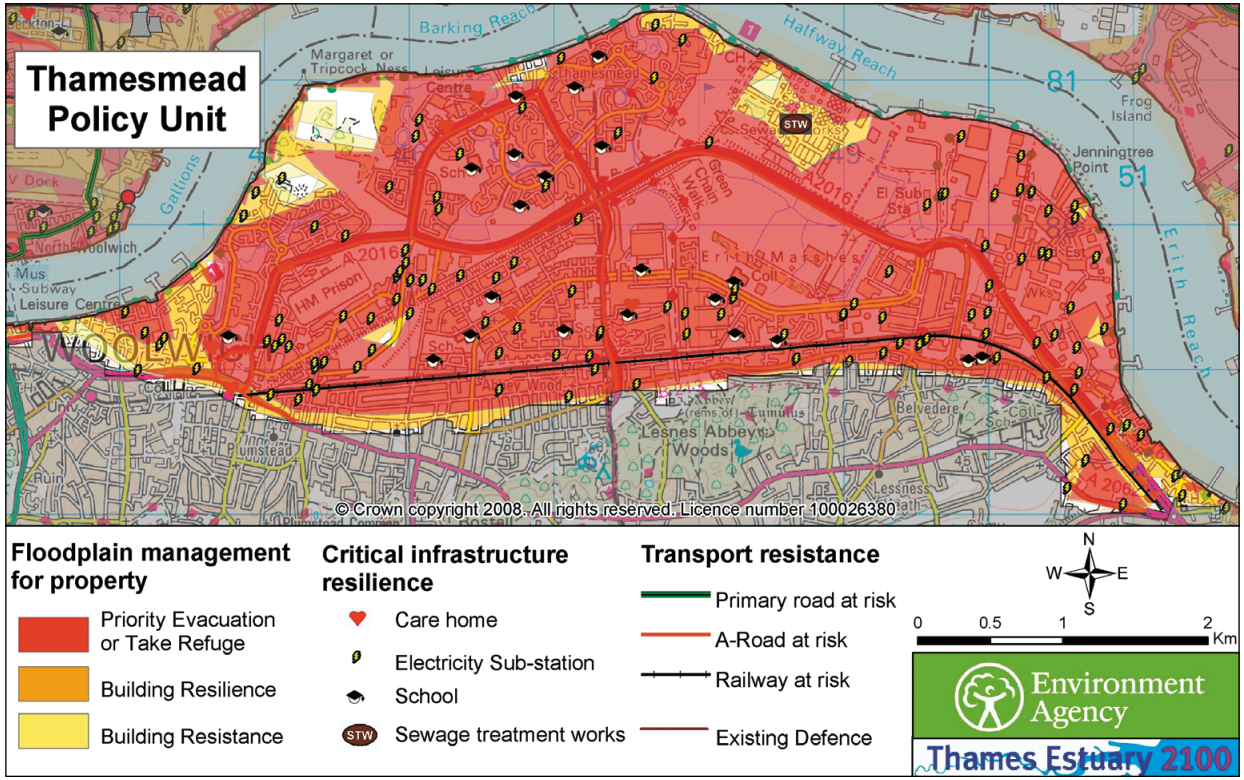
Policy unit – Thamesmead

Policy: Our recommended flood risk management policy for Thamesmead policy unit is policy P4 to take further action to keep up with climate and land use change so that flood risk does not increase.

Description

The Thamesmead policy unit contains extensive development including the urban residential area of Thamesmead, the Belvedere Employment Area, and the Crossness Sewage Treatment Works. In the western sector of the Policy Unit, there is HM Prison Belmarsh.

A major road network serves the area and the main rail link to Dartford runs through the southern edge of the policy unit. The area is low lying, and ground levels are typically 2 m to 3 m below high water on spring tides. Flood depths in a surge tide event overtopping or breaching the defences could exceed 5 m (though this would be an extreme event). The area is therefore very vulnerable to tidal flood risk. In the tidal flood risk area there are 21 schools, six care homes and over 100 electricity sub stations. There are raised areas of landfill at the north west part of the policy unit where land has been set aside for a new east London river crossing (currently on hold).



At risk in Thamesmead policy unit

There is a substantial area of construction waste reprocessing in the same area which is part of the Tilfen site for proposed residential and parkland use. In the same area there is a striking conical raised landscape feature formed of inert waste materials as part of the Thames Point development.

TE2100 action plan: **action zone 4** – east London downstream of Thames Barrier

Sources of flooding

- Tidal: from the Thames downriver of the Thames Barrier (probability 0.1% per annum or less frequent, flood depths up to 5 m but very variable).
- Fluvial: from the Marsh Dykes drainage system in Thamesmead (probability 1% per annum or less, flood depths ‹2 m).

Landscape feature at Thamesmead

- Fluvial: from the Plumstead and Erith Marshes drainage systems (probability ›1% per annum, flood depths ‹2 m).
- There is a serious risk of pluvial and urban drainage flooding in this policy unit in areas where the capacity of the drainage system is low. One reason for this is that the Thamesmead policy unit is made from a large area of reclaimed land and is low lying and very flat.
- Groundwater: This is from rock aquifers (i.e. not related to the Estuary) is also a source of flooding.

The existing flood risk management system

- Tidal flood defences downriver of the Thames Barrier.
- Fluvial flood management is provided by a system of open channels with pumped and gravity outfalls into the Thames (the 'Marsh Dykes' drainage system).
- Flood forecasting and warning is provided for tidal flooding via Flood Warning Direct (FWD). Fluvial flooding or surface runoff are more likely, the former is covered by FWD. Surface runoff can be predicted by our Extreme Rainfall alert service but this is an inexact science.

Policy context

Thamesmead forms part of the Thames Gateway regeneration area and is covered by Thames Strategy East.

There are extensive areas of redevelopment planned in this policy unit including much of the Erith industrial area. Improved transport links to London are likely to add to the development pressure.

Vision

The Thamesmead policy unit is vulnerable to tidal and fluvial flooding. Large defences are always likely to be needed but to some extent these have been landscaped within new development areas. There is scope to further improve the frontage as development takes place. It is likely that much of the industrial area of Erith Marshes will be redeveloped in the next 50 years. This provides opportunities to improve flood risk management arrangements including floodplain management to achieve safer floodplains, and defences that enhance the riverfront environment. This might include resilient development and realignment of defences. Existing open space could be further enhanced to provide for tidal flood storage.

TE2100 action plan: **action zone 4** – east London downstream of Thames Barrier

If infrequently used, this could also be enhanced to provide habitats and recreation opportunities. Erith Marshes may offer such an opportunity.

Wherever possible the estuary frontages should be enhanced to facilitate public access and improve the environment, particularly with such a large local population. During major reconstructions, setting back of defences would reduce the dependence on vertical walls and provide opportunities for sloping riversides and public amenity areas.

In view of the vulnerability of the area, flood awareness should be raised and flood risk management taken into account in new development and redevelopment. New buildings should be built so that people are safe and have a way to leave in an emergency. The risk of groundwater and surface runoff flooding are likely to increase. Property resilience could offset this increased risk.

Local issues and choices

Most of the ground level is very low (about 0 to 1 m AOD) but there is high ground near the defences in parts of Thamesmead. The main trunk sewer to the Crossness sewage treatment works divides the area into two parts. Development or redevelopment on the river frontage is almost continuous.

Canal at Thamesmead

The area is drained by the Marsh Dykes which includes the Thamesmead, Plumstead and Erith Marshes drainage systems. These include systems of canals, lakes, drainage channels, gravity outfalls and pumped outfalls. Whilst this provides an effective drainage system for much of the policy unit, there are some problem areas because of the large size and flat topography of the area.

Although Thamesmead is well defended, it is a vulnerable area because of the low ground level and size of the resident population. It is also vulnerable to pluvial and urban drainage flooding. The drainage systems in Thamesmead and Plumstead were state of the art concepts when they were designed in the 1960s. The Erith Marshes drainage system is older and has smaller channels. Improvements will be required over the next 10 to 30 years as the sea level rises and fluvial flows increase. These could include control of runoff, enlargement of drainage channels, increases in flood storage and improvements to the outfall capacity.

Improvements will also be needed to the major Lake 4 pumping station if the defences are raised, as the outfall currently passes over the top of the defences. The vulnerability of the pumping station to fluvial flood and other hazards must also be investigated.

Erosion of the river bed is occurring at Thamesmead and Crossness. Accretion of the river bed is occurring elsewhere on most of the frontage. There are no reported problems with the defences (for example, erosion of the toe) or outfalls (for example, blockage by siltation).

Policy unit – Barking & Dagenham

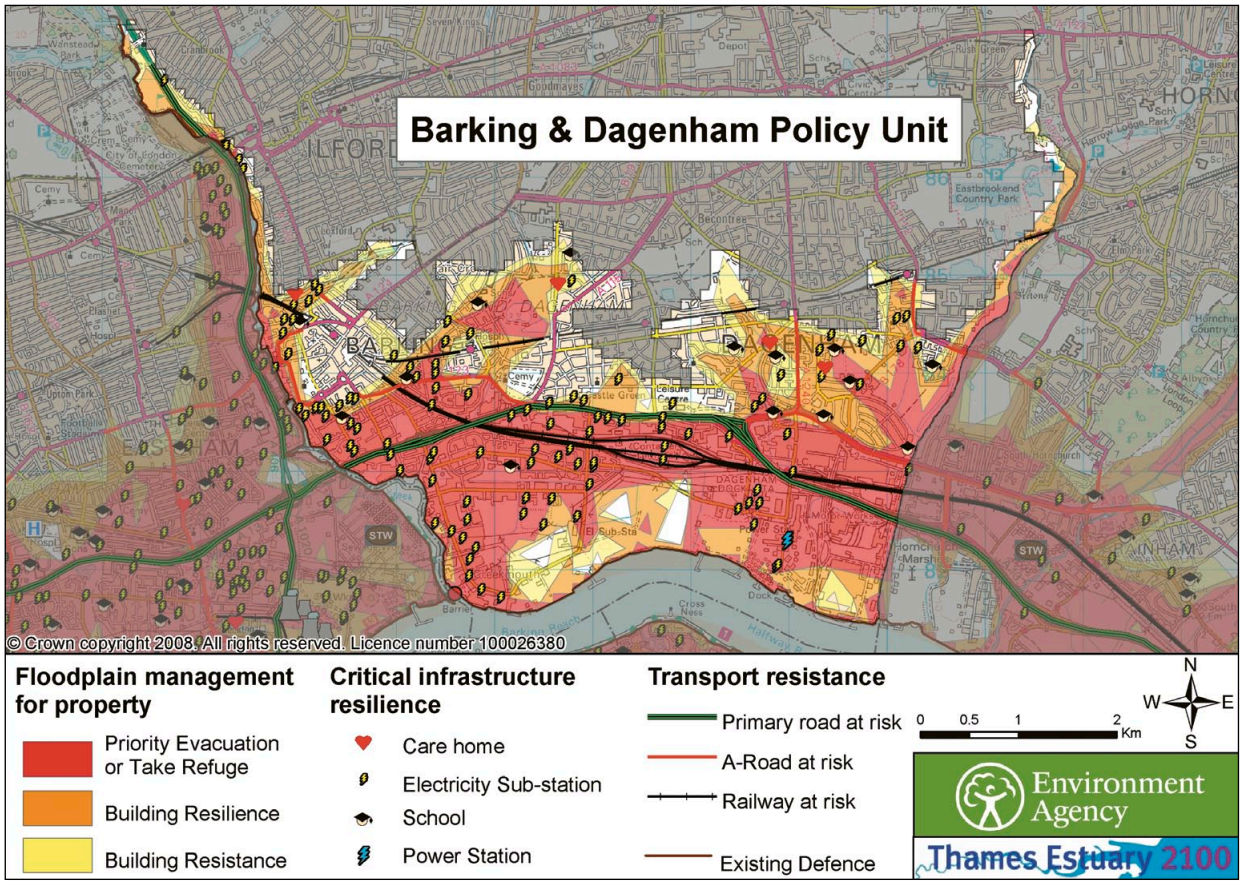
Policy: Our recommended policy for Barking & Dagenham is policy P4 to take further action to keep up with climate and land use change so that flood risk does not increase.

Description

The Barking & Dagenham policy unit contains major industrial areas, some of which are now redundant and land is available for redevelopment, and some dense residential development. The industrial areas are generally closer to the Thames but new residential areas are being developed on the river front. There are therefore opportunities to improve this area as new developments are implemented.

There are large areas of raised ground, and therefore a proportion of development in this policy unit is raised above flood level. There are also important transport links and two tributaries of the tidal Thames, the River Roding and the Beam River.

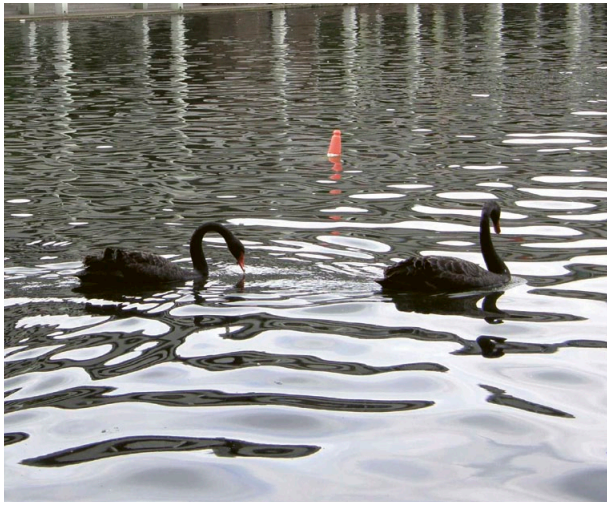
The River Roding forms the boundary with the Royal Docks policy unit, and the Beam River forms the boundary with Rainham Marshes policy unit. The River Roding and Beam River are both covered in the action plan for this policy unit.



At risk in Barking & Dagenham policy unit

Sources of flooding

- Tidal: from the Thames downriver of the Thames Barrier (probability 0.1% per annum or less frequent), flood depths up to 5 m but very variable.
- Tidal: on the River Roding (probability about 0.1% per annum). Barrier controlled.
- Fluvial and tidal/fluvial: from the River Roding (probability ›1% per annum), flood depths 0 m to 3 m. Inflow from Beckton STW when Thames levels are high.



Black swans – now a regular sight on the Thames

- Fluvial and tidal/fluvial: from the Beam River (West Bank) (probability 5% per annum), flood depths 0 m to 2 m.
- Fluvial from local watercourses: including Mayes Brook, Gores Brook and Buzzard Mouth Sewer (probability varies but ›1% per annum in several cases), flood depths 0 to 3 m.
- Local drainage: This needs to be investigated further at a local level and is included in our action plan.

The existing flood risk management system

- Tidal flood defences downriver of the Thames Barrier.
- The Barking Barrier for tidal flood protection on the River Roding.
- Secondary tidal and tidal/fluvial flood defences on the River Roding.
- The Beam Washlands fluvial flood storage area on the Beam River.
- Fluvial flood storage on Mayes Brook.
- Local fluvial flood defences including the Beam River.
- Drainage system outfalls including Beam River, Mayes Brook, Gores Brook, Buzzard Mouth Sewer and Oakentrough Sewer.
- Flood forecasting and warning.

Policy context

Barking & Dagenham forms part of the Thames Gateway regeneration area and is covered by Thames Strategy East. There are extensive areas of redevelopment planned in this policy unit including the large Barking Riverside mixed use development and several Thames Gateway housing sites. These provide opportunities to improve flood risk management arrangements including floodplain management to achieve safer floodplains, and defences that enhance the riverfront environment.

Vision

Changes to the defences provide opportunities for local realignment and landscaping along the Thames frontage. This could provide amenity areas for the many people who live and work in the area. They also provide opportunities for the following: use of the Thames frontage to provide a public access route where possible, with associated facilities; creation of environmental enhancements, taking account of likely accretion along the Thames frontage; reduced dependence on vertical walls where possible, thus providing more robust and sustainable flood defences with access for maintenance; and an improved river

frontage on the River Roding, although there is little space for re-alignment of the defences.

In addition, resilient new development could reduce the flood risk to people and property, and provide a safer and more sustainable floodplain environment. For example, there is scope for the creation of open space in the same way as already implemented at Thamesmead, to provide both flood storage, environmental improvement and amenity areas.

Local issues and choices

Much of the Thames river frontage in this policy unit has relatively high ground as a result of landfill and fill for development. This area is therefore not as vulnerable as Thamesmead on the south bank. The river bed is accreting in front of the Thames defences. Not only does this mean that the defences are not threatened by erosion, but also that the accretion could contribute to enhancing the intertidal areas along the frontage.

Measures will be needed for tributary flooding from the River Roding. The River Roding is already protected from extreme tidal floods by the Barking Barrier. However, the River Roding is a tributary which has potentially serious flood risk management problems because: the flood risk is high; the River Roding is protected by the Barking Barrier but the volume of storage upriver is very limited; the storage problem is exacerbated by overflows from Beckton STW; and whilst there are tidal defences on the River Roding, there is very little space for improvement. For the River Roding our TE2100 Plan recommends that the tidal defences will be raised and fluvial flood storage will be provided. However a detailed study for the River Roding catchment is needed to develop a preferred approach at local level. This is covered in our action plan.

In addition to the River Roding and the Beam River, there are a number of important drainage channels including Mayes Brook and Gores Brook where responses and choices have been identified. There are already difficulties discharging drainage water at some outfalls, and improvement will be needed as the sea level rises and fluvial flows increase.

Reed beds on the River Roding

Policy unit – Rainham Marshes

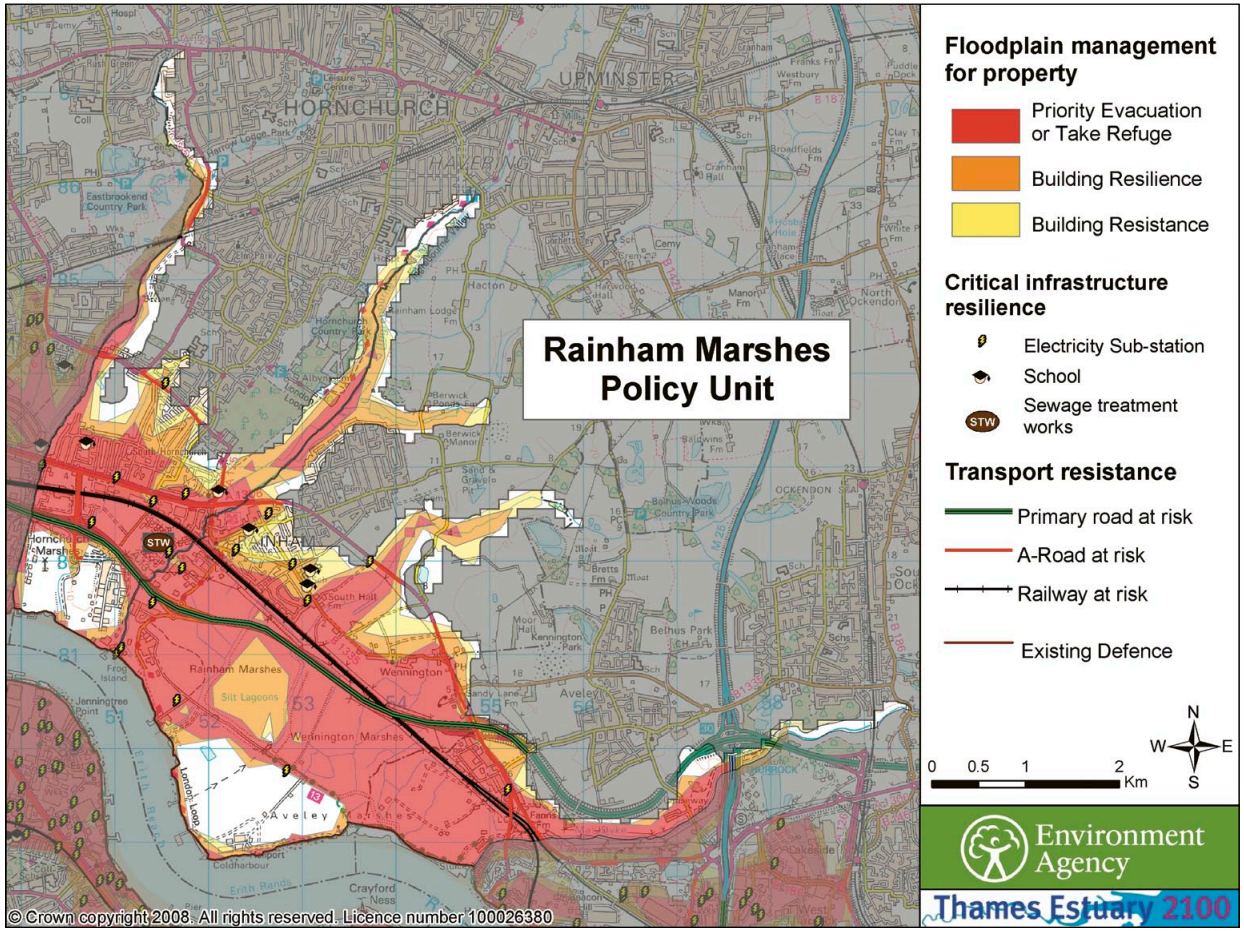
Policy: Our recommended flood risk management policy for Rainham Marshes is policy P4 to take further action to keep up with climate and land use change so that flood risk does not increase.

Description

Rainham Marshes policy unit contains extensive freshwater marshes, a large landfill area, development and major transport links. The marshes are of particular importance. They have a complex historic environment and form a RSPB nature reserve and are included in a proposed community parkland in the Thames Gateway Parklands vision. They therefore provide a key area of green space on the Estuary.

This policy unit is within the Thames Gateway regeneration area, and new developments are planned. There are likely to be opportunities to improve this area as new developments are implemented.

The west boundary of this policy unit is the Beam River, and the east boundary is the Mar Dyke. Flood risk management for each tributary should be associated with a single policy unit. The Beam River is covered by the Barking & Dagenham policy unit, and the Mar Dyke is covered by the Purfleet, Grays & Tilbury policy unit.



At risk in Rainham Marshes policy unit

Sources of flooding

- Tidal from the Thames downriver of the Thames Barrier (probability 0.1% per annum or less frequent), flood depths up to 5 m but very variable.
- Fluvial and tidal/fluvial from the Beam River (East Bank) (probability 5% per annum), flood depths 0 to 2 m.

High Speed One (CTRL) crossing Rainham Marshes on piled raft

- Fluvial and tidal/fluvial from the Ingrebourne River (probability 1% per annum), flood depths 0 to 2 m.
- Fluvial and tidal/fluvial from the Mar Dyke (West Bank) (probability >1% per annum), flood depths 0 to 2 m.
- Fluvial from local watercourses including Havering Sewer and the marsh drainage systems on Rainham, Aveley and Wennington marshes (probability generally about 1% per annum as development is on raised ground). The marshes inundate at lower flood probabilities.
- Local drainage.

The existing flood risk management system

- Tidal flood defences downriver of the Barrier on the Thames.
- The Beam Washlands fluvial flood storage area on the Beam River.
- Local fluvial flood defences on the Mar Dyke and Beam River.
- Drainage system outfalls including Havering Sewer and Rainham Marshes.

Policy context

Rainham Marshes policy unit forms part of the Thames Gateway regeneration area and is covered by Thames Strategy East in addition to the Thames Gateway Parklands vision. There is a large landfill between the marshes and the Estuary. When this reaches capacity and is landscaped, it will form part of proposed community parkland.

Vision

This policy unit can provide important green space in the middle of an otherwise heavily developed area. The parklands vision includes both the marshes and the landfill, and provides an opportunity for a key amenity, recreation and environmentally important area. Redevelopment is planned for other parts of this policy unit, particularly near the CTRL (Channel Tunnel Rail Link). Changes are likely to the industrial frontages. There is therefore scope to improve the overall environment as these changes take place.

Enhancement of the marshes in this policy unit could be carried out to improve their capacity to support freshwater and grazing marsh and historic environment interest features in the Thames. This enhancement could contribute to compensation for losses of freshwater and grazing marsh features elsewhere in the Thames. The Rainham, Aveley and Wennington Marshes and the Ingrebourne River Valley may provide these opportunities.

There is a need to support planning authorities to create a plan that fully integrates flood risk management with new developments, new amenity areas and new/improved conservation areas.

Local issues and choices

Much of the frontage has raised ground or landfill, thus reducing vulnerability to tidal flood risk.

The river bed is accreting in front of the Thames defences. Not only does this mean that the defences are not threatened by erosion, but also that there may be environmental enhancement opportunities. In particular, there is an opportunity to set back the defence at the east end of the landfill near Coldharbour to create replacement intertidal and saltmarsh habitat.

Measures may be needed for tributary flooding from the Beam River, Ingrebourne River and Mar Dyke. The Beam River is covered under the Barking and Dagenham policy unit and the Mar Dyke under the Purfleet, Grays and Tilbury policy unit.

Flood risk from the Ingrebourne River is relatively low. Responses to manage fluvial flood risk on the Ingrebourne River includes local fluvial flood storage and upstream storage for fluvial flooding.

The marshes are drained by a system of open drains. This will require enhancement as the sea level rises and storm rainfall increases. Management measures for fluvial flood risk on the marsh drainage systems include outfall improvements (including pumps) and local fluvial flood storage.

Additional fluvial flood storage may be considered for some of the marsh areas, to store water from the Ingrebourne River, Beam River, smaller drainage systems and possibly the River Roding. The Beam Washlands scheme is a good example of what can be achieved at local level.

Works would be needed in the local drainage systems to mitigate changes in local flood risk if our end of the century option 2, the proposed storage area on Aveley and Wennington marshes, is implemented – although this is not currently a preferred option.

Responses for local flood risk management have not been designed or assessed in detail and further work will be required at local scheme level. Local consultation and appraisal will be required at this stage and our action plan includes the requirement to identify project partners to assist with this detailed development work.

Riverside at Rainham

Action Zone 4 – Policy units

Thamesmead P4 | Barking & Dagenham P4 | Rainham Marshes P4

[Note that all dates are based on government's current guidance on climate change – the TE2100 Plan will be reviewed and updated if these predictions change]

	TE2100 recommended actions	Implementation partners	How this will be achieved
First 25 years	**Action Zone 4 – Recommendation 1** TE2100 Plan informs the development and revision of local authority strategic flood risk assessments (SFRAs) and flood plans. *(Cost of implementing this action not included in TE2100 Plan as Environment Agency standing costs not included, but TE2100 data and information will be available to assist)*	Environment Agency RFCCs (Regional Flood and Coastal Committees) London Boroughs in action zone 4: • LB Greenwich • LB Bexley • LB Barking & Dagenham • LB Havering North East Local Resilience Forum	Downstream of the Thames Barrier, the river defences provide highly reliable protection to this area against surge tides. But should there be a failure of a defence or an extreme event which overtops the defences, low-lying areas of this zone would be at risk as shown on the policy unit "at risk" maps. Flooding from non tidal sources is much more likely. The Flood Plans will set out arrangements for preparing for and managing these sort of emergencies. TE2100 data and information will be provided to local authorities preparing SFRAs, flood plans and emergency capability testing. The Environment Agency will support local authorities with interpretation of TE2100 data and information as required to ensure SFRAs and flood plans are developed with an understanding of TE2100 analysis and recommendations. TE2100 data and information will be provided to LRF to inform Community Risk Registers and support exercises. A community engagement programme to ensure the public, businesses and other groups understand, are involved in and support the flood plans. Feedback from stakeholders indicates interest in greater collaborative working supported by technical workshops to share best practice and support the development of these key documents and plans – and ensure the links to related CFMPs and SMPs are properly understood. The Environment Agency will scope this activity, and prepare a proposal for the ways in which we can promote this collaborative working.

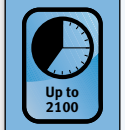
TE2100 action plan: **action zone 4** – east London downstream of Thames Barrier

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 4 – Recommendation 2** To agree a programme of floodplain management including localised flood protection, resilience and local emergency plans for vulnerable key sites in action zone 4. *(Environment Agency, Local Authority and other standing costs not included but additional costs included as described in Action Zone 0 – Recommendation 11. In addition, technical support from the Environment Agency will be provided to promote this action together with the availability of TE2100 data and information. Requirements for future funding will have to be agreed)*	Environment Agency RFCCs London Boroughs in action zone 4: • LB Greenwich • LB Bexley • LB Barking & Dagenham • LB Havering North East Local Resilience Forum Transport for London EDF Energy Thames Water CTRL Highways Authority RSPB Other owners and managers of vulnerable sites	The "at risk" maps show sites and key infrastructure which would be particularly vulnerable in the TE2100 area in the event of a failure or overtopping of the defences. The Environment Agency will discuss with implementation partners to agree strategic scope of measures and future funding requirements. A working group will be established to ensure agreement between implementation partners on the strategic approach, and roles and responsibilities for achieving it. The objectives of this action are that local floodplain management measures in place or planned within 25 years and all site owners supportive of approach and confidence maintained. The Environment Agency will support community engagement programmes to ensure the public, businesses and other groups understand, are involved in and supportive of the flood plans. In particular it is important that individuals understand their own level of risk, and the required level of self-preparedness. An Important action during the preparation phase of this action is to undertake an audit of resilience to flooding of key sites. The Environment Agency will ensure that businesses and communities at risk are informed of the risks, particularly for vulnerable communities (e.g. those in care homes and mobile homes) and what action has been taken or is required – and who is responsible as the risk owner.

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 4 – Recommendation 3** To agree partnership arrangements and principles to ensure that new development in this zone is safe, and that where possible, the application of the NPPF[9] reduces the consequence flood risk – particularly in the areas where large numbers of people congregate or there is aggregation of flood risk. For flood risk management to be factored into the planning process at all levels for the first 25 years from 2010 to 2034. *(Cost of implementing this action not included in TE2100 Plan as Environment Agency standing costs not included, but TE2100 data and information will be available to assist)*	Environment Agency RFCCs GLA, Mayor's Development Corporation, TGLP, Development Corporations Local authority spatial and emergency planners in action zone 4: • LB Greenwich • LB Bexley • LB Barking & Dagenham • LB Havering Landowners & Site managers Developers & Architects	There is need for greater clarity over methods and procedures for safety in new development behind defences. We, along with local authority staff, are providing advice to developers and responding to difficult planning applications. The Environment Agency will provide data, information and technical support to ensure the TE2100 Plan and associated information is able to inform Local Development Frameworks (LDF) and future updates of existing LDFs. These LDFs to be supported by sustainability appraisals that include local tidal flood risk and the implications of climate change. The Environment Agency will encourage application of the NPPF[9] and its supporting technical guidance for new development and encourage adoption of property-level protection and resilience. The Environment Agency will work with implementation partners and Communities and Local Government (CLG) to develop guidance for development in the defended Thames tidal floodplain. These activities will be aimed at promoting partnerships with a wide range of interested parties – recognising the pressures and different timetables and complexities that partners are working within. This could be provided by local guidance for planning staff (Environment Agency and local authority) and developers. The guidance could be a supplement to the Environment Agency's Developers Guide.
	**Action Zone 4 – Recommendation 4** To review and maintain from 2035 to 2049, the partnership arrangements and principles for development and flood risk management established in the first 25 years of our Plan.	As Action Zone 4 – Recommendation 3	Local guidance is updated to reflect changing needs. The TE2100 10-yearly update to include review of Action Zone 4 – Recommendation 3 and recommend any changes or developments. We cannot know what institutional arrangements will be in place during this period or what pressures there will be on the environment. We do know that for the east London downstream of Thames Barrier zone to continue to thrive, flood risk management must continue to be integrated into the spatial planning process.

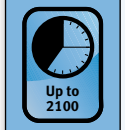
[9] National Planning Policy Framework (CLG 2012)

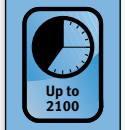
TE2100 action plan: **action zone 4** – east London downstream of Thames Barrier

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 4 – Recommendation 5** To review and maintain from 2050 and into the 22nd century, the partnership arrangements and principles for development and flood risk management established in the middle years of the Plan.	As Action Zone 4 – Recommendation 3	TE2100 10-yearly update will include review of Action Zone 4 – Recommendation 4 and recommend further action. Local guidance will be updated to reflect changing needs. Flood risk management must continue to be integrated into the spatial planning process into the 22nd century.
	**Action Zone 4 – Recommendation 6** To maintain, enhance and improve or replace, the river defence walls and active structures through the east London downstream of Thames Barrier zone over the first 25 years of the Plan from 2010 to 2034. *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency RFCCs Local authority spatial planners in action zone 4: • LB Greenwich • LB Bexley • LB Barking & Dagenham • LB Havering GLA Landowners Developers & Architects Thames Estuary Partnership	This is a continuation of the Environment Agency's activities to ensure that confidence in the Thames tidal flood risk management system is maintained and that opportunities for environmental enhancements and partnership through planning are actively sought and carried out. The Environment Agency's teams responsible for spatial planning and flood risk will promote these works in partnership with landowners and local authority planning teams as part of ongoing development applications. The Environment Agency's teams responsible for management of the flood defence assets will promote these schemes. However, the method of managing the defences is different from the present day approach. It involves greater maintenance and repair work in addition to essential replacement. Promotion of schemes through the capital replacement programme may not be appropriate for optimising maintenance and repair, and the Environment Agency will need to develop new ways of planning and implementing these works. As well as looking for ways of working better with limited resources, we will need to seek opportunities for environmental and recreational enhancements which will create a better place, and for partnerships which will help achieve this. **(continued)**

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 4 – Recommendation 6** **(continued)**		Working with other initiatives will be a key element of this action. When works to flood defence structures are planned, it is important to take opportunities to integrate flood defence into developments – and ensure that the developments are designed with a proper understanding of the flood risk they face. Alignment of programmes may be required. Our TE2100 Technical Report and local choices document for the policy units provide our assessment of the choices which are available in the east London downstream of Thames Barrier zone in the short term.
	**Action Zone 4 – Recommendation 7** To maintain, enhance and improve or replace the defence walls and active structures through east London downstream of Thames Barrier during the 15 year period of the Plan from 2035 to 2049. [Note: Continuing our activities to ensure that confidence in the Thames tidal flood risk management system is maintained and that opportunities for environmental enhancements and partnership through planning are actively sought and carried out] *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency RFCCs Local authority spatial planners in action zone 4: • LB Greenwich • LB Bexley • LB Barking & Dagenham • LB Havering Landowners Developers & Architects Thames Landscape Strategy	Our aims remain as Action Zone 4 – Recommendation 6 above, but during this period, there will be a major programme of rebuilding and refurbishment of the river walls and defences through our east London downstream of Thames Barrier zone. This provides many opportunities for creating a better place and to plan for a better riverside environment. There are major opportunities for reshaping the local landscape as part of these works. During this period we will be preparing for the "end of the century" options – see Action Zone 4 – Recommendation 8 below and any decisions made as part of Action Zone 4 – Recommendation 7 must recognise that there may be major changes from 2070. Our TE2100 Technical Report and local choices document for the policy units provide our assessment of the choices which are available in east London downstream of Thames Barrier in the medium term (2035 to 2049). The TE2100 Plan 10-yearly review and update will give a clear picture of the end of the century works to be recommended.

TE2100 action plan: **action zone 4** – east London downstream of Thames Barrier

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 4 – Recommendation 8** **To Implement our "end of the century" option between 2050 and 2070.** The decision on which "end of the century" option is to be adopted will not be needed until 2050. However, appraising against 2009 conditions, our front runners at this stage for end of the century options are: Option 1.4 – Improve existing system which includes improvements to the Thames Barrier and defence raising down river of the Thames Barrier. Option 3.2 – New barrier at Long Reach. If a new downriver barrier is constructed in 2070 (option 3.2), further defence raising in this zone will not be needed and there will be an opportunity to lower the defences by up to a metre. *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency RFCCs Landowners London Boroughs in action zone 4: • LB Greenwich • LB Bexley • LB Barking & Dagenham • LB Havering Developers & Architects The public Local interest groups GLA Floodplain users Thames Landscape Strategy	This will be a major multi billion pound construction project and the arrangements for implementation are likely to differ from our normal defence construction projects. There are major opportunities for reshaping the local landscape as part of these works. 2070 is a long way ahead but a decision needs to be made on the TE2100 "end of the century" option – and our current Plan provides our best answer given current information. Our recommendations in the Plan are based on conditions now, in 2009, but the final decision on the end of the century options will not be taken until the Plan review in 2050. Intermediate reviews will be undertaken a minimum of 10 yearly intervals – or more frequently if there are significant changes to one or more of the TE2100 indicators for change. There will be further consultation each time the Plan is reviewed. Our 2009 consultation has provided a "snapshot" of Middle Estuary stakeholder views and this will form a starting point for measurement of public attitudes in the future.

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 4 – Recommendation 9** To maintain, improve and enhance or replace the river defence walls and active structures in east London downstream of Thames Barrier zone post 2050 and into the 22nd century. *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency RFCCs Landowners Developers London Boroughs in action zone 4: • LB Greenwich • LB Bexley • LB Barking & Dagenham • LB Havering Thames Landscape Strategy	Whether or not there is a new barrier (i.e. Option 3.2) all the defences in east London downstream of Thames Barrier zone raised will still require ongoing maintenance, repair and replacement (and hence engineering works) and this has been allowed for in our Plan investment profile. There are major opportunities for reshaping the local landscape as part of these works. We cannot know what institutional arrangements there will be as we approach the 22nd century, but our TE2100 vision imagines an environment where the estuary environment downstream of the Thames Barrier continues to thrive and the riverside is increasingly enjoyed and respected by the people who live, work and visit. This means that the actions established in Action Zone 4 – Recommendation 6 and 7 will be continued by whoever is looking after our environment at that time. The detailed work programmes will be developed following the 2050 review and there will be further consultation at that time.
	**Action Zone 4 – Recommendation 10** To agree a programme of managing flooding from other sources in the defended tidal floodplain. *(Cost of implementing this action is not included in TE2100 Plan as Environment Agency standing costs not included, but TE2100 data, information and recommendations are available to support the successful implementation of the action)*	Environment Agency RFCCs London Boroughs in action zone 4: • LB Greenwich • LB Bexley • LB Barking & Dagenham • LB Havering	Large areas of east London downstream of Thames Barrier are low-lying, and there is potentially a high risk of pluvial and urban drainage flooding, particularly in areas where the urban drainage system has relatively low capacity and/or is prone to tide locking. There is also fluvial/pluvial flood risk from Marsh Dykes, River Roding and the Beam River. There are issues which must be better understood before schemes are promoted. For example, there are potential difficulties with any new structures on the River Roding because the river is an important fish migration route. **(continued)**

TE2100 action plan: **action zone 4** – east London downstream of Thames Barrier

	TE2100 recommended actions	Implementation partners	How this will be achieved
	Action Zone 4 – Recommendation 10 **(continued)**	Internal Drainage Boards Thames Water Landowners Developers & Architects	Managing fluvial flood risk on the Marsh Dykes could include: • increase in flood storage volume in the system; • managing surface runoff; • land raising; • improved outfalls including an increase in pumping capacity; • combinations of the above. Local choices for the River Roding could include: • raising the tidal defences; a new flapped outfall upstream of the navigation area, to reduce the need for defence raising; realignment of the tidal defences where improvement on the existing line would be difficult; • upstream fluvial flood storage. This is the response favoured in the Roding strategy for fluvial flood management, although its effectiveness for the lower reach has not been demonstrated; diversion of fluvial flows. A provisional route has been identified, which could divert flows to Rainham marshes although the feasibility of this idea has not been investigated. Responses and choices for the Beam River could include: • improvements to the outfall including possible pumping; • more local fluvial flood storage (in addition to the existing scheme); • local defence raising; a combination of these responses. Other watercourses Responses to manage fluvial flood risk on drainage channels including Mayes Brook and Gores Brook could include: • outfall improvements including pumps; • local fluvial flood storage; • local defence improvements; • a combination of the above responses. **(continued)**

	TE2100 recommended actions	Implementation partners	How this will be achieved
	Action Zone 4 – Recommendation 10 **(continued)**		Our TE2100 Technical Plan and local choices documents for the policy units provide further information on these matters and the choices which are available to assist with problems. The programme adopted must take account of the viability of potential actions to reduce flood risk from other sources. These works will be the responsibility of local Environment Agency teams and those responsible for surface water and other drainage systems. The planning and agreement on what is needed should happen in the short term and this will be supported by the TE2100 Legacy team. Implementation may be a medium term action, depending on local scheme justification based on agreement between implementation partners on the strategic approach, and roles and responsibilities for achieving it.
	Action Zone 4 – Recommendation 12 **To agree a programme for habitat enhancement and replacement and implement habitat improvement and replacement schemes up to 2050.** In 2024 planning and, soon after, groundworks may need to be started in this policy unit to compensate for the loss of designated grazing marsh interest features as a result of intertidal habitat creation.	Environment Agency RFCCs Natural England Landowners Local authorities • LB Greenwich • LB Bexley • LB Barking & Dagenham • LB Havering	The Environment Agency will lead on the creation of planning and groundworks that would take at least five years and there would be an additional 10 years before the habitat is fully established at the sites. We will be looking for partnership arrangements to manage these sites and get the best for the natural environment, for the local population and for visitors. In the Environment Agency we see habitat creation as a positive step toward the goal of sustainability and supporting the habitats and species that make the Thames estuary internationally important. Habitat creation also provides opportunities for enhancements for recreation, visitors' centres and other facilities. There are also resilience benefits arising from creation of saltmarsh and other "soft" defence surfaces which absorb wave and surge energy and protect the structures behind. **(continued)**

TE2100 action plan: **action zone 4** – east London downstream of Thames Barrier

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 4 – Recommendation 12** **(continued)** The following sites have been identified in this action zone as having the potential to support the interest features that could be lost, either through enhancement of existing habitat features or creation of new features or creation of new habitat: • Erith Marshes • Ingrebourne River In addition, there is a need to seek out enhancements throughout the action zone to mitigate the effects of essential construction works and improve the overall quality of the natural environment in this action zone.	Public and local interest groups RSPB Wildlife Trusts Thames Estuary Partnership (TEP) Thames Discovery Programme English Heritage	In identifying schemes, it is essential to promote an integrated approach to management of the historic and natural environment. In this action zone there are significant areas of historic environment sensitivity. It is important that the presence of significant historic environment assets is understood to enable planned changes such as habitat creation. The valleys of the Mardyke and the Ingrebourne are complex historic landscapes and this must form a major consideration in any habitat creation schemes. It is also important to recognise the value of salt marsh and other “soft” inter tidal cover in protecting flood defence structures by absorbing wave and surge energy. This action zone includes the Erith saltings, the last remnant of salt marsh (reed on peat) in south east London and also include the remains of a Neolithic forest. Investigations aimed at saving this habitat have identified that the only feasible way of protecting this asset is to retreat the defences. It seems likely that this habitat will be gone in 30 to 50 years. If riparian landowner requirements, scheme approvals and development proposals can be aligned, and additional funding secured, it may be worth investigating the bringing forward of the middle 15 years reconstruction activities in this area. Meanwhile the TEP/Thames Discovery Programme is recording the site before it is destroyed by rising sea level and wave action.

Action plan for zone 5

11 actions identified

Description of the policy units

- Dartford & Erith
- Swanscombe & Northfleet
- Purfleet, Grays & Tilbury

This section describes the 11 actions for Zone 5 – middle Estuary which have been identified through the TE2100 Plan. The actions are described under the following headings:

- TE2100 recommended actions (and whether or not costs for this have been included in the TE2100 Plan)
- Implementation partners
- How this will be achieved.

"The findings of the TE2100 project show that the Thames estuary has the best coastal flooding defence in the UK. These findings provide well founded reassurance to the communities throughout Thames Gateway and estuary, showing tidal flooding is not a barrier to sustainable economic development."

Homes and Communities Agency

Policy unit – Dartford & Erith

Policy: Our recommended flood risk management policy is policy P4 to take further action to keep up with climate and land use change so that flood risk does not increase.

Description

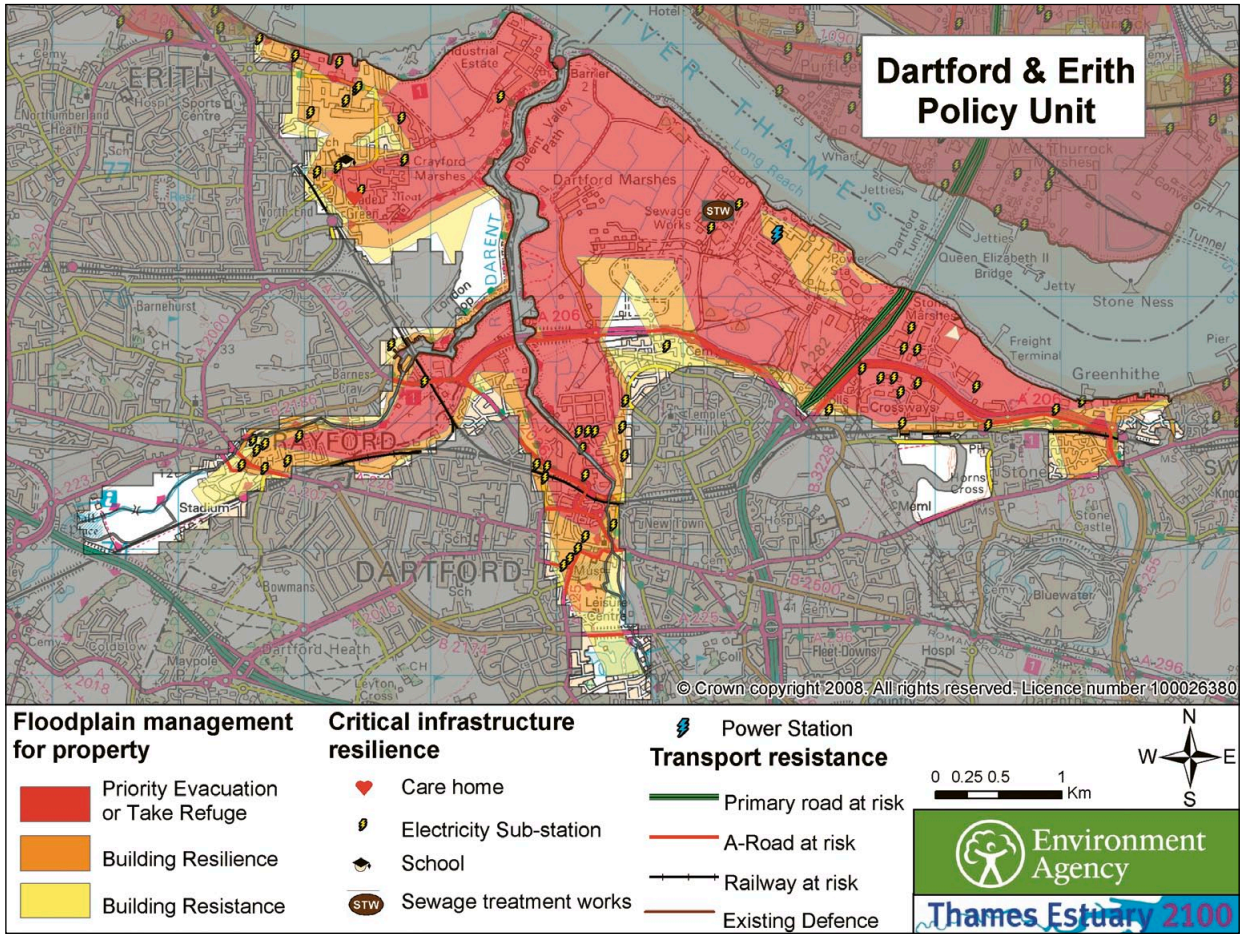
The Dartford & Erith policy unit includes extensive areas of undeveloped and developed marshes and the riverfront town of Greenhithe. It also includes parts of Dartford and Crayford.

The new developments include large areas of ground raising to reduce flood risk. Much of the development is recent, and further development is planned. There is new residential development on the east side of Erith, and new commercial development on Stone Marshes near the Queen Elizabeth II Bridge.

The River Darent (and a tributary, the River Cray) pass through the policy unit. The lower reaches of these rivers pass through the largely undeveloped Dartford and Crayford Marshes.

Sources of flooding

- Tidal from the Thames downriver of the Thames Barrier (probability 0.1% per annum or greater), flood depths up to 5 m.
- Tidal on the Rivers Darent and Cray (probability about 0.1% per annum). Barrier controlled.



At risk in Dartford & Erith policy unit

- Fluvial from the Rivers Darent and Cray (probability 1 to 20% per annum), flood depths up to 2 m.
- Fluvial from the marsh drainage system on Crayford Marshes (probability >1% per annum).
- Fluvial from marsh drainage systems on Dartford and Stone Marshes (probability <1% per annum).
- Local drainage.
- Groundwater from rock aquifers.

The existing flood risk management system

- Tidal flood defences downriver of the Thames Barrier.
- The Dartford Barrier for tidal water levels on the Rivers Darent and Cray.
- Secondary tidal and tidal/fluvial flood defences on the Rivers Darent and Cray.
- Local fluvial flood defences.
- Drainage system outfalls including Crayford, Dartford and Stone Marshes.

Policy context

Dartford & Erith policy unit forms part of the Thames Gateway regeneration area and is covered by Thames Strategy East. There are extensive areas of redevelopment planned in this policy unit, which provide opportunities to improve flood risk management arrangements including floodplain management and new defences that enhance the riverfront environment.

Vision

There is likely to be considerable new development in this policy unit, and there are opportunities to improve the river frontage as new defences are constructed. In particular, there is scope to combine new defences with new development, and possibly retreat the defence in some areas with resilient development on the riverward side.

The marshes should be retained as an important green space in an otherwise developed area. There is a possibility that these marshes could be used for tidal flood storage. If infrequently used the storage area could also be enhanced to provide habitats and recreation opportunities. The marshes provide considerable opportunities for environmental and amenity enhancement with or without the proposed flood storage area at this location. The use of the entire marsh area for flood storage is currently restricted by the presence of the Darent Industrial Estate.

Local issues and choices

Measures will be needed for tributary flooding from the River Darent and the River Cray (which joins the Darent in this policy unit). The Darent is already protected from extreme tidal floods by the Dartford Barrier but defence raising will be needed. Choices for the River Darent are given in the action table for Action Zone 5.

Separate fluvial flood risk management schemes would be needed for Dartford and Crayford. These schemes could include fluvial storage in the marshes to draw flood levels down, although at present this would not be very effective because of the restricted conveyance upstream.

In addition to the River Darent/Dartford Creek, there are a number of marsh drainage systems with outfalls into the Estuary. Responses to manage fluvial flood risk in these systems might include outfall improvements, local fluvial flood storage and management of surface runoff. The need for these has not been investigated.

Responses for local flood risk management have not been designed or assessed in detail and further work will be required at local scheme level. Local consultation and appraisal will be required at this stage and our action plan includes the requirement to identify project partners to assist with this detailed development work.

Policy unit – Swanscombe & Northfleet

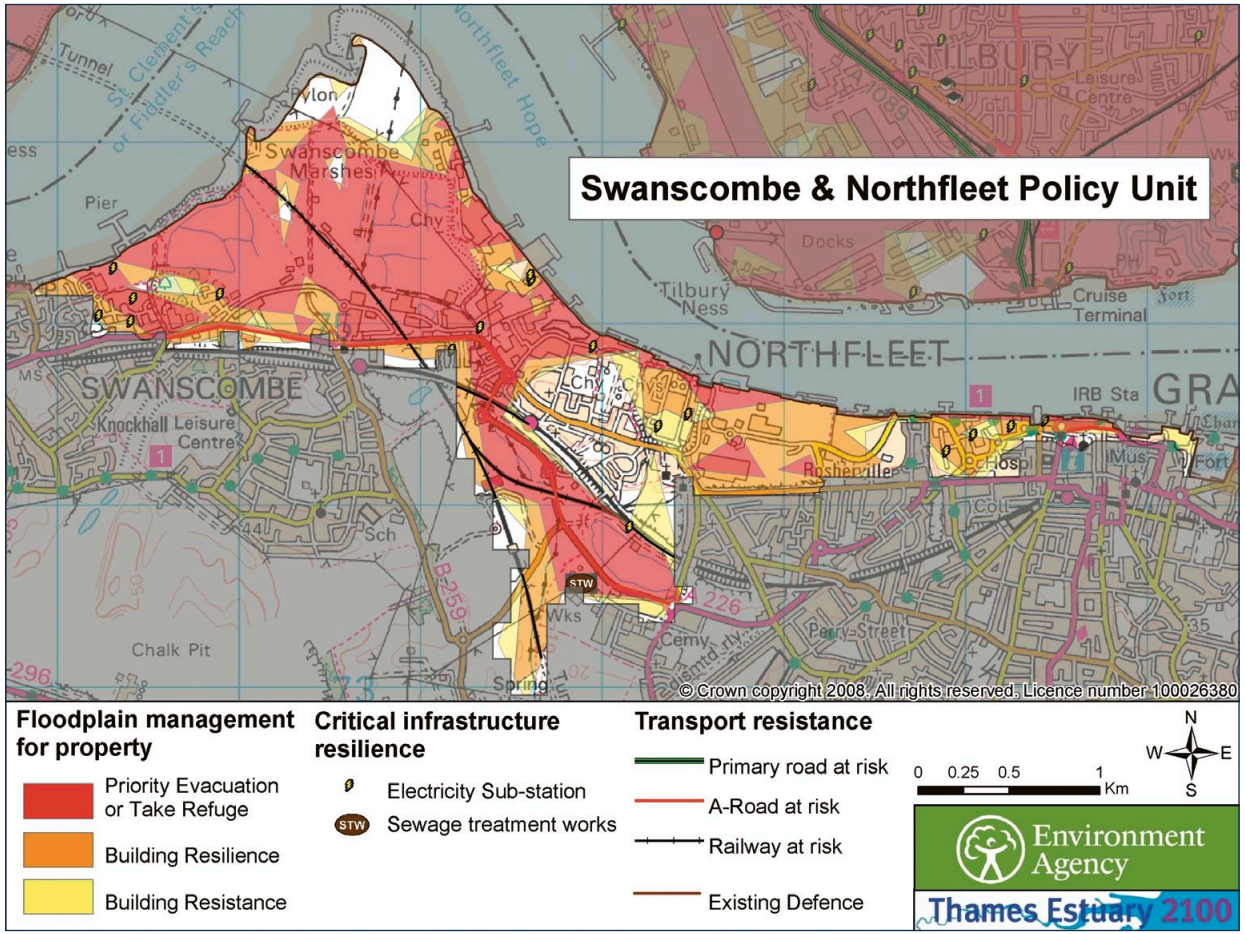
Policy: Our recommended flood risk management policy is policy P4 to take further action to keep up with climate and land use change so that flood risk does not increase.

Description

The Swanscombe & Northfleet policy unit includes the Swanscombe peninsula, the industrial area of Northfleet and part of the town of Gravesend.
The Gravesend and Northfleet frontage includes residential, industrial and recreation areas.
The industrial area extends into the Swanscombe peninsula. Most of the peninsula is currently undeveloped. It includes landfill sites and two areas of freshwater marsh. It also contains a portal of the High Speed 1 (formerly CTRL) tunnel under the Thames.

Sources of flooding

- Tidal from the Thames downriver of the Thames Barrier (probability 0.1% per annum or greater), flood depths up to 5 m but much less in most of the area owing to raised ground levels.
- Fluvial from local watercourses including the River Ebbsfleet and the marsh drainage systems on Black Duck, Swanscombe and Botany marshes (probability ›1% per annum in marsh areas).
- Local drainage.
- Groundwater from rock aquifers.



At risk in Swanscombe & Northfleet policy unit

The existing flood risk management system

- Tidal flood defences downriver of the Thames Barrier.
- Drainage system outfalls including the River Ebbsfleet and the marsh drainage systems on Black Duck and Botany marshes.

Policy context

Swanscombe & Northfleet forms part of the Thames Gateway regeneration area and is covered by Thames Strategy East.

There are extensive areas of redevelopment planned in this policy unit.

This provides opportunities to improve flood risk management arrangements including floodplain management and new defences that enhance the riverfront environment.

Vision

There are opportunities to combine improved arrangements for flood risk management in this area with the creation of green space on the Swanscombe peninsula. This could be developed to promote closer links between the floodplain and the Estuary in Northfleet and Gravesend.

Swanscombe – High Speed 1 (formerly CTRL)

There is also a need to work with planning authorities to create a plan that fully integrates flood risk management with new developments, new amenity areas and new/improved conservation areas.

Local issues and choices

Management of flood risk on the River Ebbsfleet might include improvements to the outfall or conserving the floodplain and maximising flood storage.

The fluvial flood risk on the Swanscombe marsh drainage systems is small. Flood mitigation measures might include improved outfalls and local fluvial flood storage.

There is a potential flood risk from groundwater emerging from the chalk aquifer which is very close to the Estuary in this policy unit, although this is unconnected with the Estuary.

Responses for local flood risk management have not been designed or assessed in detail and further work will be required at local scheme level. Local consultation and appraisal will be required at this stage and our action plan includes the requirement to identify project partners to assist with this detailed development work.

Policy unit – Purfleet, Grays & Tilbury

Policy: Our recommended flood risk management policy is policy P4 to take further action to keep up with climate and land use change so that flood risk does not increase.

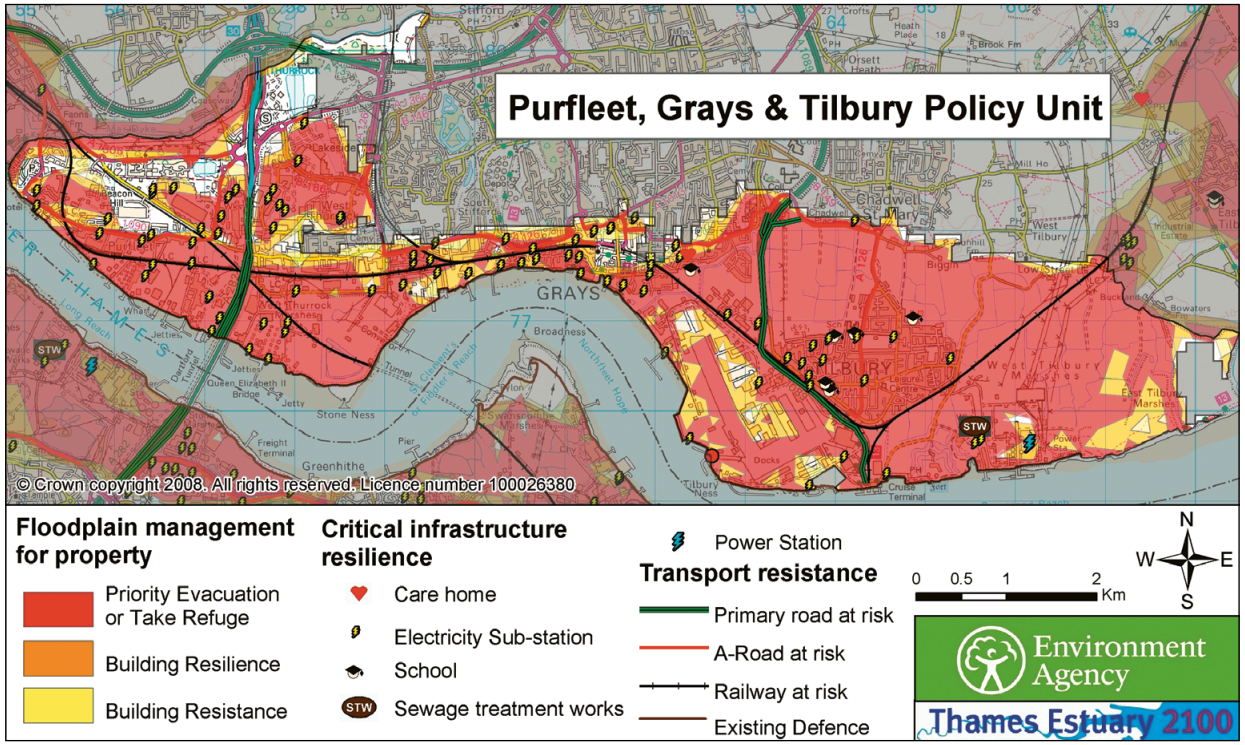
Description

Purfleet, Grays & Tilbury is a large policy unit that includes Tilbury Town and parts of the urban areas of Grays and Purfleet. This policy unit has two main floodplain areas, at Tilbury and West Thurrock/ Purfleet. Much of the marsh areas are low lying, less than 1 m AOD, and some of the developed areas are very vulnerable to flooding.

Purfleet and West Thurrock marshes are mainly industrial and commercial, with some residential areas and large redevelopment sites. Tilbury marshes include Tilbury Fort, one of the finest post-medieval fortifications in England, Tilbury Docks and Tilbury Power Station together with the residential area of Tilbury Town.

Part of the riverside town of Grays is on a strip of floodplain between these two areas. This policy unit contains numerous port facilities and there are a large number of active riverside jetties and wharves.

The western boundary of the Purfleet, Grays and Tilbury policy unit is the Mar Dyke, which is included within this policy unit.



At risk in Purfleet, Grays & Tilbury policy unit

The Dartford Tunnel and HS1 railway northern portals are in this policy unit.

Sources of flooding

- Tidal from the Thames downriver of the Thames Barrier (probability 0.1% per annum or greater), flood depths up to 5 m.

- Fluvial and tidal/fluvial from the Mar Dyke (probability >1% per annum).
- Fluvial from local watercourses in West Thurrock Marshes (probability about 1% per annum).
- Fluvial from local watercourses in West and East Tilbury Marshes (probability about 1% per annum).
- Local drainage.

The existing flood risk management system

- Tidal flood defences downriver of the Thames Barrier.
- Tilbury Dock floodgate.
- Local fluvial flood defences on the Mar Dyke.
- Local fluvial defences at Tilbury Town.
- Drainage system outfalls including West Thurrock and West Tilbury marshes.

Policy context

The Purfleet, Grays & Tilbury policy unit forms part of the Thames Gateway regeneration area and is covered by Thames Strategy East in addition to the Thames Gateway Parklands vision. These areas of planned redevelopment provide opportunities to improve flood risk management arrangements including floodplain management and new defences that enhance the riverfront environment.

Vision

It is likely that this area will continue to be an important commercial and industrial centre. However there are likely to be major changes following the extensive development and redevelopment in the area, and plans to create parks and green corridors.

Future flood defences can be an important catalyst for improvement by providing good access to the Estuary and helping to create important public amenity areas. There is also an opportunity to create a safer floodplain where developments are resilient to flood damage and people would be safe during a flood event.

Local issues and choices

Measures are not included in our Plan for tributary flooding from the Mar Dyke as the flood risk is very low.

Drainage systems in the Purfleet, West Thurrock and Tilbury areas will require upgrading as the sea level rises and storm rainfall is expected to increase. Mitigation measures might include improved outfalls and drainage channels, additional pumping capacity, additional flood storage and new or improved local flood defences.

There is likely to be a limit to the number of times the new Tilbury Dock flood gate can be closed because of the interference with shipping. A possible mitigation measure would be to raise the quay edges in the dock, although this may interfere with commercial operations.

Responses for local flood risk management have not been designed or assessed in detail and further work will be required at local scheme level. Local consultation and appraisal will be required at this stage and our action plan includes the requirement to identify project partners to assist with this detailed development work.

Action Zone 5 – Policy units

Dartford & Erith P4 | Swanscombe & Northfleet P4 | Purfleet, Grays & Tilbury P4

[Note that all dates are based on government's current guidance on climate change – the TE2100 Plan will be reviewed and updated if these predictions change]

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 5 – Recommendation 1** **TE2100 Plan informs the development and revisions of local authority Strategic Flood Risk Assessments (SFRAs) and flood plans.** [Note: there is a night time population of over 29,000 and over 50,000 workers during the day. Some 5600 are classed as highly vulnerable to a flood, implying physical immobility or other severe health problems and the financially deprived. These factors provide particular challenges to local authorities in the event of a flood. Particularly, with limited transport infrastructure, much of which could be inaccessible – see "at risk" maps]	Environment Agency • LB Bexley • Dartford Borough Council • Gravesham Borough Council • Thurrock Unitary Authority • Thurrock TG Development Corporation • Kent County Council • Essex County Council	TE2100 data and information will be provided to local authorities preparing SFRAs, flood plans and emergency capability testing. The Environment Agency will support local authorities with interpretation of TE2100 data and information as required to ensure SFRAs and flood plans are developed with an understanding of TE2100 analysis and recommendations. TE2100 data and information will be provided to Local Resilience Fora (LRF) to inform Community Risk Registers and support exercises. There is already a considerable amount of work being done in local authorities. For example, Thurrock's Local Development Framework (LDF) documents will include sustainability appraisals taking account of flood risk management, and a review of the Thurrock SFRA and water cycle studies is currently under way. Kent County Council flood plan is undergoing review and Kent Thameside SFRA has been produced. There is a need however to improve links and collaboration between plans and strategies. **(continued)**

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 5 – Recommendation 1** **(continued)** *(Cost of implementing this action not included in TE2100 Plan as Environment Agency standing costs not included, but TE2100 data and information will be made available and Environment Agency technical support will be provided to promote collaborative working)*	RFCCs (Regional Flood and Coastal Committees) Kent Resilience Forum, Essex Resilience Forum English Heritage	Feedback from stakeholders indicates interest in greater collaborative working supported by technical workshops to share best practice and support the development of these key documents and plans – and ensure the links to related CFMPs and SMPs are properly understood. The Environment Agency will scope this activity, and prepare a proposal for the ways in which it can promote this collaborative working.
	**Action Zone 5 – Recommendation 2** To agree a programme of floodplain management including flood warning, emergency planning, and localised flood protection and resilience for vulnerable key sites in the middle Estuary action zone. [Note: there are 203 electricity sub-stations, four railway stations and three care homes in the middle Estuary. There are small proportions of basements and mobile homes which are particularly vulnerable in this zone. The "at risk" map provides more detail and our proposed floodplain management measures] *(Environment Agency, Local Authority and other standing costs not included but additional costs included as described in Action Zone 0 – Recommendation 11.*	Environment Agency • LB Bexley • Dartford Borough Council • Gravesham Borough Council • Thurrock Unitary Authority • Thurrock TG Development Corporation • Kent County Council • Essex County Council RFCCs	The Environment Agency will discuss with implementation partners to agree strategic scope of measures and future funding requirements. A working group will be established to ensure agreement between implementation partners on the strategic approach, and roles and responsibilities for achieving it. The objectives of this action are that local floodplain management measures in place or planned within 25 years and all site owners supportive of approach and confidence maintained. The Dartford crossing, Ebbsfleet development and the CTRL/HS1 tunnel portal are in the flood risk zone and a key landowner Lafarge Cement UK has a number of key infrastructure elements in this action zone. The Environment Agency will support community engagement programmes to ensure the public, businesses and other groups understand, are involved in and supportive of the flood plans. In particular it is important that individuals understand their own level of risk, and the required level of self-preparedness. An important action during the preparation phase of this action is to undertake an audit of resilience to flooding of key sites. The Environment Agency will ensure that businesses and communities at risk are informed of the risks, particularly for vulnerable communities (e.g. those in care homes and mobile homes) and what action has been taken or is required – and who is responsible as the risk owner. **(continued)**

TE2100 action plan: **action zone 5** – middle Estuary

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 5 – Recommendation 2 (continued)** *In addition, technical support from the Environment Agency will be provided to promote this action together with the availability of TE2100 data and information. Requirements for future funding will have to be agreed)*	Kent Resilience Forum, Essex Resilience Forum English Heritage CTRL/HS1 Lafarge Cement	
	**Action Zone 5 – Recommendation 3** To agree partnership arrangements and principles to ensure that new development in this zone is safe, and flood risk management is factored into the planning process at all levels for the first 25 years from 2010 to 2034. [Note: There is need for greater clarity over methods and procedures for safety in new development behind defences. Environment Agency and local authority staff are providing advice to developers and responding to difficult planning applications] *(Cost of implementing this action not included in TE2100 Plan as Environment Agency standing costs not included, but Environment Agency Technical support and TE2100 data and information will be available to assist)*	Environment Agency • LB Bexley • Dartford Borough Council • Gravesham Borough Council • Thurrock Unitary Authority • Thurrock TG Development Corporation • Kent County Council • Essex County Council RFCCs, GLA Lafarge Cement	The Environment Agency will provide data, information and technical support to ensure the TE2100 Plan and associated information is able to inform Local Development Frameworks (LDF) and future updates of existing LDFs. These LDFs to be supported by sustainability appraisals that include local tidal flood risk and the implications of climate change. The Environment Agency will encourage application of the NPPF for new development and encourage adoption of property-level protection and resilience. The Environment Agency will produce and promote further guidance on interpretation of the NPPF in the heavily defended Thames tidal floodplain. These activities will be aimed at promoting partnerships with a wide range of interested parties – recognising the pressures and different timetables and complexities that partners are working within. **(continued)**

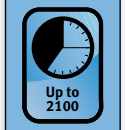
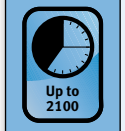
	TE2100 recommended actions	Implementation partners	How this will be achieved
First 25 years	Action Zone 5 – Recommendation 3 **(continued)**	Other landowners Developers & architects	The development of Northfleet Cement Works is an example of a scheme in this action zone where a collaborative approach with the owners and developers could achieve good results in terms of factoring flood risk into the development at an early stage.
Middle 15 years	Action Zone 5 – Recommendation 4 To review and maintain partnership arrangements and principles from 2035 to 2049 As Action Zone 5 – Recomm. 3 above	As Action Zone 5 – Recommendation 3 above	Local guidance updated to reflect changing needs. The TE2100 10-yearly update to include review of Action Zone 5 – Recommendation 3 and recommend further action. We cannot know what institutional arrangements will be in place during this period or what pressures there will be on the environment. We do know that for the middle Estuary zone to continue to thrive, flood risk management must continue to be integrated into the spatial planning process.
Up to 2100	Action Zone 5 – Recommendation 5 To review and maintain partnership arrangements and principles from 2050 and into the 22nd century As Action Zone 5 – Recomm. 3 above	As Action Zone 5 – Recommendation 3 above	TE2100 10-yearly update to include review of Action Zone 5 – Recommendation 4 and recommend further action. Local guidance is updated to reflect changing needs.
First 25 years	Action Zone 5 – Recommendation 6 To maintain, enhance and replace the river defence walls and active structures through the middle Estuary zone over the first 25 years of the Plan from 2010 to 2034.	Environment Agency • LB Bexley • Dartford Borough Council	The Environment Agency's teams responsible for spatial planning and flood risk will promote these works in partnership with landowners and local authority planning teams as part of ongoing development applications. The Environment Agency's teams responsible for management of the flood defence assets will promote these schemes. However, the method of managing the defences is different from the present day approach. It involves greater maintenance and repair work in addition to essential replacement. **(continued)**

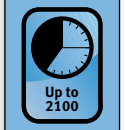
TE2100 action plan: **action zone 5** – middle Estuary

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 5 – Recommendation 6** **(continued)** [Note: This is a continuation our current activities to ensure that confidence in the Thames tidal flood risk management system is maintained and that opportunities for environmental enhancements and partnership through planning are actively sought and carried out] *(Cost of implementing this action is included in TE2100 Plan)*	• Gravesham Borough Council • Thurrock Unitary Authority • Thurrock TG Development Corporation • Kent County Council • Essex County Council RFCCs English Heritage Landowners Thames Path Thames Strategy East	Promotion of schemes through the capital replacement programme may not be appropriate for optimising maintenance and repair, and the Environment Agency will need to develop new ways of planning and implementing these works. As well as looking for ways of working better with limited resources, we will need to seek opportunities for environmental and recreational enhancements which will create a better place, and for partnerships which will help achieve this. Working with other initiatives will be a key element of this action. When works to flood defence structures are planned, it is important to take opportunities to integrate flood defence into developments – and ensure that the developments are designed with a proper understanding of the flood risk they face. Alignment of programmes may be required. River wall and embankment works need to be sensitive to coastal features. For example, in this action zone there are important military, historic and inter tidal features west of Gravesend, in the Ebbsfleet valley and in other areas. These schemes will require careful mitigation of impacts. Concerns have been raised (response from KCC) over the reliability of operation of moveable gates in different ownerships. Defence schemes should examine ways in which these "weak link" moveable gates could be replaced with more reliable, fixed designs. The TE2100 Legacy team will be preparing design guidance in consultation with local teams. The design guidance will set down design principles applicable to the Thames tidal defences, including a presumption that wherever the opportunity arises we will move away from movable defences and towards passive structures.
	**Action Zone 5 – Recommendation 7** To operate, maintain and enhance the defence walls and active structures through the middle Estuary zone over the 15 year period of the Plan from 2035 to 2049 – this will include defence raising in 2040.	Environment Agency • LB Bexley • Dartford Borough Council • Gravesham Borough Council	Our aims remain as Action Zone 5 – Recommendation 6 above, but during this period, there will be a major programme of rebuilding and refurbishment of the river walls and defences through middle Estuary zone. This provides many opportunities for creating a better place and to plan for a better riverside environment. The Environment Agency's staff responsible for spatial planning and flood risk will promote these works as part of ongoing development applications. **(continued)**

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 5 – Recommendation 7** **(continued)** [Note: Continuing our activities to ensure that confidence in the Thames tidal flood risk management system is maintained and that opportunities for environmental enhancements and partnership through planning are actively sought and carried out] *(Cost of implementing this action is included in TE2100 Plan)*	• Thurrock Unitary Authority • Thurrock TG Development Corporation • Kent County Council • Essex County Council RFCCs English Heritage Landowners Thames Path Thames Strategy East	A key issue is how land allocated for development can take account of the need for the raising of flood defences in 2040. The Environment Agency will take lead in providing clear and consistent advice to developers in these matters. The Environment Agency will promote schemes through the capital programme and they will form part of strategic and investment plans subject to replacement/repair working arrangements as Action Zone 5 – Recommendation 6 above. There are major opportunities for reshaping the local landscape as part of these works and a primary purpose of the Riverside Strategies (ref Action Zone 0 – Recommendation 16) is to enable these opportunities to be factored into medium to long term spatial plans. During this period we will be preparing for the "end of the century" any decisions made as part of Action Zone 5 – Recommendation 7 must recognise that there may be major changes during the period 2050 to 2070. New and creative partnership approaches must be sought to make the most of the opportunity to reshape the riverside. A possible candidate for a changed approach – raised during our consultation – is to consider opening up "Robbins Creek", blocked by flood defence works during the 1970s. This could potentially be reshaped to become a harbour of refuge. Facilities such as these for recreational navigation are lacking on the North Kent coast.
	**Action Zone 5 – Recommendation 8** **To Implement our "end of the century" option in 2070.** The decision on which "end of the century" option is to be adopted will not be needed until 2050. However, appraising against 2009 conditions, our front runners at this stage for end of the century options are: Option 1.4 – Improve Existing system	Environment Agency RFCCs Defra/CLG Landowners Local authorities Developers The public • Kent County Council	This will be a major multi billion pound construction project and the arrangements for implementation are likely to differ from our normal defence construction projects. There are major opportunities for reshaping the local landscape as part of these works. 2070 is a long way ahead but a decision needs to be made on the TE2100 "end of the century" option. Our recommendations in the Plan are based on conditions now, in 2009, but the final decision on the end of the century options will not be taken until the Plan review in 2050. Intermediate reviews will be undertaken a minimum of 10 yearly intervals – or more frequently if there are significant changes to one or more of the TE2100 indicators for change. **(continued)**

TE2100 action plan: **action zone 5** – middle Estuary

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 5 – Recommendation 8** **(continued)** Option 3.2 – New Barrier at Long Reach The Long Reach barrier site is within this zone. If a new barrier is constructed between 2050 and 2070 (option 3.2), further defence raising upstream of the barrier site will not be needed in this zone and there will be an opportunity to lower the defences by up to a metre. The TE2100 10-yearly update will include a review of Action Zone 5 – Recommendation 8 and recommend further whether the end of the century recommendations have changed. *(Cost of implementing this action is included in TE2100 Plan)*	• Essex County Council English Heritage GLA Floodplain users	There will be further consultation each time the Plan is reviewed. The defences will require raising during the period covered by the Plan including the Dartford Barrier. The amount of raising will depend on the rate of sea level rise. The flood control gate at Tilbury Dock would be difficult to raise and will require replacement. Our 2009 consultation has provided a "snapshot" of middle Estuary stakeholder views and this will form a starting point for measurement of public attitudes in the future.
	**Action Zone 5 – Recommendation 9** **To maintain and enhance the river defence walls and active structures through the middle Estuary post 2050 and into the 22nd century.** Whether or not defences are raised, all defences will still require ongoing maintenance, repair and replacement	As Action Zone 5 – Recommendation 7	We cannot know what institutional arrangements there will be as we approach the 22nd century, but our TE2100 vision imagines an environment where the middle Estuary riverside continues to thrive, is increasingly enjoyed and respected by the people who live, work and visit. This means that the actions established in Action Zone 5 – Recommendation 6 and 7 will be continued by whoever is looking after our environment at that time. The detailed programmes will be developed following the 2050 review and there will be further consultation at that time. **(continued)**

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 5 – Recommendation 9** **(continued)** (and hence engineering works) and this has been allowed for in our Plan investment profile. *(Cost of implementing this action is included in TE2100 Plan)*		
	**Action Zone 5 – Recommendation 10** **To agree a programme of managing flooding from other sources in the defended tidal floodplain in the first 25 years of the TE2100 Plan.** Large areas of middle Estuary zone are low-lying, and there is potentially a high risk of pluvial and urban drainage flooding, particularly in areas where the urban drainage system has relatively low capacity and/or is prone to tide locking. There is a particular problem where tributaries such as the Darent and the Ebbsfleet discharge to the Estuary. *(Cost of implementing this action is not included in TE2100 Plan as Environment Agency standing costs not included, but TE2100 data, information and recommendations are available to support the successful implementation of the action)*	Environment Agency RFCCs Landowners Developers and local authority planning teams	These works will be the responsibility of local Environment Agency teams and those responsible for surface water and other drainage systems. The planning and agreement on what is needed should happen in the short term and this will be supported by the TE2100 Legacy team. Implementation may be a medium term action, depending on local scheme justification based on agreement between implementation partners on the strategic approach, and roles and responsibilities for achieving it. Our TE2100 Technical Plan and local choices documents for the policy units provide further information on these matters and the choices which are available to assist with problems.

TE2100 action plan: **action zone 5** – middle Estuary

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 5 – Recommendation 12** **To agree a programme for habitat enhancement and creation.** In 2024 planning and, soon after, groundworks may need to be started in this policy unit to compensate for the potential loss of designated grazing marsh interest features as a result of intertidal habitat creation. The following sites have been identified in this action zone as having the potential to support the interest features that could be lost, either through enhancement of existing habitat features or creation of new sites: • Dartford Marshes East • Dartford and Crayford Marshes • Tilbury Marshes and West Tilbury Marshes	Environment Agency RFCCs Natural England English Heritage RSPB Wildlife Trusts • LB Bexley • Dartford Borough Council • Gravesham Borough Council • Thurrock Unitary Authority • Thurrock TG Development Corporation • Kent County Council • Essex County Council GLA	The Environment Agency will lead on the creation of new habitat. Planning and groundworks would take at least five years and there would be an additional 10 years before the habitat is fully established at the sites. We will be looking for partnership arrangements to manage these sites and get the best for the natural environment, for the local population and for visitors. In the Environment Agency we see habitat creation as a positive step toward the goal of sustainability and supporting the habitats and species that make the Thames estuary internationally important. Habitat creation also provides opportunities for enhancements for recreation, visitors' centres and other facilities. There are also resilience benefits arising from creation of saltmarsh and other "soft" defence surfaces which absorb wave and surge energy and protect the structures behind. In identifying schemes, it is essential to promote an integrated approach to management of the historic and natural environment. In this action zone there are significant areas of historic environment sensitivity including Neolithic land surfaces, 19th century fortifications and more recent assets of historic importance. It is important that the presence of significant historic environment assets is understood to enable planned changes such as habitat creation. For example, projects such as LB Bexley's "Managing the Marshes" should inform the opportunities in their local area.

Action plan for zone 6

Eight actions identified

Description of the policy units

- East Tilbury & Mucking Marshes
- North Kent Marshes
- Hadleigh Marshes

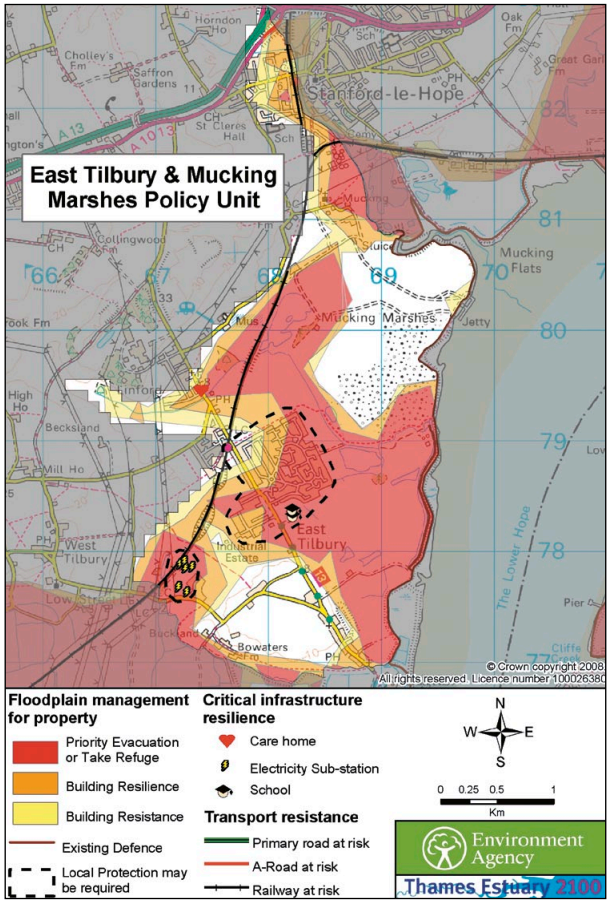
This section describes the eight actions for zone 6 – lower Estuary Marshes which – have been identified through the TE2100 Plan. The actions are described under the following headings:

- TE2100 recommended actions (and whether or not costs for this have been included in the TE2100 Plan)
- Implementation partners
- How this will be achieved

"There is a strong sense of community among those that live alongside the marshes. We look forward to the future; we see that the way forward is to share this magical wilderness, its sights and sounds with others who will come to learn about the wildlife, wander the footpaths, and enjoy the tranquillity and atmosphere. This is truly a place of importance for future generations."

The Friends of North Kent Marshes

Policy unit – East Tilbury & Mucking Marshes



At risk in East Tilbury & Mucking Marshes policy unit

Policy: Our recommended policy for East Tilbury & Mucking Marshes is policy P3, to continue with existing or alternative actions to manage flood risk. We will continue to maintain flood defences at their current level, accepting that the likelihood and/or consequences of a flood will increase because of climate change.

Description

East Tilbury & Mucking Marshes consist of an area of marshes to the west of the Lower Hope reach of the Estuary. The area has a complex historic environment with both upstanding historic features and buried archaeological remains. There is an important area of designated intertidal habitat which runs along the frontage parallel to the defences. Much of this area of freshwater marsh is being used for landfill and gravel extraction. As a result, the landscape is in transition and will look very different in the future.

Sources of flooding

- Tidal from the Thames downriver of the Thames Barrier (probability 0.1% per annum or greater), flood depths up to 4 m.
- Fluvial from local watercourses including Mucking Creek and the marsh drainage systems on East Tilbury Marshes (probability ›1% per annum), flood depths up to about 2 m.

The existing flood risk management system

- Tidal flood defences on the Thames.
- Drainage system outfalls including Mucking Creek and East Tilbury Marshes.

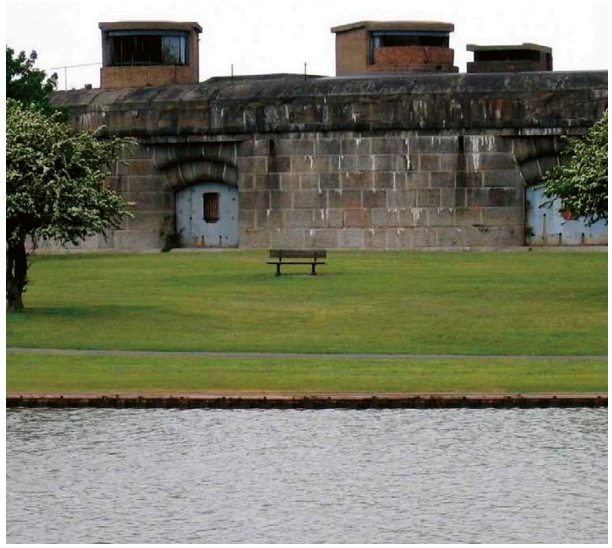
East Tilbury

Policy context

The main residential development is East Tilbury. This includes a major landfill area that provides an area of high ground. There is public access along the defences to the south of the landfill area, and it is envisaged that continuous public access will be provided in the future.

Much of the remainder of the freshwater marshes has been or is being used for gravel extraction. As the land is being restored after gravel removal, there is potential for the marshes to be used for compensation freshwater habitat in the future.

Coalhouse Fort is an important historical feature which provides a focus point for public access to the Estuary. It is recognised as a key feature of the historic estuary environment. There are a number of other important historic military remains which provide high group value with Coalhouse Fort. In addition there are significant below-ground archaeological remains, particularly in the south of the policy unit.



Coalhouse Fort

Vision

Whilst the policy unit is dominated by landfill and gravel extraction, it presents important opportunities because:

- There is a tidal Special Protection Area (SPA) along the foreshore, and managed realignment could extend this area.
- The floodplain will be restored after completion of gravel extraction.

The replacement of defences can make an important contribution to the improvement of this area, particularly by providing better public access.

Local issues and choices

It will be difficult to justify wholesale replacement of defences when they come to the end of their lives because of the low value of assets in this area. However, local secondary defences for important assets, and key infrastructure and residential areas such as East Tilbury may be a more appropriate solution.

As the tidal flood defences will not be raised, flood risk will increase. The Plan includes a secondary defence for East Tilbury and the adjacent railway line, although this will require appraisal and justification. New and improved defences should be designed so that all defences have continuous public access, including adequate access points.

Managed realignment is planned at Mucking in association with the proposed new London Gateway Port to provide replacement intertidal area and saltmarsh.

There is a fluvial drainage system for the marshes. Fluvial flood risk is likely to rise as the sea level rises and fluvial flows increase. Potential mitigation measures include outfall improvement, flood storage and local flood defences.

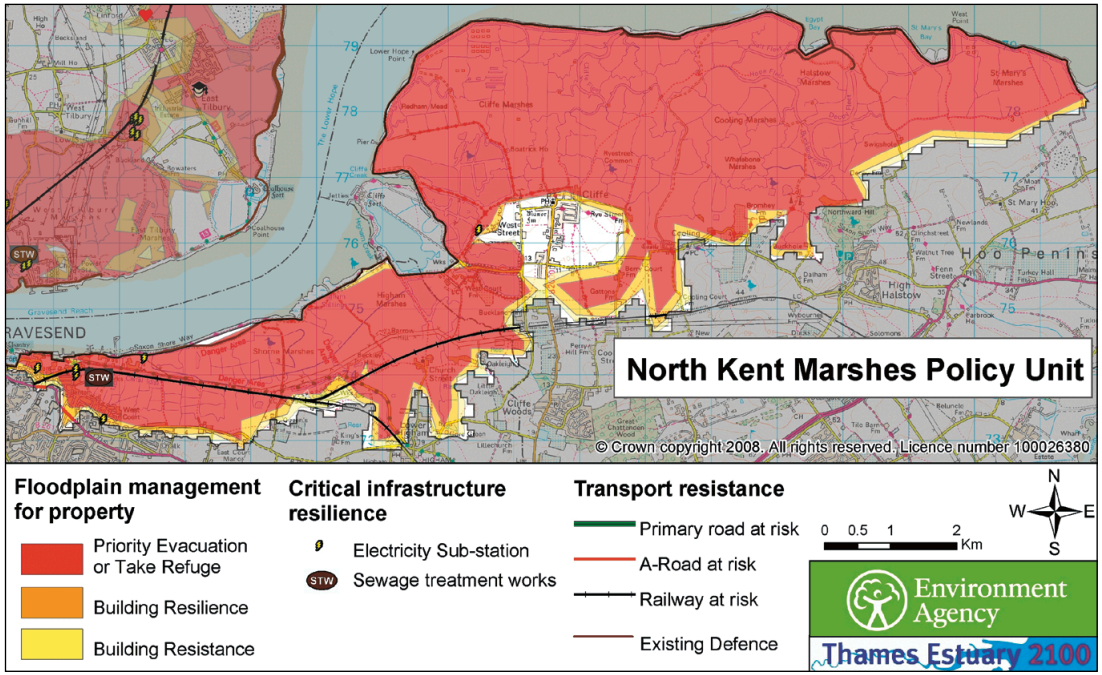
Responses for local flood risk management have not been designed or assessed in detail and further work will be required at local scheme level. Local consultation and appraisal will be required at this stage and our action plan includes the requirement to identify project partners to assist with this detailed development work.

Policy unit – North Kent Marshes

Policy: Our recommended policy for North Kent Marshes is policy P3, to continue with existing or alternative actions to manage flood risk. We will continue to maintain flood defences at their current level, accepting that the likelihood and/or consequences of a flood will increase because of climate change.

Description

North Kent marshes consists of two extensive areas north and west of the village of Cliffe. This is the landscape evoked by Dickens and its preservation is strongly promoted by groups such as the Friends of North Kent Marshes.



At risk in North Kent Marshes policy unit

Much of the area consists of freshwater grazing marsh and has designated freshwater habitats. There are also designated intertidal habitats along much of the Estuary frontage. In addition to the habitat features, the marshes also contain valuable historic military and industrial features such as Shornemeade and Cliffe Forts, and Cliffe Gunpowder Works.

There is little development apart from the east end of Gravesend where policy P4 is proposed. There is an industrial area at Cliffe with its own secondary defence to a ›0.1% standard and an important railway line across Shorne Marshes.

There is public access along the defences, and the area forms an important rural landscape.

Sources of flooding

- Tidal from the Thames downriver of the Thames Barrier (probability 0.1% per annum (Shorne Marshes) and 1% per annum (Cliffe & Halstow Marshes)), flood depths up to 4 m.
- Fluvial from local watercourses including the marsh drainage systems on Shorne, Higham, Cliffe & Halstow Marshes (probability ›1% per annum), flood depths up to 1 m.
- Groundwater from rock aquifers.

The existing flood risk management system

- Tidal flood defences downriver of the Thames Barrier.
- Drainage system outfalls including Shorne, Cliffe & Halstow Marshes.

Policy context

Shorne Marshes and Cliffe Pools are designated as community parklands in the Thames Gateway Parklands vision, including restoration of the marshes. In addition, there are some historic villages on the edge of the marshes, including Cliffe.

Shorne Marshes has also been identified as a potential area for flood risk management (flood storage) or replacement intertidal habitat. Ideally, this land should be safeguarded for future flood risk management options. But we acknowledge the potential influence of the regional priority attached to additional capacity for traffic crossing the Thames.

Vision

The vision for this policy unit is to conserve and enhance this important marine and freshwater environment, in cooperation with local stakeholders.

The main changes to the North Kent Marshes policy unit are likely to be caused by the need to create replacement intertidal habitat as the sea level rises and to enhance existing freshwater and grazing marsh habitats as potential compensation for loss of designated habitat.

Local issues and choices

The existing tidal defence system is likely to be retained except where the defences are realigned to create intertidal habitat, or because of erosion. However justification for maintaining the line may prove difficult in the eastern part of this policy unit, and the alternative would be to provide secondary defences for the communities on the edge of the floodplain.

New defences and improvements to existing defences should be designed so that public access along the Estuary is improved, including paths which provide views of the Estuary and access points. The Thames Gateway Parklands vision includes path and cycleway access along this entire frontage.

Defences should be in keeping with the rural landscape. This is currently achieved by the existing grassed embankments, but opportunities should be taken to enhance the landscape including, for example, different embankment profiles and earthworks that break up the generally straight lines of the defences. Any defence improvement provides opportunities to enhance both tidal and freshwater habitats.

The marshes have extensive open drainage systems. Severe problems have been encountered in the past with siltation of outfalls, particularly at Cliffe Marshes. There is an important need to provide drainage outfalls that are more sustainable under conditions of erosion and accretion along the Estuary frontage.

As the sea level rises and storm rainfall increases, there will be a greater need for an efficient drainage system. The drainage system will therefore require upgrading as the sea level rises to maintain a satisfactory level of storm drainage.

Erosion is occurring on the Cliffe & Halstow Marshes including Lower Hope Point, and Higham Marshes. It may be necessary to set the defence line back in some locations.

Responses for local flood risk management have not been designed or assessed in detail and further work will be required at local scheme level. Local consultation and appraisal will be required at this stage and our action plan includes the requirement to identify project partners to assist with this detailed development work.

Policy unit – Hadleigh Marshes

Policy: Our recommended policy for Hadleigh Marshes is policy P3, to continue with existing or alternative actions to manage flood risk. We will continue to maintain flood defences at their current level, accepting that the likelihood and/or consequences of a flood will increase because of climate change.

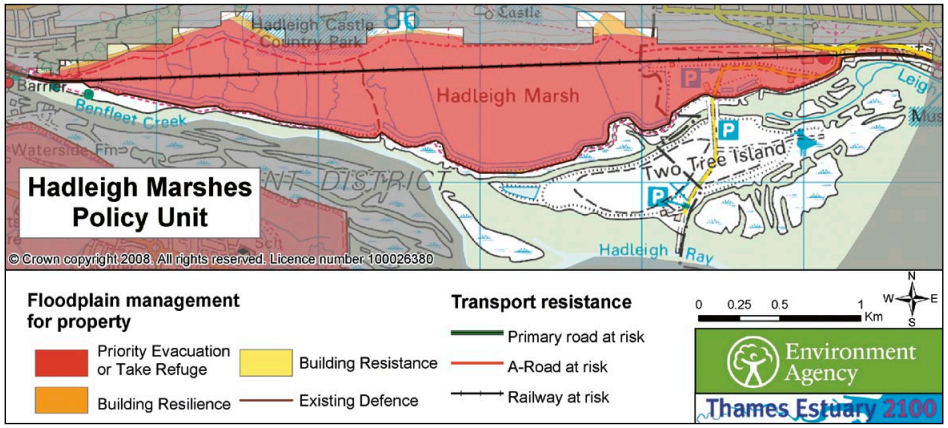
Description

Hadleigh Marshes policy unit consists of an open area of freshwater marshes crossed by a railway line. There is a car parking area at the eastern end, and a separate island (Two Tree Island) which also has flood defences. The defences contain contaminated material which may cause environmental damage if it is able to leach out into the river and adjoining intertidal habitats.

The western part of the marshes is an SPA (Special Protection Area), and the policy unit is adjacent to extensive areas of designated intertidal habitat. The Hadleigh marshes are a complex historic environment with both upstanding historic features and buried archaeological remains.

Sources of flooding

- Tidal from the Thames downriver of the Thames Barrier (probability 0.5% per annum or greater), flood depths up to 4 m.
- Fluvial from local watercourses including the drainage systems on Hadleigh Marshes.



At risk in Hadleigh Marshes policy unit

Hadleigh Marsh

The existing flood risk management system

- Tidal flood defences to Hadleigh Marshes.
- Drainage outfalls for the marsh drainage system.
- Tidal flood defences around Two Tree Island.

Policy context

The land on the higher ground to the north of Hadleigh Marshes includes Hadleigh Castle, and the overall area provides an important open rural landscape with public access along the entire Estuary frontage.

The City to Sea railway line between London and Southend crosses the marshes. The line is raised above ground level but is still at risk of flooding in a major flood event. The marshes are designated as community parklands in the Thames Gateway Parklands Vision.

Vision

This policy unit presents important environmental opportunities, partly because there is already a Special Protection Area along the foreshore and partly because it has been designated as an area of community parklands. Opportunities exist for compensatory grazing marsh habitat creation and enhancement of the historic environment.

Local issues and choices

There is a potential contamination issue with the flood defences on Hadleigh Marsh and the adjacent Two Tree Island. Therefore continued maintenance of these defences is needed to prevent contamination of the Estuary. Longer-term remediation of this land would open up management options and provide great environmental benefits to this area.

Looking across Hadleigh Marshes to the castle

Measures may be needed to manage fluvial flood risk from the marsh drainage system and watercourses that drain into the marshes. This could consist of improvements to channels and outfalls as the needs arise.

Floodplain management

The need for floodplain management responses will be limited because the policy unit is largely undeveloped. There are no communities apart from visitors to the marshes and Two Tree Island.

However flood warning will be needed for the railway line (which continues through Leigh Old Town & Southend-on-Sea policy unit to the east and Bowers Marshes policy unit to the west) particularly as the likelihood of flooding increases with climate change.

Responses for local flood risk management have not been designed or assessed in detail and further work will be required at local scheme level. Local consultation and appraisal will be required at this stage and our action plan includes the requirement to identify project partners to assist with this detailed development work.

TE2100 action plan: **action zone 6** – lower Estuary Marshes

Action Zone 6 – Policy units

East Tilbury & Mucking Marshes P3 | North Kent Marshes P3 | Hadleigh Marshes P3

[Note that all dates are based on government's current guidance on climate change – the TE2100 Plan will be reviewed and updated if these predictions change]

	TE2100 recommended actions	Implementation partners	How this will be achieved
First 25 years	**Action Zone 6 – Recommendation 1** **Management of Defences.** No defence raising is envisaged in the Plan, but defence maintenance and repair will be needed. In some areas this may involve realignment of defences that are threatened by erosion, for example in Shorne Marshes and near Lower Hope Point. Maintain the existing defence alignment but provide secondary defences for key assets including East Tilbury, as flood risk would otherwise increase.	Environment Agency RFCCs (Regional Flood and Coastal Committees) Gravesham Borough Council Medway Council Southend on Sea Council Thurrock Council Thurrock Thames Gateway Development Corporation Castle Point District Council Landowners	The Environment Agency's teams responsible for spatial planning and flood risk will promote these works in partnership with landowners and Local Authority planning teams as part of ongoing development applications. The Environment Agency's teams responsible for management of the flood defence assets will promote these schemes. However, the method of managing the defences is different from the present day approach. It involves greater maintenance and repair work in addition to essential replacement. Promotion of schemes through the capital replacement programme may not be appropriate for optimising maintenance and repair, and the Environment Agency will need to develop new ways of planning and implementing these works. As well as looking for ways of working better with limited resources, we will need to seek opportunities for environmental and recreational enhancements which will create a better place, and for partnerships which will help achieve this. The Environment Agency's teams responsible for Fisheries, Recreation and Biodiversity and Habitat Creation will be involved in promoting enhancements to freshwater and inter tidal habitats as part of these defence management schemes. **(continued)**

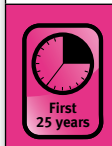
	TE2100 recommended actions	Implementation partners	How this will be achieved
First 25 years	**Action Zone 6 – Recommendation 1** **(continued)** Some frontages are accreting and therefore erosion at the defences is not a problem, for example at East Tilbury & Mucking Marshes. However there may be opportunities to further enhance the intertidal habitats by setting back the defence line rather than repair existing defences. *(Cost of implementing these works is included in TE2100 Plan. TE2100 data and information will be available to assist local implementation partners in more detailed planning and justification of schemes)*	Developers Essex SMP (shoreline management plan) Client Steering Group Kent County Council Essex County Council	Gravesham Borough Council is supporting a scheme which includes the provision of a new flood defence to the east end of Gravesend. The TE2100 Plan includes this scheme which will provide a P4 level of flood risk management for this part of Gravesend (which falls within a P3 policy unit). This scheme requires further detailed consideration particularly in terms of the residual risk of flooding, surface water drainage aspects, and impact on areas of nature conservation value. The Milton Ranges are of heritage interest and that this should be factored into any decision making and design process. The Hadleigh Marshes tidal defence structures contain contaminated material. Any works to these defences must be informed by TE2100 Action Zone 6 – Recommendation 4 (investigate contamination issues). Thurrock Council notes the proposal to focus on secondary defences within this zone and will work with the Environment Agency to understand the scope, scale and design of these at scheme development stage. Thurrock Council would welcome the opportunity to have a working group to meet with the Environment Agency and other partners. The working group should also allow cross party discussions to take place. We recommend that Local Authorities should prepare Riverside Strategies (Action Zone 0 – Recommendation 16) to enable co-ordinated long term spatial and environmental planning for the riverside. These riverside strategies will take into account existing and future plans for the riverside including the management of the tidal defences, and will promote multi-partner planning and implementation of projects to create a better riverside environment for people and wildlife.
First 25 years	**Action Zone 6 – Recommendation 2** To agree a programme of floodplain management including flood warning, emergency planning, and localised flood protection and resilience to vulnerable	Environment Agency RFCCs Gravesham Borough Council	The Environment Agency will work with Local Authority teams, landowners and infrastructure providers to agree roles and responsibilities and the programme for these activities. This will include consideration of managing flood incidents, emergency planning, asset management and spatial planning in zone 6. **(continued)**

TE2100 action plan: **action zone 6** – lower Estuary Marshes

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 6 – Recommendation 2** **(continued)** key sites in the Lower Estuary Marshes zone. This will include the c2c Railway line and East Tilbury. Providing the secondary defences are built at Tilbury there are no large settlements at risk in the marshes. Local infrastructure will be affected (e.g. the c2c railway line across Hadleigh Marshes). We recommend replacement with resilient or protected assets to manage the flood risk at the time when maintenance works or planned improvements are undertaken. No defence raising is envisaged in the Plan, but defence maintenance and repair will be needed. In some areas this may involve realignment of defences that are threatened by erosion, for example in Shorne Marshes and near Lower Hope Point. *(Environment Agency, Local Authority and other standing costs not included but additional costs included as described in Action Zone 0 – Recommendation 11. TE2100 data and information will be available to assist more detailed planning at local scheme level)*	Southend on Sea Borough Council Medway Unitary Authority Thurrock Unitary Authority Castle Point District Council English Heritage Kent Resilience Forum, Essex Resilience Forum Landowners, site managers Essex SMP (shoreline management plan) Client Steering Group Network Rail c2c rail operator Essex County Council Kent County Council	It is recommended that all implementation partners work together to establish a shared vision for the policy units in this action zone. This shared vision should consider the short, medium and long term needs of the Lower Estuary Marshes. The Environment Agency will provide a lead on the development of this action, and Local Authorities to provide a lead on the development of the Riverside strategies which will support its delivery. There will be a particular need to consider the impact that contamination issues have on the programme to be defined under this action (see also Action Zone 6 – Recommendation 4). A dialogue to develop a joint long term programme is required with the c2c railway operators and Network Rail infrastructure providers. This must ensure that long term impacts of climate change on the c2c rail line are understood and built into local plans for infrastructure improvement and for flood warning.

	TE2100 recommended actions	Implementation partners	How this will be achieved
	## Action Zone 6 – Recommendation 3 **Habitat Creation site 1 of 4.** In 2020 the first of four intertidal habitat creation sites will be implemented. Valuable habitat is being lost because our defences are preventing it from migrating landwards as sea level rises and over the 100 year life of our Plan, 876 hectares of new habitat will be needed. We have identified five sites which have the right characteristics for inter tidal habitat creation. The locations of the sites are shown on the estuary-wide option maps. The potential site in this policy unit is: St. Mary's Marsh (including a possible expansion to the west). By 2022 ground works may need to be started to compensate for the loss of designated grazing marsh interest features as a result of intertidal habitat creation. *(Cost of inter tidal habitat creation included in TE2100 Plan. Freshwater habitat needs will not be known until later in the Plan)*	Environment Agency RFCCs Natural England Landowners including Church of England Medway Council Southend on Sea Borough Council Public and local interest groups Friends of North Kent Marshes RSPB Kent Wildlife Trust English Heritage Kent County Council Essex County Council	The Environment Agency will undertake preliminary discussions and negotiations leading to agreement on site selection and management arrangements. We will be looking for partnership arrangements to manage these sites and get the best for the natural environment, for the local population and for visitors and in consultation with these partners, we will develop design details for the chosen site(s). Planning and groundworks will commence 10 years before implementation of the managed realignment. This preliminary site conditioning work includes construction of a new line of defence to protect people and properties from the risk of flooding from the new intertidal zone. It also includes – in some cases, recharging the land levels so that the correct habitat develops. It may take up to 10 years after the realignment is implemented before the habitat is fully established at the site. Intertidal habitat creation schemes will be linked to creation of compensatory grazing marsh and other freshwater features where these have been lost as a result of intertidal habitat creation. The following sites in this action zone have been identified as having the potential to support the interest features that could be lost, either through enhancement of existing features or creation of new habitat: • Shorne Marshes West • Cooling Marshes • Hadleigh Marsh East • Westcourt and Great Dane Lane Marshes • High Halstow Marshes A monitoring programme will be established by the Environment Agency. An audit of habitat gains and losses to be maintained. The Environment Agency in collaboration with Natural England, landowners and wildlife groups will design and implement appropriate compensation schemes.

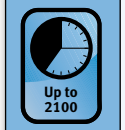
TE2100 action plan: **action zone 6** – lower Estuary Marshes

	TE2100 recommended actions	Implementation partners	How this will be achieved
	## Action Zone 6 – Recommendation 4 **Investigate contamination issues.** There is an area of contaminated land on Two Tree Island adjacent to Hadleigh Marshes that is protected by flood defences. In addition, the flood defences on Hadleigh Marshes contain contaminated material. Following consultation and re appraisal, our Plan now recommends a P3 policy for the Hadleigh Marshes policy unit. This will allow for maintenance of the defences. However further study is needed to identify longer term options which do more than simply contain the problem. *(Costs for remediation of contaminated land not included. Environment Agency to undertake investigation. Environment Agency and other standing costs not included)*	Environment Agency RFCCs Natural England Landowners Local Authorities Public and local interest groups RSPB Wildlife Trusts Essex County Council	The Hadleigh Marsh policy unit presents particular difficulties to any proposals which involve changes to the defence system because of the contamination issues. Our P3 policy recommendation means that the defence system will be maintained at current levels. This should be regarded as a temporary expedient to contain the contamination problem while it is being investigated. An investigation into the scale and extent of contamination is underway. The feasibility of remediation will be determined along with roles and responsibilities for this work.
	## Action Zone 6 – Recommendation 5 **Habitat Creation – site 2, 3, or 4.** In this period the remaining habitat creation sites will be implemented in 2040, 2050 and 2065. Further sites will	Environment Agency RFCCs Natural England Local Authorities Kent County Council	Monitoring and review will be undertaken by the Environment Agency to confirm actual loss of intertidal habitat compared to that which was projected. Adjustment may need to be made to planned replacement activities. A monitoring programme will be established by the Environment Agency to support this work. An audit of habitat gains and losses will be maintained. **(continued)**

	TE2100 recommended actions	Implementation partners	How this will be achieved
Middle 15 years	**Action Zone 6 – Recommendation 5** **(continued)** be realigned to make up the necessary 876 hectares of intertidal habitat creation required this century. The potential site for inter tidal habitat in this policy unit is St Mary's Marshes (with a possible extension to the west). Further freshwater habitat compensation may be required. The same sites described in Action Zone 6 – Recommendation 3 are proposed as options that could support the nature conservation features that may be lost. *(Cost of inter tidal habitat creation and monitoring programme included in TE2100 Plan, cost of freshwater habitat creation not included – requirements not known at present)*	Essex County Council English Heritage Landowners Public and local interest groups RSPB Wildlife Trusts	Planning and groundworks will commence 10 years before implementation of the managed realignment. This preliminary site conditioning work includes construction of a new line of defence to protect people and properties from the risk of flooding from the new intertidal zone. It also includes – in some cases, recharging the land levels so that the correct habitat develops. It may take up to 10 years after the realignment is implemented before the habitat is fully established at the site. Intertidal habitat creation schemes will be linked to creation of compensatory grazing marsh and other freshwater features where these have been lost as a result of intertidal habitat creation. The following sites in this action zone have been identified as having the potential to support the interest features that could be lost, either through enhancement of existing features or creation of new habitat: • Shorne Marshes West • Cooling Marshes • Hadleigh Marsh East • Westcourt and Great Dane Lane Marshes • High Halstow Marshes The Environment Agency in collaboration with Natural England, landowners and wildlife groups will undertake an audit of requirements as the intertidal habitat creation proceeds and will design and implement appropriate compensation schemes.
First 25 years	**Action Zone 6 – Recommendation 6** **To maintain, enhance and replace the river defence walls and active structures through the Middle Estuary zone over the first 25 years of the Plan from 2010 to 2034.** [Note: This is a continuation of our current activities to ensure that confidence in the	Environment Agency RFCCs Landowners Developers and local authority planning teams Thames Strategy East	This is the work which the Environment Agency does now. We will continue with our programme of operations, maintenance and replacement but we are looking for ways of working better and more effectively. The Environment Agency's staff responsible for spatial planning and flood risk will promote these works as part of ongoing development applications. During this period, there will be an ongoing programme of refurbishment and improvement of the river walls and defences through the Lower estuary zone – although as a P3 policy zone, there will be no requirement to raise defence levels. **(continued)**

TE2100 action plan: **action zone 6** – lower Estuary Marshes

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 6 – Recommendation 6** **(continued)** Thames tidal flood risk management system is maintained and that opportunities for environmental enhancements and partnership through planning are actively sought and carried out]. *(Cost of implementing this action is included in TE2100 Plan)*	Kent County Council Essex County Council English Heritage	The Environment Agency will promote these schemes. However, the method of improving the defences will differ from the present day approach. The recommended Option 1.4 optimising maintenance and repair work in relation to replacement of defences. Promotion of schemes through the capital replacement programme may not be appropriate for optimising maintenance and repair, and our teams will need to develop new ways of planning and implementing these works. As well as looking for ways of working better with limited resources, we will need to seek opportunities for environmental and recreational enhancements which will create a better place, and for partnerships which will help achieve this. A particular problem in this area is siltation of outfalls. The Environment Agency to investigate this and flooding from other non tidal sources.
	**Action Zone 6 – Recommendation 7** **To operate and maintain the defence walls and active structures through the middle estuary zone over the 35 year period of the Plan from 2035 to 2049.** [Note: Continuing our activities to ensure that confidence in the Thames tidal flood risk management system is maintained and that opportunities for environmental enhancements and partnership through planning are actively sought and carried out] *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency RFCCs Landowners Developers and local authority planning teams Thames Strategy East Kent County Council Essex County Council English Heritage	This is the work which the Environment Agency does now. We will continue with our programme of operations, maintenance and replacement but we are looking for ways of working better and more effectively. The Environment Agency's staff responsible for spatial planning and flood risk will promote these works as part of ongoing development applications. The Environment Agency's teams responsible for management of the flood defence assets will promote these schemes. However, the method of improving the defences will differ from the present day approach. The recommended Option 1.4 optimising maintenance and repair work in relation to replacement of defences. During this period, there will be a major programme of refurbishment of the river walls and defences through the Lower estuary zone – although as a P3 policy zone, there will be no requirement to raise defence levels. This major reconstruction work provides many opportunities for creating a better place and to plan for a better riverside environment. The Local Authority riverside strategies should be used to capture this opportunity – promoting multi-partner planning and implementation of projects to create a better riverside environment for people and wildlife.

	TE2100 recommended actions	Implementation partners	How this will be achieved
	## Action Zone 6 – Recommendation 8 To maintain the river defence walls and active structures through lower estuary marshes zone 6 post 2050 and into the 22nd century. These are the TE2100 "End of the Century" options to provide continuing tidal flood risk management to the lower estuary marshes zone 6.	Environment Agency RFCCs Natural England Local Authorities Kent County Council Essex County Council English Heritage Landowners Public and local interest groups RSPB Wildlife Trusts Essex SMP	In 2050, the Environment Agency will review the TE2100 Plan and recommend the end of the century option. Our appraisal under current (2009) conditions recommends two "front runners". (i) To continue with Option 1.4 (maintain and improve existing system) – this would include a major upgrade of the existing Thames Barrier (ii) A new barrier and associated improvement and defence raising works downstream of the new structure. Current (2009) appraisal indicates a preferred site at Long Reach (Option 3.2) but site at Tilbury (Option 3.1) is also a potential choice. The other options – Option 2, flood storage and Option 4, an open barrage, together with all potential barrier locations will be re examined in the 2050 re appraisal which will include detailed assessment of the environmental and social impacts of any end of the century scheme. Once a decision is made, this end of the century Plan will be implemented. We cannot know what institutional arrangements there will be as we approach the 22nd century, but our TE2100 vision imagines an environment where the lower estuary marshes have successfully remediated the contaminated lands and have a stable, flourishing natural environment which is increasingly enjoyed and respected by the people who live, work and visit. This means that the actions established in this action zone will be continued by whoever is looking after our environment at that time. The future management of Hadleigh Marshes policy unit will depend largely on how contamination has been dealt with on Two Tree Island and in the defence structures on Hadleigh Marshes. The future of all policy units within lower estuary zone 6 will depend on the scale of climate change impacts, and it is essential that continued monitoring of the TE2100 Plan considers how these impacts will be managed in zones which have been assigned a P3 policy.

TE2100 action plan: **action zone 6** – lower Estuary Marshes

Caravan park at Allhallows

Action plan for zone 7

12 actions identified

Description of the policy units

- Canvey Island
- Bowers Marshes
- Shell Haven & Fobbing Marshes
- Isle of Grain

This section describes the 12 actions for zone 7 – lower Estuary (urban/industrial) which have been identified through the TE2100 Plan. The actions are described under the following headings:

- TE2100 recommended actions (and whether or not costs for this have been included in the TE2100 Plan)
- Implementation partners
- How this will be achieved.

"...Councillors recognised that political differences should be set aside and were united in their wish to act in the best interests of the community of Castle Point and its future."

"The Council looks forward to continuing discussions to develop the Plan and partnership arrangements for the programme to provide local flood protection, resilience and emergency plans for vulnerable key sites."

Castle Point District Council

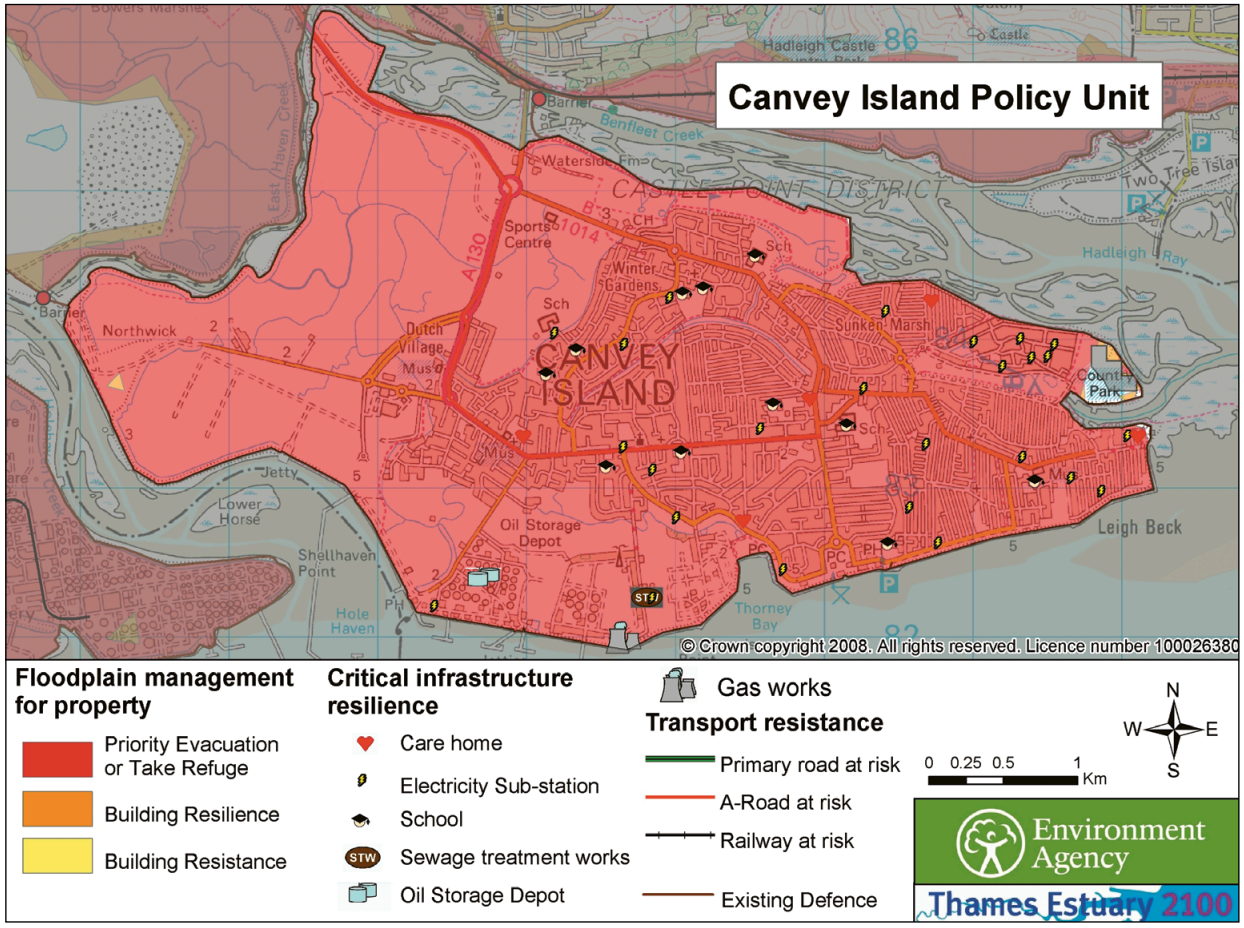
Policy unit – Canvey Island

Policy: Our recommended flood risk management policy for Canvey Island policy unit is policy P4, to take further action to keep up with climate and land use change so that flood risk does not increase.

Description

Canvey Island consists of low-lying former marshland (generally <1 m AOD) surrounded by high defences. The ground level is thus about 2 m below high water on spring tides. About 60% of the island is developed, with a large residential area, caravan parks and an oil-related industrial area. The north western part of the island is undeveloped and consists of coastal grazing marsh – an historic landscape with both upstanding historic features and buried archaeological remains.

The island is protected by a major system of defences that are of the order of 6 m in height. It currently has two road access points, and evacuation during a flood event would be very problematic. There is public access to all the defences around the island, and these form an important amenity facility.



At risk in Canvey Island policy unit

Sources of flood risk

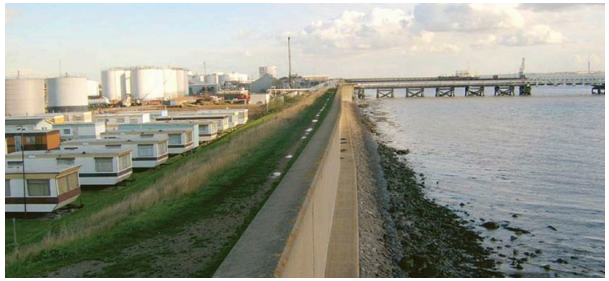
- Tidal from the Thames including Benfleet Creek and Holehaven Creek (probability 0.1% per annum or greater), flood depths up to 4 m.
- Tidal from East Haven Creek (south bank) (probability 0.1% per annum). East Haven and Benfleet Barrier-controlled.
- Fluvial from local watercourses including the drainage systems for the developed area of Canvey Island and the West Canvey Marshes.

The existing flood risk management system

- Main tidal flood defences on the Thames including Holehaven and Benfleet Creeks.
- East Haven and Benfleet Barriers, which control tidal water levels on East Haven Creek.
- Secondary tidal flood defences on East Haven Creek.
- An extensive drainage system for the developed area with open channels and pumped and gravity outfalls.
- Drainage outfalls for the marsh drainage system.

Policy context

There is a thriving community in Canvey Island. There are 11 schools, four care homes, 21 electricity substations and community facilities for the resident population of 40,000. Further development and regeneration is planned for the island, along with regeneration projects, which are being led by the Castle Point Regeneration Partnership. Maintenance and improvement of the system of large defences is well justified.



Flood defences at Canvey Island

The western part of the island is freshwater marsh. This area provides an open rural landscape which contrasts sharply with the developed eastern part of the island. The marshes form part of the proposed South Essex community parklands in the Thames Gateway Parklands vision.

There are opportunities identified through the Thames Gateway Parklands vision and implementation of the TE2100 plan to create an important area both for public amenity, enhancement of the historic environment and habitat creation in this area, although there is a debate to be had as to whether this should be freshwater habitat or tidal habitat. The Thames Gateway Parklands vision also includes a pier for passenger ferries, improved public access to the Estuary and better public access around the area (including a new footpath/cycleway crossing at the western end of East Haven Creek).

Vision

This policy unit contains a large population and would be very vulnerable to flooding in the event of failure or overtopping of the defences. Our vision for the policy unit is to make Canvey Island a safer place. The defence system will be maintained and improved but in parallel with this we recommend the introduction of community strategies for safe havens, appropriate development and other floodplain management measures as recommended in Government's NPPF[15]. Vulnerable development such as single storey buildings, mobile home parks and camp sites should have escape or community refuge plans. If this is not possible, they should be replaced by other uses or buildings which have living accommodation above flood level. The chances of the defences failing or being overtopped are very small, but the consequence of such a failure is very high.

[15] National Planning Policy Framework (CLG 2012)

TE2100 action plan: **action zone 7** – lower Estuary, urban/industrial and marshland

PC Roberts – Canvey Island 1953

Remembering 1953

Canvey Island is defended to a much higher standard than it was in 1953 and our Plan recommends that the defences are further improved to keep pace with climate change. But the consequences of flooding have increased more than ten-fold on Canvey since 1953, so we recommend that reliable flood plans are put in place. The plans may never be put into action, but if there is a serious breach or overtopping of the defences, the Plans will save lives.

Our TE2100 Plan includes a programme of defence improvements and it is recommended that whenever defence improvements are carried out, opportunities should be maximised to improve landscape and local recreational facilities such as paths.

Local issues and choices

Creating new areas of intertidal habitat helps to maintain a healthy estuary ecosystem and fulfils our obligation under EU and UK law to replace intertidal areas that are being lost in the estuary due to climate change. West Canvey Marsh is one of several sites in the Estuary where the current line of the flood defences could be set back to create an area of intertidal marsh on their seaward side. However, following our public consultation West Canvey Marshes has not been identified as one of our preferred sites for habitat creation in the first half of the century.

It is difficult to predict what conditions will exist in the Estuary from 2050 onwards. If climate change mitigation worldwide has been unsuccessful, the Estuary will look very different indeed and the choices for us all will be stark. However, if climate change mitigation has been successful then the choices will be easier and more varied.

The TE2100 recommendations for the second half of the century, including further intertidal habitat requirements, will be made around 2050. They will be based on a comprehensive public consultation and consideration of our indicators for change at that time.

The drainage systems on Canvey Island will require upgrading as the sea level rises and rainfall increases. This will consist of improvements to channels and outfalls as the need arises together with a programme of upgrading of the outfalls, most of which are pumped.

This has not been covered in detail by the TE2100 project, but we recommend further investigation and this is included in our action plan for Action Zone 7.

As noted above, in view of the potential difficulty of evacuating the island, measures should include safe havens, high level access and shelters. This will provide the opportunity for people to move to safe areas above flood level in the unlikely but serious eventuality of tidal flooding.

The weakest links in any flood defence system are the moveable gates. There are three large barriers which provide protection to the west and north of the island, and a number of smaller gates. Replacement of Benfleet, East Haven and Fobbing Horse barriers by fixed defences is a possibility although it would be a costly option.

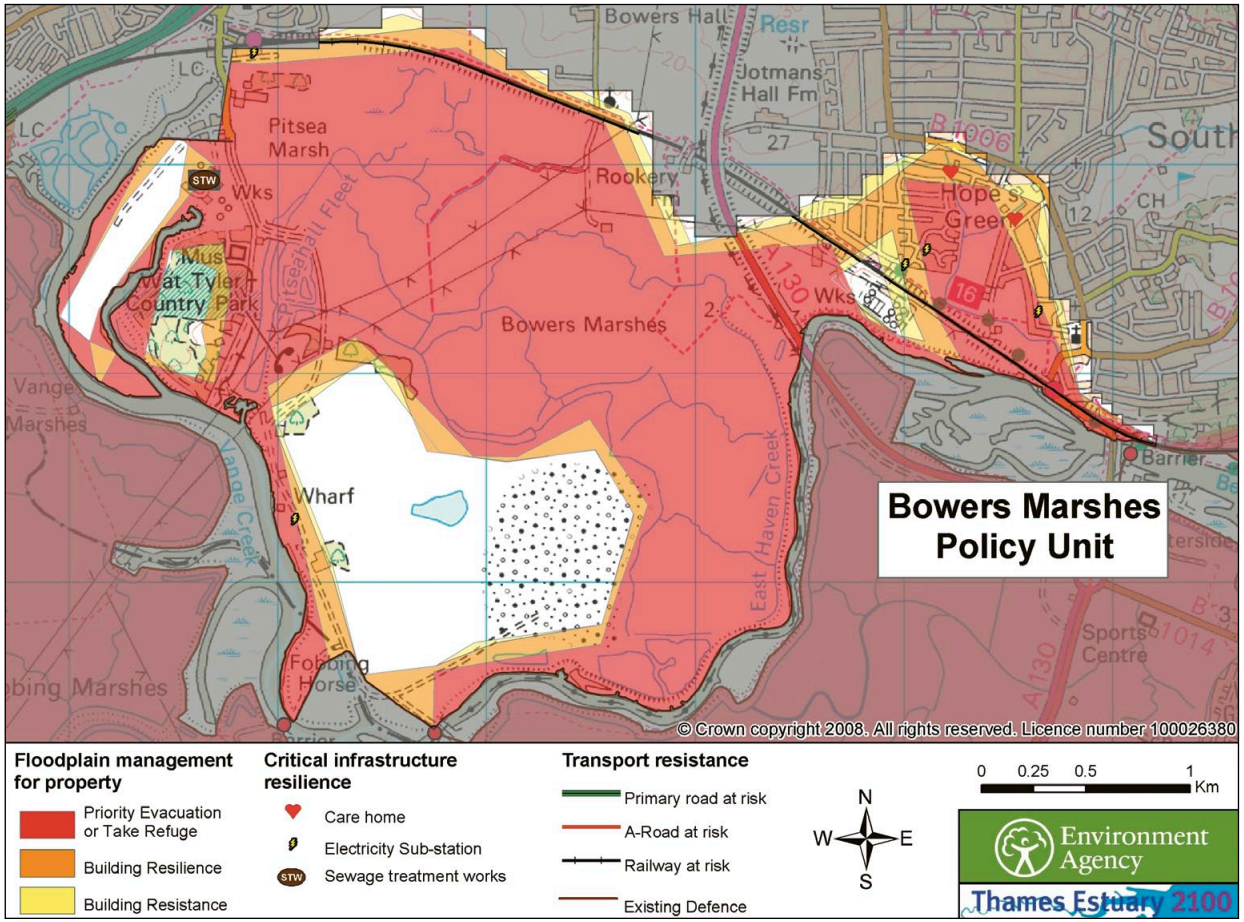
Responses for local flood risk management have not been designed or assessed in detail and further work will be required at local scheme level. Local consultation and appraisal will be required at this stage and our action plan includes the requirement to identify project partners to assist with this detailed development work.

Policy unit – Bowers Marshes

Policy: We recommend a policy P4 for this policy unit – to take further action to keep up with climate and land use change so that flood risk does not increase. The reason this policy unit justifies such a high standard although it is largely unpopulated is because of infrastructure (rail, road, sewage treatment works and electricity generation plant) and the risks of contamination from the landfill which covers a large part of the Bowers Marshes policy unit. These areas at risk are not concentrated in one location so localised secondary defences are not considered a feasible option.

Description

Bowers Marshes policy unit is an open area of freshwater grazing marshes – an historic landscape with both upstanding historic features and buried archaeological remains. It has a major landfill site to the west, and some areas of historic landfill within the marsh areas. The flood risk area includes the City to Sea railway line, the main A130 road, properties in South Benfleet, the Wat Tyler Country Park, an electricity generation plant and a sewage works. Primary tidal defence is provided by three barriers and a short length of primary defence. In addition, there are secondary tidal defences along East Haven and Vange Creeks.



At risk in Bowers Marshes policy unit

Sources of flooding

- Tidal from Vange Creek (east bank) (probability 0.1% per annum, Fobbing Horse barrier-controlled).
- Tidal from East Haven Creek (north bank) (probability 0.1% per annum, East Haven and Benfleet barrier-controlled).
- Fluvial from local watercourses including the Pitseahall Fleet, Benfleet Hall Sewer and the marsh drainage system on Bowers Marshes.

The existing flood risk management system

- Fobbing Horse Barrier, which controls tidal water levels on Vange Creek.
- East Haven and Benfleet Barriers, which control tidal water levels on East Haven Creek.
- Secondary tidal flood defences on Vange Creek.
- Secondary tidal flood defences on East Haven Creek.
- Drainage system outfalls including Benfleet Hall Sewer and Bowers Marshes.

Policy context

The marshes are designated as part of the proposed South Essex community parklands in the Thames Gateway Parklands vision (including the landfill site). This includes restoration of the marshes. Therefore, new development should be limited in the marsh areas in order to maintain this important rural landscape in an otherwise heavily developed area.

Low tide in the Canvey creeks

There is already public access to much of the area, and the Thames Gateway Parklands vision envisages improved access and connections with local communities.

Vision

Our vision for the Bowers Marshes policy unit is to provide a level of flood risk management compatible with creating an important green space in an area of intense development which includes Southend-on-Sea, Basildon, east Canvey, Coryton and the London Gateway port area. The marshes form part of the proposed South Essex community parklands in the Thames Gateway Parklands vision which includes the landfill site and restoration of the marshes.

Flood risk management can contribute to enhancing this vision by providing good public access along the tidal creeks, creating a mosaic of tidal, brackish and freshwater habitats, and contributing to this important and historic rural landscape whilst providing the appropriate level of protection to assets at risk.

Local issues and choices

The choice between retaining and removing Benfleet, East Haven and Fobbing Horse Barriers is covered in our Action Zone 7 recommended actions together with associated changes to the defences on Vange and East Haven Creeks.

These choices affect the way flood risk management will be provided for the main assets at risk in this policy unit (including the railway, parts of South Benfleet, Wat Tyler Country Park and the sewage works). The drainage systems on

Mixed land uses in Bowers Marshes

East Haven tidal control barrier

the marshes will require upgrading as the sea level rises and rainfall increases, although this has not been investigated in detail in this Plan. This mainly consists of improvements to channels and outfalls as the need arises.

The need for floodplain management will be limited because the policy unit is largely undeveloped. However flood warning will be needed for the railway line (which continues through Hadleigh Marshes policy unit to the east) and the flood risk area in South Benfleet.

In addition, potential flood impacts on new development should be reduced by flood resilient development and building designs and careful application of planning guidelines.

An area of Bowers Marsh has been identified as a preferred site for intertidal habitat creation. Through our public consultation an opportunity has been identified to provide approximately 80 hectares of salt marsh on the new RSPB nature reserve. Our Regional Habitat Creation Programme is looking into the details of these proposals.

Responses for local flood risk management have not been designed or assessed in detail and further work will be required at local scheme level. Local consultation and appraisal will be required at this stage and our action plan includes the requirement to identify project partners to assist with this detailed development work.

Policy unit – Shell Haven & Fobbing Marshes

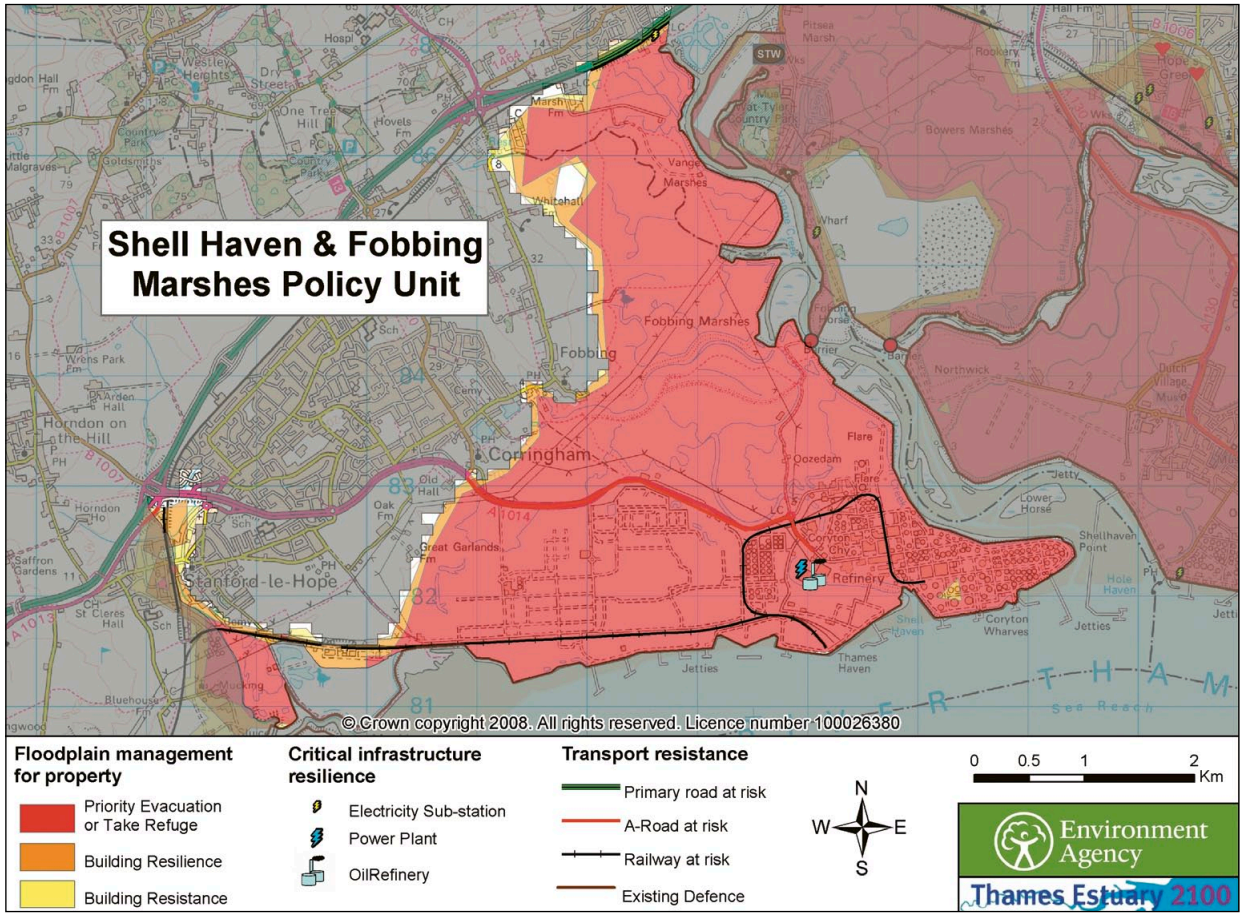
Policy: Our recommended flood risk management policy for this policy unit is policy P3, to continue with existing or alternative actions to manage flood risk. We will continue to maintain flood defences at their current level accepting that the likelihood and/or consequences of a flood will increase because of climate change. We will supplement this policy with improved defences to protect key sites such as Coryton.

Description

Shell Haven & Fobbing Marshes policy unit is divided into two distinct areas either side of the A1014 access route to the Coryton refinery. To the north are the freshwater marshes and to the south is the industrial area along the Thames frontage.

The industrial area includes Coryton oil refinery – a key strategic site, and Shell Haven, which is the site of the new London Gateway container port.

The marshes comprise a complex historic environment with both upstanding historic features and buried archaeological remains. They also include some SSSIs (Sites of Special Scientific Interest). Much of the defence system for the marshes consists of embankments on Vange Creek upriver of Fobbing Horse Barrier.



At risk in Shell Haven & Fobbing Marshes policy unit

The remaining defences on the River Thames and Holehaven Creek are primary full height defences.

Sources of flooding

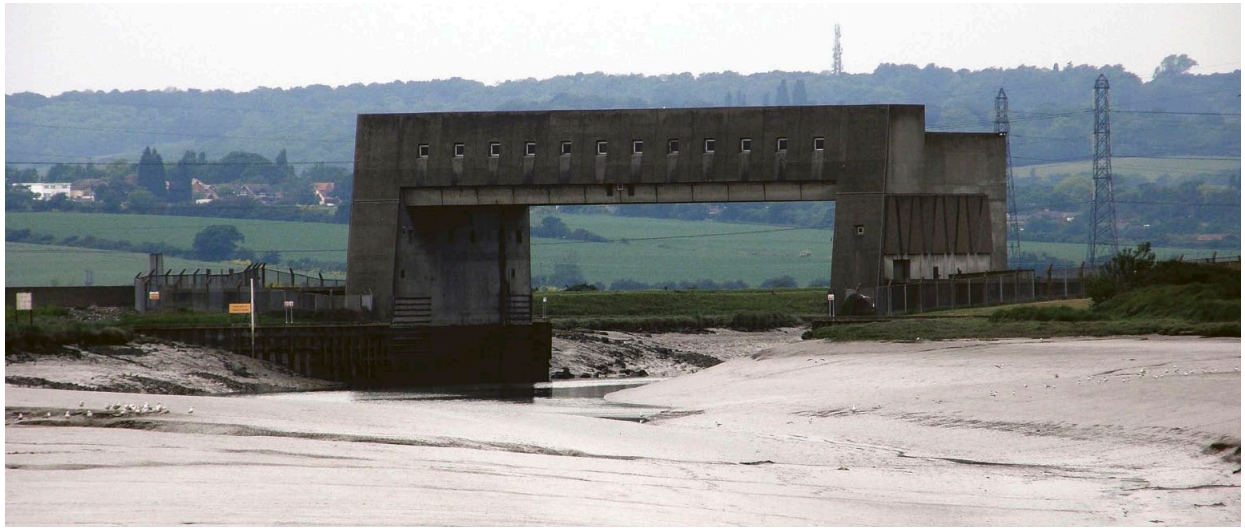
- Tidal from the Thames and Holehaven Creek (probability 0.1% per annum or greater), potential flood depths of up to 4 m.
- Tidal from Vange Creek (west bank) (probability 0.1% per annum, controlled by the Fobbing Horse Barrier).
- Fluvial from local watercourses including the marsh drainage systems on Fobbing and Vange Marshes.

The existing flood risk management system

- Tidal flood defences on the Thames and Holehaven Creek.
- Fobbing Horse Barrier and defences on Vange Creek, as these prevent tidal flooding from the north.
- Secondary tidal flood defences on Vange Creek.
- Drainage system outfalls including Mucking Creek, Shell Haven and Coryton, Fobbing Marshes and Vange Marshes.

Policy context

The freshwater marshes are designated as part of the proposed South Essex community parklands in the Thames Gateway Parklands Vision, including restoration of Fobbing Marshes. They also provide areas where freshwater habitat could be created to compensate for losses elsewhere in the Estuary.



Fobbing Horse tidal barrier

Whilst public access to the marshes is possible, it is generally poor and the marshes are therefore remote. The Thames Gateway Parklands Vision envisages improved access as part of the proposed Parklands Vision.

Vision

It is recognised that flood defence improvements will be needed including defences for the critical infrastructure sites at Coryton. It will also be necessary to improve Fobbing Horse Barrier and associated defences as the barrier also protects Bowers Marshes which has a P4 policy.

The southern part of this policy unit is likely to remain commercial and industrial for the foreseeable future. Whilst it may be possible to achieve some environmental enhancements as

new works are carried out, our Plan proposes to support these industrial activities by recommending defence improvements to provide localised protection against rising sea levels to these key industrial and commercial sites.

There is an opportunity to create an important green area on the marshes. This should include improved public access and amenity as well as habitat creation.

Local issues and choices

The choice between retaining and removing Benfleet, East Haven and Fobbing Horse Barriers is covered in our action plan for Action Zone 7, together with associated changes to the defences on Vange Creek.

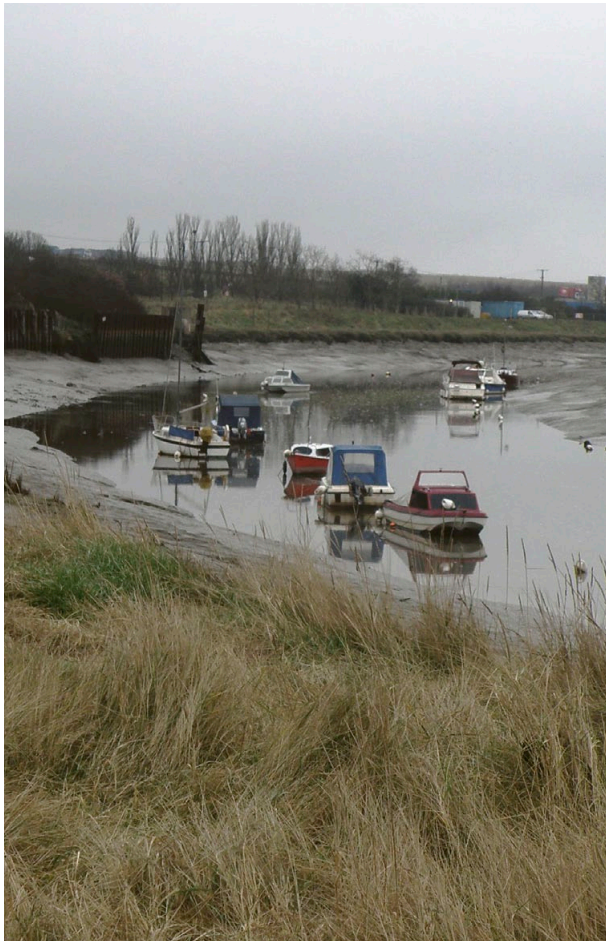
Removing the barriers would result in gradual overtopping of the existing tidal defences into the marsh land, allowing the marshes at Fobbing and Vange to become more brackish, hence supporting natural change. If this approach is adopted, new defence arrangements would have to be put in place to protect the densely populated part of Canvey Island. This could form the basis of a more reliable defence system for Canvey Island as discussed in the Canvey Island policy unit description above.

It is anticipated that the London Gateway Port at Shell Haven will include improved flood defences, possibly by raising the new quay level above flood defence level.

The drainage systems on Fobbing and Vange Marshes will require upgrading as the sea level rises and rainfall increases, although this has not been investigated in detail in our Plan. This mainly consists of improvements to channels and outfalls as the need arises.

Particular issues will include potential saline intrusion and siltation on outfalls. There is heavy siltation in Vange and Holehaven Creeks, and outfalls have been abandoned in the past and reconstructed elsewhere.

Responses for local flood risk management have not been designed or assessed in detail and further work will be required at local scheme level. Local consultation and appraisal will be required at this stage and our action plan includes the requirement to identify project partners to assist with this detailed development work.



Vange Creek from Wat Tyler Country Park

Policy unit – Isle of Grain

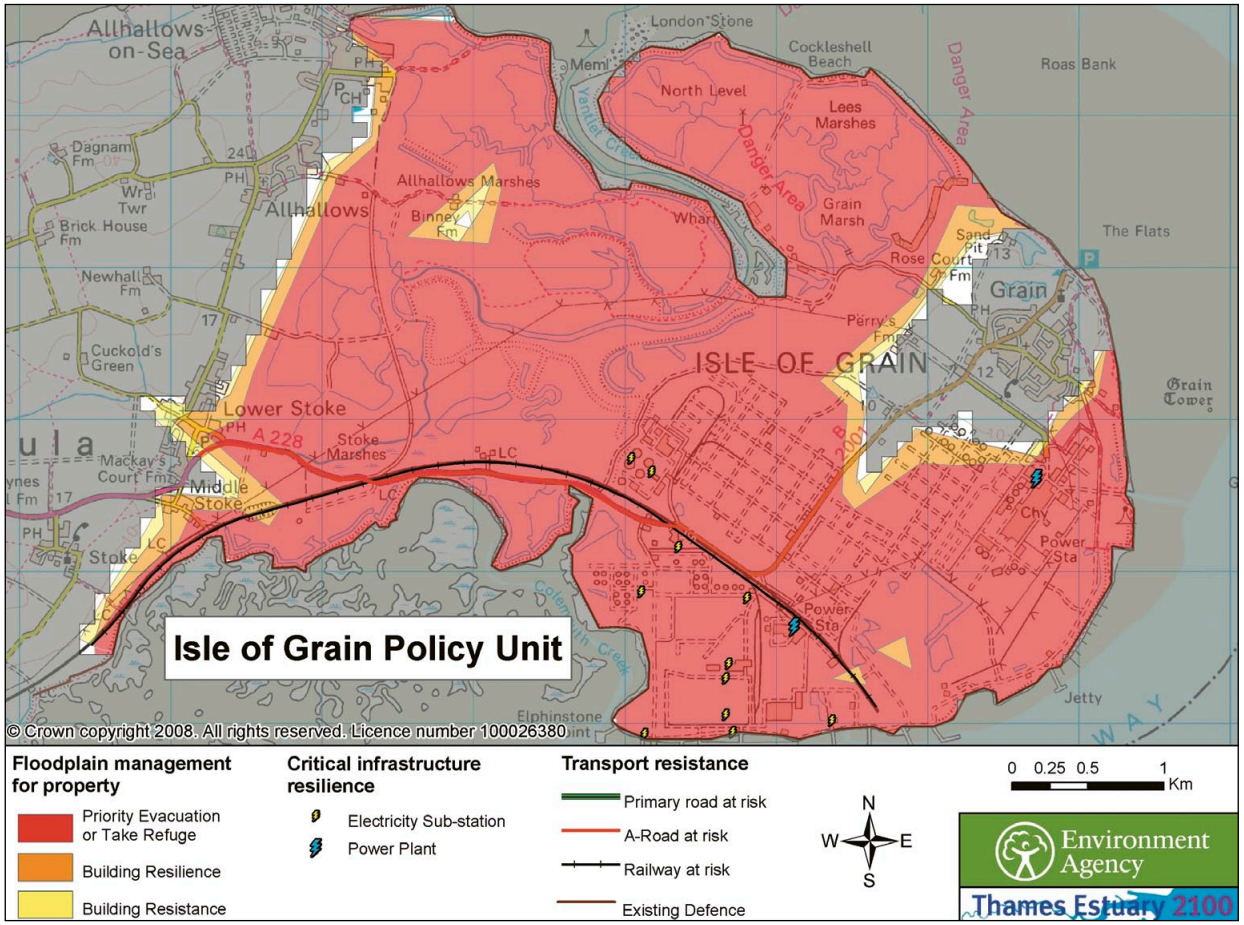
Policy: We recommend flood risk management policy P4, take further action to keep up with climate and land use change so that flood risk does not increase.

Description

The Isle of Grain policy unit has two distinct parts: an area of freshwater marshes to the west (Allhallows and Grain Marshes) and an industrial area to the south and east. The village of Grain lies on higher ground at the north-eastern extremity of the policy unit. Much of the freshwater grazing marsh in the western part of this policy unit is a designated SPA (Special Protection Area). The adjacent intertidal areas are also designated as an SPA. The main road and rail access routes to the eastern half of the policy unit cross the southern part of the freshwater grazing marsh. There are also relic military defences from World War II.

Sources of flooding

- Tidal from the Thames and Medway including Yantlet Creek (probability 0.5% per annum), flood depths up to 4 m but variable.
- Fluvial from local watercourses including the drainage systems on the Allhallows and Grain Marshes.



At risk in Isle of Grain policy unit

The existing flood risk management system

- Tidal flood defences on the Thames and Medway including Yantlet Creek.
- Drainage system outfalls. The main outfalls for Allhallows and Grain Marshes are heavily silted.

Policy context

Large parts of the grazing marshes are designated, and the area also provides an open rural landscape. The adjacent intertidal areas to the north and south west of this policy unit are also designated. No new development should therefore be permitted in these areas. However, the marshes themselves do not justify the current level of tidal flood protection along the Thames and Yantlet Creek and this must be examined as part of the implementation of the TE2100 Plan – possibly as part of the TE2100 habitat creation strategy.

The industrial area contains some very large facilities including Grain Power Station, the port of Thamesport and a new gas plant. It is therefore of considerable strategic and economic importance. Access is via a road and railway that cross the marshes. It is understood that these are to be upgraded. Further development is expected in the already industrial eastern part of the Isle of Grain policy unit. It will therefore be necessary to continue to provide flood protection for this area together with protection of the transport links.

Vision

The western and northern part of the policy unit would be suitable for the creation of replacement intertidal habitat. This would require compensation of the designated grazing marsh habitat that would be lost. The vision for this area is therefore a combination of intertidal habitat with surrounding community parkland areas including public access and facilities. This area will also provide safe transport links to the eastern part of the policy unit.

The eastern part of the policy unit will continue to be developed for industry and commerce in the foreseeable future. This is an important industrial and port area with large installations, and flood risk management must continue to be provided, keeping pace with climate change.

Local issues and choices

The impacts of local sources of flooding are small. The drainage systems in the eastern half of the Isle of Grain will require upgrading as the sea level rises and rainfall increases. The systems in the western half of the Isle of Grain will not be required if the defences are realigned as part of a habitat creation scheme. They are seriously affected by siltation of the outfalls.

Responses for local flood risk management have not been designed or assessed in detail and further work will be required at local scheme level. Local consultation and appraisal will be required at this stage and our action plan includes the requirement to identify project partners to assist with this detailed development work. St Mary's Marsh on the Isle of Grain has been identified as a preferred site for the creation of intertidal habitat in the Thames estuary.

Action Zone 7 – Policy units

Canvey Island P4 | Bowers Marshes P4 | Shell Haven & Fobbing Marshes P3 | Isle of Grain P4

[Note that all dates are based on government's current guidance on climate change – the TE2100 Plan will be reviewed and updated if these predictions change]

	TE2100 recommended actions	Implementation partners	How this will be achieved
First 25 years	**Action Zone 7 – Recommendation 1** TE2100 Plan informs the development and revision of local authority strategic flood risk assessments (SFRAs) and flood plans. *(Cost of implementing this action not included in TE2100 Plan as Environment Agency standing costs not included, but TE2100 data and information will be available to assist)*	Environment Agency RFCCs (Regional Flood and Coastal Committees) Local authorities • Thurrock Unitary Authority • Basildon District Council • Castle Point District Council • Medway Unitary Authority Local Resilience Fora • Kent Resilience Forum, Essex Resilience Forum	TE2100 data and information will be provided to local authorities preparing SFRAs, flood plans and emergency capability testing. The Environment Agency will support Local authorities with interpretation of TE2100 data and information as required to ensure SFRAs and flood plans are developed with an understanding of TE2100 analysis and recommendations. TE2100 data and information will be provided to LRF to inform Community Risk Registers and support exercises. Local Resilience Fora take ownership of the flood plans and all responders have confidence in them. A community engagement programme to ensure the public, businesses and other groups understand, are involved in and supportive of the flood plans. The Thames tidal defences provide highly reliable protection to this lower estuary zone against surge tides. But should there be a failure of a defence or an extreme event which overtops the defences, low-lying areas of this zone would be at risk as shown on the policy unit At Risk maps. The Flood Plans will set out arrangements for managing this sort of emergency.

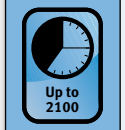
TE2100 action plan: **action zone 7** – lower Estuary, urban/industrial and marshland

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 7 – Recommendation 2** **To agree a programme of floodplain management including flood warning, emergency planning, and local flood protection, resilience and emergency plans for vulnerable key sites in action zone 7.** Our At Risk maps for lower estuary zone 7 show that particular sites and key infrastructure which would be particularly vulnerable in the event of a failure or overtopping of the defences. *(Environment Agency, Local Authority and other standing costs not included but additional costs included as described in Action Zone 0 – Recommendation 11. In addition, technical support from the Environment Agency will be provided to promote this action together with the availability of TE2100 data and information. Requirements for future funding will have to be agreed)*	Environment Agency RFCCs Local authorities • Thurrock Unitary Authority • Basildon District Council • Castle Point District Council • Medway Unitary Authority Local Resilience Fora Kent Resilience Forum, Essex Resilience Forum Developers and vulnerable site owners/ managers including: Medway Ports, Coryton Oil Refinery, Dubai Ports (London Gateway)	The Environment Agency will discuss with implementation partners to agree strategic scope of measures and future funding requirements. A working group will be established to ensure agreement between implementation partners on the strategic approach, and roles and responsibilities for achieving it. The objectives of this action are that local floodplain management measures in place or planned within 25 years and all site owners supportive of approach and confidence maintained. All site owners must be supportive of approach and confidence of public and users maintained. Local floodplain management measures in place or planned within 25 years. Areas with a large residential population such as Canvey Island, and key industrial sites such as Coryton refinery and the Medway ports will require evacuation and flood management plans. Mobile homes on the Isle of Grain are vulnerable to flood risk. Moreover, Grain could be isolated in the event of tidal flooding. Flooding would disrupt port activities and freight transport by road and rail. Local residents may also be cut off for the duration of flooding. Canvey Island benefits from amongst the strongest flood defences on the Estuary. But no flood defence is infallible. The population on Canvey would be vulnerable to flooding. Mobile homes here are particularly vulnerable, as are single story properties in low lying areas. We recommend a policy of substituting vulnerable housing with resilient replacements with a second story for refuge.

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 7 – Recommendation 3** **To agree partnership arrangements and principles to ensure that new development in lower estuary zone 7 is safe, and that where possible the application of the NPPF reduces the consequence flood risk** – particularly in the areas where there is aggregation of flood risk for people or industry. We, along with local authority staff, are providing advice to Developers and responding to difficult Planning applications. *(Cost of implementing this action not included in TE2100 Plan as Environment Agency standing costs not included, but TE2100 data and information will be available to support the action)*	Environment Agency RFCCs Essex County Council, Kent County Council Local authority spatial and emergency planners: • Thurrock Unitary Authority • Basildon D.C. • Castle Point D.C. • Medway Unitary Authority Thames Gateway Kent & Essex Partnerships Developers and site owners including: Medway Ports, Coryton Oil Refinery, Dubai Ports (London Gateway)	TE2100 Plan and associated information informs Local Development Frameworks (LDF) and future revisions. Local authority and Environment Agency Planning staff require guidance for applying the principles of the NPPF[16] to the complexities of lower estuary defended tidal floodplain. For flood risk management to be factored into the planning process at all levels for the first 25 years from 2010 to 2034, there is need for greater clarity over methods and procedures for safety in new development behind defences. The Environment Agency, along with implementation partners and Communities and Local Government (CLG) will develop guidance for development in lower estuary defended tidal floodplain.

[16] National Planning Policy Framework (CLG 2012)

TE2100 action plan: **action zone 7** – lower Estuary, urban/industrial and marshland

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 7 – Recommendation 4** To review and maintain from 2035 to 2049, the partnership arrangements and principles for development and flood risk management established in the first 25 years of our Plan.	As Action Zone 7 – Recommendation 3	Guidance will be updated to reflect changing needs. The TE2100 10-yearly update to include review of Action Zone 7 – Recommendation 3 and recommend any changes or developments. We cannot know what institutional arrangements will be in place during this period or what pressures there will be on the environment. We do know that for the lower estuary zone to continue to thrive and for regeneration to be a success, flood risk management must continue to be integrated into the spatial planning process.
	**Action Zone 7 – Recommendation 5** To review and maintain from 2050 and into the 22nd century, the partnership arrangements and principles for development and flood risk management established in the middle years of the Plan.	As Action Zone 7 – Recommendation 3	TE2100 10-yearly update to include review of Action Zone 7 – Recommendation 4 and recommend further action. Guidance is updated to reflect changing needs. Flood risk management continues to be integrated into the spatial planning process into the 22nd century.

	TE2100 recommended actions	Implementation partners	How this will be achieved
	## Action Zone 7 – Recommendation 6 **To maintain, enhance, improve or replace, the river defence walls and active structures – including the Canvey Island Barriers through lower estuary zone 7 over the first 25 years of the Plan from 2010 to 2034.** This is a continuation of our current activities to ensure that confidence in the Thames tidal flood risk management system is maintained and that opportunities for environmental enhancements and partnership through planning are actively sought and carried out. *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency RFCCs Local authorities in action zone 7: • Thurrock Unitary Authority • Basildon District Council. • Castle Point District Council • Medway Unitary Authority Landowners Developers	The Environment Agency's teams responsible for spatial planning and flood risk will promote these works in partnership with landowners and Local Authority planning teams as part of ongoing development applications. The Environment Agency's teams responsible for management of the flood defence assets will promote these schemes. However, the method of managing the defences is different from the present day approach. It involves greater maintenance and repair work in addition to essential replacement. Promotion of schemes through the capital replacement programme may not be appropriate for optimising maintenance and repair, and the Environment Agency will need to develop new ways of planning and implementing these works. As well as looking for ways of working better with limited resources, we will need to seek opportunities for environmental and recreational enhancements which will create a better place, and for partnerships which will help achieve this. Working with other initiatives will be a key element of this action. When works to flood defence structures are planned, it is important to take opportunities to integrate flood defence into developments – and ensure that the developments are designed with a proper understanding of the flood risk they face. Alignment of programmes may be required. Our TE2100 Technical Report and local choice documents for the policy provide our assessment of the choices which are available in the lower estuary zone 7 in the short term.

TE2100 action plan: **action zone 7** – lower Estuary, urban/industrial and marshland

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 7 – Recommendation 7** To maintain, enhance and improve or replace the defence walls and active structures through lower estuary zone 7 during the 15 year period of the Plan from 2035 to 2049 with a first defence raising in 2040. *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency RFCCs Local authorities in action zone 7: • Thurrock Unitary Authority • Basildon District Council. • Castle Point District Council • Medway Unitary Authority Landowners and site operators including: Medway Ports, Coryton Oil Refinery, Dubai Ports (London Gateway) Site developers Essex County Council Kent County Council	Our aims remain as Action Zone 7 – Recommendation 6 above, but during this period, there will be a major programme of rebuilding and refurbishment of the river walls and defences through middle Estuary zone. This provides many opportunities for creating a better place and to plan for a better riverside environment. The Environment Agency's staff responsible for spatial planning and flood risk will promote these works as part of ongoing development applications. A key issue is how land allocated for development can take account of the need for the raising of flood defences in 2040. The Environment Agency will take a strong lead in providing clear and consistent advice to developers in these matters. The Environment Agency will promote schemes through the capital programme and they will form part of strategic and investment plans subject to replacement/repair working arrangements as Action Zone 7 – Recommendation 6 above. There are major opportunities for reshaping the local landscape as part of these works and a primary purpose of the Riverside Strategies (ref Action Zone 0 – Recommendation 16) is to enable these opportunities to be factored into medium to long term spatial plans. During this period we will be preparing for the "end of the century" option so any decisions made as part of Action Zone 7 – Recommendation 7 will have to be shaped to accommodate these developing long term plans. The defences will require raising during this period of our Plan. This will require a decision to be made about the future of the existing barriers on the creeks around Canvey Island. It is likely that the Benfleet Barrier will require replacement with another structure or with alternative measures as it has very little scope for being raised. The East Haven and Fobbing Horse barriers may not be appropriate structures for future flood risk management. If these barriers are removed, this will alter management arrangements for the secondary defences on East Haven and Vange Creeks. Our TE2100 Technical Report and local choice documents for the policy provide further information and local detail. **(continued)**

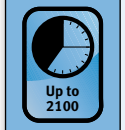
	TE2100 recommended actions	Implementation partners	How this will be achieved
	## Action Zone 7 – Recommendation 7 **(continued)**		Secondary defences will be required to protect the industrial areas at Coryton and Medway ports and the transport links to and from these key sites. In particular, protection will be needed for the road and rail access to the eastern part of the Isle of Grain. This will either require high defences on both sides, or raising of the road and railway to form a causeway. A similar arrangement may be required for Coryton oil refinery access routes.
	## Action Zone 7 – Recommendation 8 Habitat Creation site 1 of 4 In 2020 the first of four intertidal habitat creation sites will be implemented. Valuable habitat is being lost because our defences are preventing it from migrating landwards as sea level rises and over the 100 year life of our Plan, 876 hectares of new habitat will be needed. We have identified five sites which have the right characteristics for habitat creation. The location of the sites are shown on the estuary-wide option maps. The potential sites in the lower estuary action zone are: • Grain Marshes • Allhallows Marshes • St Mary's Marsh (including a possible further expansion to the west) • West Canvey Marshes • Bowers Marshes	Environment Agency RFCCs Natural England Landowners Local authorities • Thurrock Unitary Authority • Basildon District Council Public and local interest groups RSPB Wildlife Trusts Site owners and operators	Planning and groundworks will commence 10 years before implementation of the managed realignment. This preliminary work includes construction of a new line of defence to protect people and properties from the risk of flooding from the new intertidal zone. It also includes – in some cases, recharging the land levels so that the correct habitat develops. It may take up to 10 years after the realignment is implemented before the habitat is fully established at the site. In the Environment Agency, we see habitat creation as a positive step toward the goal of sustainability and supporting the habitats and species that make the Thames Estuary internationally important. As managers of flood defences we also have an obligation to maintain the ecological integrity of internationally designated habitats where it is determined our defences are having a detrimental effect. There will be no increased tidal flood risk to the public as a result of the intertidal habitat creation schemes as they will always include a new defence construction on the landward side of the new habitat to protect people and property. This provides major opportunities for improving the reliability of the defence system. It also provides opportunities for enhancements for recreation, key infrastructure, visitors' centres and other facilities. We will be looking for partnership arrangements to manage these sites and get the best for the natural environment, for the local population and for visitors. Vange and Fobbing Marshes have particularly sensitive historic environments which must be fully considered in any scheme. **(continued)**

TE2100 action plan: **action zone 7** – lower Estuary, urban/industrial and marshland

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 7 – Recommendation 8** **(continued)** Some of these sites contain designated coastal grazing marsh. If these sites are selected for intertidal habitat creation, new freshwater habitat will be needed to compensate for the loss of these designated grazing marsh interest features. The following sites in lower estuary zone have been identified as having the potential to support the interest features that could be lost, either through enhancement of existing features or creation of new habitat: • Vange Marshes • Fobbing Marshes *(Cost included in TE2100 Plan)*		There is also a potential issue of contaminated land which should be fully investigated prior to any works being proposed on Vange and Fobbing Marshes.
	**Action Zone 7 – Recommendation 9** To maintain, operate, modify and improve the Canvey Island Barriers during the 15 year period of the Plan from 2035 to 2069 in this action zone includes: • Fobbing Horse Barrier • East Haven Barrier • Benfleet Barrier. *(Cost included in TE2100 Plan)*	Environment Agency RFCCs Riparian owners with responsibility for their defences Landowners adjacent to the defences	Restoring natural function to the floodplain by removing structures supports the provision of an appropriate and sustainable flood risk management system and aligns with the Government's making space for water strategy. Fixed defences could be implemented to provide an appropriate level of risk management to property at risk. We will promote schemes through the Environment Agency's capital programme and they will form part of strategic investment plans.

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 7 – Recommendation 10** **Habitat Creation – site 2, 3, and 4.** In this period the remaining habitat creation sites will be implemented in 2040, 2050 and 2065. Further sites will be realigned to make up the necessary 876 hectares of intertidal habitat creation required this century. As in Action Zone 7 – Recommendation 8, the potential sites in this action zone are: • Grain Marshes • Allhallows Marshes • St Mary's Marsh (including a possible further expansion to the west) • West Canvey Marshes • Bowers Marsh Further grazing marsh compensation may be required. The same sites described in Action Zone 7 – Recommendation 8 are proposed as options that could support the nature conservation features that may be lost. *(Cost included in TE2100 Plan)*	Environment Agency RFCCs Natural England Local authorities Landowners and site operators Public and local interest groups RSPB Wildlife Trusts	Monitoring and review will be required to confirm actual loss of intertidal habitat compared to that which was projected. Adjustment may need to be made to planned replacement activities. See Action Zone 7 – Recommendation 8 and 9 for additional considerations. Vange and Fobbing Marshes have particularly sensitive historic environments which must be fully considered in any scheme. There is also a potential issue of contaminated land which should be fully investigated prior to any works being proposed on Vange and Fobbing Marshes.

TE2100 action plan: **action zone 7** – lower Estuary, urban/industrial and marshland

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 7 – Recommendation 11** **To maintain, improve, enhance or replace the river defence walls and active structures through lower estuary zone 7 post 2050 and into the 22nd century.** These are the TE2100 "end of the century" raising of defence levels to provide continuing tidal flood risk management to the lower estuary zone 7. The defence raising will be the same in this zone, whatever "end of the century" option is selected. Whether or not defences are raised, all defences will still require ongoing maintenance, repair and replacement (and hence engineering works) and this has been allowed for in our Plan investment profile. *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency RFCCs Local authorities in action zone 7: • Thurrock Unitary Authority • Basildon District Council • Castle Point District Council • Medway Unitary Authority Landowners Developers Thames Strategy East	We cannot know what institutional arrangements there will be as we approach the 22nd century, but our TE2100 vision imagines an environment where the lower estuary riverside has thriving regeneration areas and a stable, flourishing natural environment which is increasingly enjoyed and respected by the people who live, work and visit. This means that the actions established in Action Zone 7 – Recommendation 6 and 7 will be continued by whoever is looking after our environment at that time. There are major opportunities for reshaping the local landscape as part of these works.

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 7 – Recommendation 12** **To agree a programme of managing flooding from other sources in the defended tidal floodplain.** Large areas of lower estuary zone 7 are low-lying, and there is a great reliance on drainage networks to deal with pluvial and fluvial flooding, particularly in areas where the urban drainage system has relatively low capacity or is prone to tide locking. The marsh and urban pumped drainage systems will require upgrading as the sea level rises and rainfall increases. Other issues include potential saline intrusion and siltation of outfalls. *(Cost of implementing this action is not included in our TE2100 Plan as Environment Agency and other standing costs not included, but TE2100 data, information and recommendations are available to support the implementation of this action)*	Environment Agency RFCCs Local authorities in action zone 7: • Thurrock Unitary Authority • Basildon District Council • Castle Point District Council • Medway Unitary Authority Internal Drainage Boards Sewage and water undertakers Landowners Developers & architects	We will discuss with our implementation partners to agree strategic scope of measures required. All site owners must be supportive of approach and confidence of public and users maintained. Local measures for management of flooding from other sources to be in place or planned within 25 years. Large areas of lower estuary zone 7 are low-lying, and there is a great reliance on drainage networks to deal with pluvial and fluvial flooding, particularly in areas where the urban drainage system has relatively low capacity or is prone to tide locking. The marsh and urban pumped drainage systems will require upgrading as the sea level rises and rainfall increases. Other issues include potential saline intrusion and siltation of outfalls. Areas which may require attention include: • The marsh and urban drainage on the eastern half of the Isle of Grain • Fobbing and Vange Marshes drainage systems • Benfleet Hall Sewer and Bowers Marshes • The extensive drainage system in Canvey Island with open channels and pumped and gravity outfalls • Drainage outfalls for the Canvey west marsh drainage system • Heavy siltation in Vange and Holehaven Creeks, and outfalls have been abandoned in the past and reconstructed elsewhere. The programme must take account of the viability of potential actions to reduce flood risk from other sources. Choices for local flood risk management have not been designed or addressed in detail in TE2100 but a number of areas have been identified as requiring further study at local level. Our TE2100 Technical Report and local choice documents for the policy provide further information on these matters and the choices which are available to assist with problems.

TE2100 action plan: **action zone 7** – lower Estuary, urban/industrial and marshland

TE2100 action plan: **action zone 8 – Seaside/fishermen's frontage**

Action plan for zone 8

Nine actions identified

Description of the policy units

Leigh Old Town & Southend-on-Sea

This section describes the nine actions for zone 8 – Seaside/ fishermen's frontage which have been identified through the TE2100 Plan. The actions are described under the following headings:

- TE2100 recommended actions (and whether or not costs for this have been included in the TE2100 Plan)
- Implementation partners
- How this will be achieved.

"The [TE2100] Plan could usefully provide formal recognition and active promotion of the principles of joint working in order to secure effective and efficient delivery of the habitat creation proposals. Such joint working ventures should embrace not only Natural England, but also other public bodies such as local authorities, port authorities, and non-governmental conservation organisations such as the RSPB."

Natural England

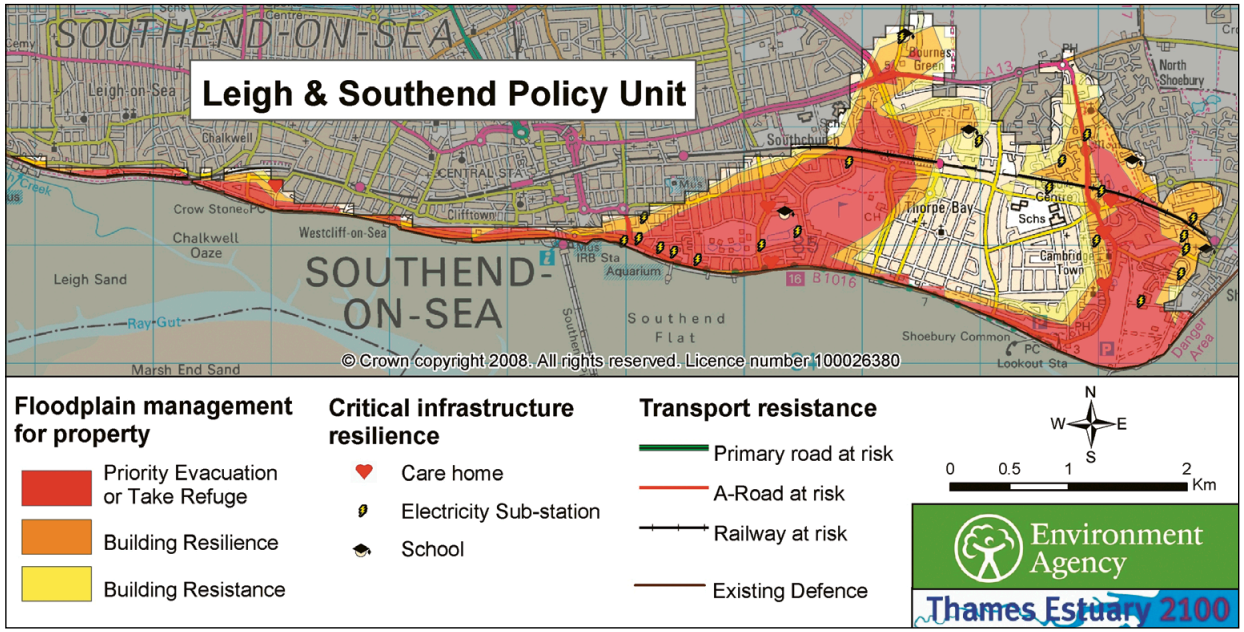
Policy unit – Leigh Old Town & Southend-on-Sea

Policy: Our recommended flood risk management policy for Leigh Old Town & Southend-on-Sea is policy P4, to take further action to keep up with climate and land use change so that flood risk does not increase.

Description

Southend-on-Sea (including Westcliff-on-sea) and Leigh Old Town are distinctly different areas, and are considered separately.

The sea front



At risk in Leigh & Southend policy unit

Southend-on-Sea has a continuous sea frontage with beaches and very extensive (designated) intertidal areas and a pier. Whilst most of Southend-on-Sea is on high ground and not at risk from tidal flooding, much of the sea front is at risk of flooding and there is a flood defence along the entire frontage.

There are five schools, six care homes and 21 electricity substations within the flood risk area. This is an important amenity and recreation area, with a parallel road and footpaths along much of the frontage. The two main areas of floodplain are to the east of the town centre.

TE2100 action plan: **action zone 8** – Seaside/fishermen's frontage

The beach at Southend-on-Sea

The number of properties at risk is relatively small because the land rises behind the sea front. The standard of protection is estimated to be about 0.5% (or 1:200) per annum, which is consistent with similar coastal and estuary locations around the country. Though it should be noted that the standard along the frontage varies depending on the local defence crest level and wave action.

Leigh Old Town has a narrow but historic frontage bounded by the railway line to the north. It has close links to the Estuary with a strong fishing tradition, and floodplain management is practised to avoid creating a barrier between the village and the Estuary.

This means that the defence level is low and properties have been built with raised thresholds and other resilience measures to protect against tidal flooding. There is evidence that more recent riverside users are unaware of this and stock for shops is stored in the floodable area.

Sources of flooding

- Tidal from the Thames (probability 0.5% per annum or greater), flood depths up to 4 m but very variable.
- Fluvial from local watercourses including Prittle Brook.
- Local drainage: Not investigated in TE2100.

The existing flood risk management system

- Tidal flood defences on the Thames including revetment and wave walls.
- Beaches with associated groynes to improve the frontage and mitigate the impacts of wave action. Beach recharge has been recently used to build up the beach and reduce the effects of wave action.
- Drainage system outfalls including Prittle Brook.
- Receptor responses in Leigh Old Town including resilient buildings and measures for rapid drainage of tidal flood water.

Policy context

This policy unit overlaps with the Essex SMP (Shoreline Management Plan) which is currently in development. It is essential that there is good communication between TE2100 and the Essex SMP to ensure that there is no conflict between the flood and coastal management policies and action plans developed by these two strategies.

Re-activation of the waterfront at Southend-on-Sea is included in the Thames Gateway Parklands vision, which also identifies the importance of the historic urban environment in the vicinity of Southend Pier.

It is likely that the Southend-on-Sea frontage will continue to be developed and improved as it is an important leisure and recreation area.

Raising of defences would affect the close link between the fishing community at Leigh Old Town and the Estuary. The intention of the TE2100 Plan would be to minimise visual impacts on Leigh Old Town as much as possible by implementing further floodplain management measures.

Reducing potential flood impacts with local resilience measures is already practised in Leigh Old Town, where flood boards are used together with means of allowing the area to drain of tidal

TE2100 action plan: **action zone 8** – Seaside/fishermen's frontage

water in the event of inundation. Any new development should also be designed so that the potential flood impacts are minimised and a programme of public information is required to ensure that residents are aware of these floodplain management arrangements.

Vision

Improvements to the flood risk management system should provide amenity, recreation and environmental enhancement, and be designed to minimise any adverse impacts on the frontage whilst supporting and enhancing the fishing industry activities.

Local issues and choices

Raised and new defences on the Southend-on-Sea frontage should be designed so that:

- They do not encroach into the Estuary.
- The raised part of the defences could consist of a new defence on a new alignment behind the sea front where space permits (for example, park areas) so that the heights of walls on the sea front are limited.
- Walkways are raised to provide sea views, and access points are improved.
- Demountable defences and gated access points may be included in the designs in some areas providing that satisfactory arrangements can be made for security of closure.

The Southend-on-Sea frontage is subject to wave attack and overtopping. Beach recharge has been implemented both to improve the beach and reduce the impacts of waves. Improvements to this approach would reduce the need for defence raising.

Local cockle fishermen have particular problems relating to siltation in and around Leigh Old Town. It is recommended that this should be included in any local morphological investigations relating to beach recharge.

Responses to mitigate the impacts of the Estuary on local flooding may be needed, including improvement of outfalls, although this has not been investigated in TE2100.

Responses for local flood risk management have not been designed or assessed in detail and further work will be required at local scheme level. Local consultation and appraisal will be required at this stage and our action plan includes the requirement to identify project partners to assist with this detailed development work.

The seafront at Leigh Old Town

Action Zone 8 – Policy units

Leigh Old Town & Southend-on-Sea policy unit P4

[Note that all dates are based on government's current guidance on climate change – the TE2100 Plan will be reviewed and updated if these predictions change]

	TE2100 recommended actions	Implementation partners	How this will be achieved
First 25 years	**Action Zone 8 – Recommendation 1** TE2100 Plan informs the development and revision of local authority strategic flood risk assessments (SFRAs) and flood plans. *(Cost of implementing this action not included in TE2100 Plan as Environment Agency and other standing costs not included, but TE2100 data and information will be available to support the action)*	Environment Agency Anglian Eastern Regional Flood and Coastal Committee Southend-on-Sea Borough Council Essex SMP (shoreline management plan) Client Steering Group Essex Resilience Forum	TE2100 data and information will be provided to local authorities preparing SFRAs, flood plans and emergency capability testing. The Environment Agency will support Local authorities with interpretation of TE2100 data and information as required to ensure SFRAs and flood plans are developed with an understanding of TE2100 analysis and recommendations. TE2100 data and information will be provided to LRF to inform Community Risk Registers and support exercises. Local Resilience Forum takes ownership of the flood plan and all responders have confidence in it. A community engagement programme to ensure the public, businesses and other groups understand, are involved in and supportive of the flood plans. Thames tidal defences provide highly reliable protection to Southend-on-Sea against surge tides. But should there be a failure of a defence or an extreme event which overtops the defences, low-lying areas of Southend-on-Sea and Leigh Old Town would be at risk as shown on the policy unit At Risk maps. The Flood Plans will set out arrangements for managing this sort of emergency. **(continued)**

TE2100 action plan: **action zone 8** – Seaside/fishermen's frontage

	TE2100 recommended actions	Implementation partners	How this will be achieved
First 25 years	**Action Zone 8 – Recommendation 1** **(continued)**		Feedback from stakeholders indicates interest in greater collaborative working supported by technical workshops to share best practice and support the development of these key documents and plans – and ensure the links to related South Essex CFMP and Essex SMP are properly understood. The Environment Agency will scope this activity, and prepare a proposal for the ways in which it can promote this collaborative working.
First 25 years	**Action Zone 8 – Recommendation 2** To agree a programme of floodplain management including emergency planning, and local flood protection, resilience and emergency plans for vulnerable key sites in action zone 8. *(Environment Agency, Local Authority and other standing costs not included but additional costs included as described in Action Zone 0 – Recommendation 11. In addition, technical support from the Environment Agency will be provided to promote this action together with the availability of TE2100 data and information. Requirements for future funding will have to be agreed)*	Environment Agency Anglian Eastern RFCC Local Authority Southend-on-Sea BC Essex Resilience Forum Developers and vulnerable site owners/ managers	The Environment Agency will discuss with implementation partners to agree strategic scope of measures and future funding requirements. A working group will be established to ensure agreement between implementation partners on the strategic approach, and roles and responsibilities for achieving it. The objectives of this action are that local floodplain management measures in place or planned within 25 years and all site owners supportive of approach and confidence maintained. Our At Risk maps for Leigh Old Town and Southend-on-Sea show that particular sites and key infrastructure which would be vulnerable in the event of a failure or overtopping of the defences. Areas of the Southend-on-Sea sea front are on the seaward side of the defended area and Leigh Old Town seafront is likely to flood during normal high tides. It is important that residents, businesses and visitors are aware of this and the measures they should be taking for their own protection.
First 25 years	**Action Zone 8 – Recommendation 3** To agree partnership arrangements and principles to ensure that new development in Seaside and Fishermen's frontage zone 8 is safe, and that where	Environment Agency Anglian Eastern RFCC Essex County Council	The Environment Agency will provide data, information and technical support to ensure the TE2100 Plan and associated information is able to inform Local Development Frameworks (LDF) and future updates of existing LDFs. These LDFs to be supported by sustainability appraisals that include local tidal flood risk and the implications of climate change. The Environment Agency will encourage application of the NPPF for new development and encourage adoption of property-level protection and resilience. **(continued)**

TE2100 action plan: **action zone 8** – Seaside/fishermen's frontage

	TE2100 recommended actions	Implementation partners	How this will be achieved
First 25 years	**Action Zone 8 – Recommendation 3** **(continued)** possible the application of the NPPF reduces the consequence of flooding. Environment Agency and local authority staff are providing advice to Developers and responding to difficult Planning applications. *(Cost of implementing this action not included in TE2100 Plan as Environment Agency and other standing costs not included, but TE2100 data and information will be available to support the action)*	Southend on Sea Borough Council; Thames Gateway Essex Partnerships; Developers and site owners	The Environment Agency, along with our implementation partners and CLG (Communities and Local Government) will develop guidance for development in a defended tidal floodplain. For flood risk management to be factored into the planning process at all levels for the first 25 years from 2010 to 2034, there is need for greater clarity over methods and procedures for safety in new development behind defences. Local authority and Environment Agency Planning staff require guidance for applying the principles of the NPPF[17] to a defended tidal floodplain.
Middle 15 years	**Action Zone 8 – Recommendation 4** To review and maintain from 2035 to 2049, the partnership arrangements and principles for development and flood risk management established in the first 25 years of our Plan.	As Action Zone 8 – Recommendation 3	Guidance will be updated to reflect changing needs. The TE2100 10-yearly update to include review of Action Zone 8 – Recommendation 3 and recommend any changes or developments. We cannot know what institutional arrangements will be in place during this period or what pressures there will be on the environment. We do know that for Leigh Old Town and Southend-on-Sea to continue to thrive and for regeneration to be a success, flood risk management must continue to be integrated into the spatial planning process.
Up to 2100	**Action Zone 8 – Recommendation 5** To review and maintain from 2050 and into the 22nd century, the partnership arrangements and principles for development and flood risk management established in the middle years of the Plan.	As Action Zone 8 – Recommendation 3	TE2100 10-yearly update to include review of Action Zone 8 – Recommendation 4 and recommend further action. Guidance is updated to reflect changing needs. Flood risk management continues to be integrated into the spatial planning process into the 22nd century enabling the relationship between spatial planning and flood risk management to develop in the Seaside/Fishermen's frontage zone as we prepare for the 22nd century.

[17] National Planning Policy Framework (CLG 2012)

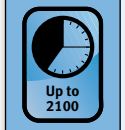
TE2100 action plan: **action zone 8** – Seaside/fishermen's frontage

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 8 – Recommendation 6** **To maintain, enhance, improve or replace, the river defence walls, active structures and beach nourishment schemes in Seaside Fishermen's frontage zone 8 over the first 25 years of the Plan from 2010 to 2034.** This is a continuation of our current activities to ensure that confidence in the Thames tidal flood risk management system is maintained and that opportunities for environmental enhancements and partnership through planning are actively sought and carried out. *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency Anglian Eastern RFCC Essex County Council Local Authority spatial and emergency planners Southend-on-Sea Borough Council Essex SMP (shoreline management plan) Client Steering Group Thames Gateway Essex Partnerships Developers and site owners Thames Strategy East	Note that Southend on Sea council is a Unitary Authority with full County and Planning functions and is responsible for a wider range of services and policy planning. Southend on Sea council is also the Operating Authority for the coastal and tidal defences so will take responsibility for [preparing the PARs (Project Appraisal Reports) which may flow from the TE2100 Plan in this Action Zone. Southend council is in the process of preparing a revised Shoreline Strategy with a view to implementing the recommendations of TE2100 and Essex SMP2. The Environment Agency will be involved in works at Hadleigh Marshes and Leigh High Street, but most of the other schemes flowing from the TE2100 Plan will be promoted and delivered by Southend. The Environment Agency's staff responsible for spatial planning and flood risk will promote these works as part of ongoing development applications. We are also seeking opportunities for environmental and recreational enhancements which will create a better place through the Seaside/Fishermen's frontage zone, and for partnerships which will help us achieve this. We also need to understand better how changes to the frontage defence arrangements can help local businesses and the fishing industry. Our TE2100 Technical Report and local choices documents for the policy units provide our assessment of the choices which are available in the Seaside/Fishermen's frontage zone 8 in the short term.

TE2100 action plan: **action zone 8** – Seaside/fishermen's frontage

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 8 – Recommendation 7** To maintain, enhance and improve or replace the defence walls, active structures and beach nourishment schemes through Seaside/Fishermen's frontage zone 8 during the 15 year period of the Plan from 2035 to 2049. *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency Anglian Eastern RFCC Essex County Council Local Authority spatial and emergency planners: Southend-on-Sea Borough Council Essex SMP (shoreline management plan) Client Steering Group Thames Gateway Essex Partnerships Developers and site owners Thames Strategy East	Our aims remain as Action Zone 8 – Recommendation 6 above, but during this period, there will be a major programme of rebuilding and refurbishment of the river walls and defences through middle Estuary zone. This provides many opportunities for creating a better place and to plan for a better riverside environment. A key issue is how land allocated for development can take account of the need for the raising of flood defences in 2040. The Environment Agency will take a strong lead in providing clear and consistent advice to developers in these matters. The Environment Agency and Southend Council will promote schemes through their capital programmes and they will form part of strategic and investment plans subject to replacement/repair working arrangements as Action Zone 8 – Recommendation 6 above. There are major opportunities for reshaping the local landscape as part of these works and a primary purpose of the Riverside Strategies (ref Action Zone 0 – Recommendation 16) is to enable these opportunities to be factored into medium to long term spatial plans. During this period we will be preparing for the "end of the century" any decisions made as part of Action Zone 8 – Recommendation 7 must recognise that there may be major changes during the period 2050 to 2070. The defences at Southend-on-Sea will require raising during the period covered by the TE2100 Plan. Any raising of the defences should include ground raising and landscaping so that the public can view the estuary; public access to the beaches and foreshore is not impaired; the defences blend with the sea front environment and do not form a barrier between the urban area and the estuary; and opportunities are taken to enhance the sea frontage landscape and access when the defences are improved. The defences at Leigh Old Town may not be raised in order to maintain the link with the estuary, but floodplain management measures will be needed to control the flood risk.

TE2100 action plan: **action zone 8** – Seaside/fishermen's frontage

	TE2100 recommended actions	Implementation partners	How this will be achieved
	**Action Zone 8 – Recommendation 8** To maintain, improve, enhance or replace the river defence walls, active structures and beach nourishment schemes through lower Estuary zone 8 post 2050 and into the 22nd century. *(Cost of implementing this action is included in TE2100 Plan)*	Environment Agency Anglian Eastern RFCC Essex County Council Local Authority spatial and emergency planners: Southend-on-Sea Borough Council Essex SMP (shoreline management plan) Client Steering Group Thames Gateway Essex Partnerships Developers and site owners Thames Strategy East	This will be a major multi billion pound construction project and the arrangements for implementation are likely to differ from our normal defence construction projects. There are major opportunities for reshaping the local landscape as part of these works. 2070 is a long way ahead but a decision needs to be made on the TE2100 "end of the century" option. Our recommendations in the Plan are based on conditions in 2009, but the final decision on the end of the century options will not be taken until the Plan review in 2050. Intermediate reviews will be undertaken at a minimum of 10 yearly intervals – or more frequently if there are significant changes to one or more of the TE2100 indicators for change. There will be further consultation each time the Plan is reviewed. These are the TE2100 "end of the century" raising of defence levels to provide continuing tidal flood risk management to the Seaside/Fishermen's frontage zone 8. The defence raising will be the same in this zone, whatever TE2100 "end of the century" option is selected. Whether or not defences are raised, all defences will still require ongoing maintenance, repair and replacement (and hence engineering works) and this has been allowed for in our Plan investment profile. We cannot know what institutional arrangements there will be as we approach the 22nd century, but our TE2100 vision imagines an environment where the Leigh Old Town and Southend-on-Sea riverside has thriving regeneration areas and a stable, flourishing natural environment which is increasingly enjoyed and respected by the people who live, work and visit. This means that the actions established in Action Zone 8 – Recommendation 6 and 7 will be continued by whoever is looking after our environment at that time. Our 2009 consultation provided a "snapshot" of zone 8 stakeholder views and this will form a starting point for measurement of public attitudes in the future.

TE2100 action plan: **action zone 8** – Seaside/fishermen's frontage

	TE2100 recommended actions	Implementation partners	How this will be achieved
	## Action Zone 8 – Recommendation 9 To agree a programme of local beach recharge measures and investigation into siltation and erosion patterns in this policy unit. *(Cost of implementing this action is not included in our TE2100 Plan as it will be included in the outputs of the Essex SMP currently in preparation. TE2100 data, information and recommendations are available to support the implementation of this action)*	Environment Agency Anglian Eastern RFCC Local Authority Southend-on-Sea Borough Council Essex SMP (shoreline management plan) Client Steering Group Fishermen	The Southend-on-Sea frontage is subject to wave attack and overtopping. Beach recharge has been implemented both to improve the beach and reduce the impacts of waves. Improvements to this approach would reduce the need for defence raising. Local cockle fishermen have particular problems relating to siltation in and around Leigh Old Town. It is recommended that this should be included in any local morphological investigations relating to beach recharge. This work would be led by Southend on Sea Borough Council who is the Operating Authority. Good dialogue must be maintained between TE2100, Southend on Sea Council and the Essex shoreline management plan to ensure no contradictory advice provided by these two overlapping strategies. This has not been designed or addressed in detail in TE2100 but a number of areas have been identified as requiring further study at local level: Our TE2100 Technical Report and local choices documents for the policy units provide further information on these matters and the choices which are available to assist with problems.

TE2100 action plan: **action zone 8** – Seaside/fishermen's frontage

Chapter 10: Find out more

After six years of study and working with people across the Thames estuary we have produced and gathered a great deal of information. We are not able to present all of this within this document and the supporting Environmental Report Summary.

However, if you would like to find out more, we have produced three comprehensive technical reports:

(i) The TE2100 Technical Report, which describes how we have developed our Plan including, the approach we have taken, the supporting studies and the evidence which underpins our conclusions.

(ii) The TE2100 Environmental Report, which describes how we have undertaken the Strategic Environmental Assessment (SEA), the key significant impacts of our Plan, suggested mitigation, enhancement and monitoring. It also explains how we have complied with other environmental legislation.

(iii) Statement of Environmental Particulars, which indicates how environmental and consultee considerations were taken into account during the preparation of the Plan and how TE2100 selected the approach adopted in the final Plan. The statement goes on to set out the monitoring procedures that have been set in place to monitor the significant environmental effects of the implementation of the Plan.

These documents can be ordered or downloaded from the publications catalogue on the Environment Agency's website.

In addition, more than 300 reports of studies and investigations with associated data sets have been produced during the lifetime of the TE2100 project. These will be made available on request and will be subject to standard Environment Agency requests for information and charging practices.

To find out more, please take a look at our website:

www.environment-agency.gov.uk/homeandleisure/floods/125045.aspx

Or contact us:

By email at enquiries@environment-agency.gov.uk

By phone on 08708 506 506

TE2100 Plan Glossary

Term	Description
Appraisal	A formal process of assessment in terms of social, economic and environmental values used to assess impacts of taking or not taking action.
Asset	An asset is something of 'enduring value' e.g. homes, heritage sites, a nature reserve, a train station etc.
Asset, flood defence	A flood defence asset is defined as any asset that would, by its failure or removal or alteration, increase the likelihood of flooding from main river or the sea. An asset can be a defence, a structure, a watercourse channel or a beach. Failure means structural failure, failure to operate and/or overtopping of the defence.
Catchment Flood Management Plan (CFMP)	A large scale planning document that identifies long-term sustainable policies for the holistic management of flood risks in a defined river catchment or group of related catchments.
Climate Change Adaptation	Means of addressing the impacts resulting from changing climate, and harnessing any opportunities.
Coastal Squeeze	The process by which coastal habitats are progressively reduced in a certain area and lose functionality when caught between rising sea level and fixed sea defences or high ground.
Designated Habitat	Habitat given special distinction under UK or European law.
Economic Appraisal	A cost-benefit analysis which attempts to estimate the costs and benefits to society.
Multi Criteria Analysis (MCA)	A form of economic appraisal used by the TE2100 which seeks to place value on the economic, environmental and social impacts and benefits of our flood risk management options to society using monetary terms.
Emergency Planning	Development and maintenance of agreed procedures to prevent, reduce, control, mitigate or take further action in the event of an emergency.
Enhancement	A process of improvement that achieves benefits for the community and/or environment through new development in nature conservation, landscape, built heritage or improved access. Such enhancements can be delivered as part of improvements to flood defences.
Estuary	An environment where terrestrial, freshwater and tidal (saline) habitats overlap.
Flood	An overflow or accumulation of an expanse of water that submerges land.
Flood Defence	Anything natural or artificial that protects against flooding, to a designed return period.
Floodplain	The area of low-lying land adjacent to a river over which water flows in times of flood. Areas of floodplain are often under pressure for development. However, if floodplains are obstructed by buildings or other man-made objects, water cannot flow away efficiently and the effects of flooding are made worse.

Term	Description
Floodplain Management Measures	An approach which aims to reduce the consequences of flooding through a set of actions which are often called 'receptor responses'. These actions include measures such as building walls and barriers around vulnerable areas within the floodplain, e.g. homes or businesses, to reduce the chance of flooding. Or, adapting buildings and infrastructure to ensure they can recover quickly after the flood event, therefore reducing its consequence.
Flood Resilience	Designing and constructing a building or infrastructure in such a way that flood water may enter and cause minimal impact. This aids swift recovery after a flood by ensuring that no permanent damage is caused, structural integrity is maintained, and drying and cleaning are made easier.
Flood Resistance	Designing and constructing a building or infrastructure in such a way to prevent flood water entering the structure and damaging its fabric or actual content.
Flood Risk	Flood risk is expressed by combining information on probability (sometimes referred to as likelihood) and consequence (sometimes referred to as impact).
Flood Risk Assessment	A use of appropriate detail and science in order to ensure that flood risk is understood sufficiently, to support the flood risk management decision being taken.
Flood Risk Management (FRM)	Ways of reducing the risks of flooding from rivers and the sea to people, property and the natural environment. Solutions may be changes in land use, temporary defences, better flood warning and self-help schemes, as well as building and maintaining flood defences.
Flood Risk Management (FRM) Systems	A group of flood defence assets that as a whole contribute to managing the flood risk to a discrete location.
Flood Storage	An area of land whose prime purpose is to receive and store flood flows to prevent flooding elsewhere. Tidal flood storage is the action of storing tidal waters during very large surge tides to help to reduce extreme water levels. For example, to help reduce extreme water levels at the Thames Barrier. Fluvial flood storage areas are assigned to accept fluvial flood water in order to alleviate flooding. This enables peak fluvial flows to be eased and release flows downstream in a controlled manner.
Fluvial	Relating to rivers and their flows.
Habitat	A place in which a species or community of species live, with characteristic plants and animals.
Habitat Creation	Under the European Union (EU) Habitats and Birds Directives, the Environment Agency has a duty to replace habitat losses in EU designated Special Protection Areas (SPAs) or Special Areas of Conservation (SAC) caused by our flood defence activity. See coastal squeeze above.

TE2100 Plan Glossary

Term	Description
Implementation Partners	Key stakeholder groups and organisations who will work with the Environment Agency to implement the recommendations of the TE2100 plan at a local level.
Intertidal	The area exposed between the lowest and highest tides.
Intertidal Habitat	Habitat exposed between the lowest and highest tides usually comprising of mudflats, gravels, sands and vegetation such as saltmarsh and reedbeds.
Key Infrastructure/Key Sites	These are aspects of a service, such as water and electricity or trunk roads, that can be flooded and as a result this service would be interrupted or reduced.
Mean Sea Level (MSL)	The average (mean) height of the sea's surface. The level is usually halfway between mean high and low tide.
Mitigation	Refers to the actions which may be taken to reduce impacts.
Peak River (Fluvial) Flood Flows	The highest freshwater river flow
Peak Surge Tide Level	The highest surge tide. Surge being the additional tide level recorded above normal tide levels.
National Planning Policy Framework (NPPF)	The NPPF and its supporting technical guidance includes Government policy on development and flood risk. Its aims are to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas of highest risk. Where new development is exceptionally necessary in such areas, this policy aims to make it safe, without increasing flood risk elsewhere and, where possible, reducing flood risk overall.
Pluvial Flooding	Flooding caused by intense rainfall, often of short duration, that exceeds the capacity of the local drainage systems.
Policy Appraisal	The social, economic and environmental value of a policy unit, which has been assessed through a formal process to allocate a flood risk management policy.
Policy Unit	A defined geographical area with similar/shared spatial and flood risk characteristics.
Realign	To change or restore to a different or former position, e.g. flood defences.
Receptor	Receptor refers to the entity that may be affected by a flood such as people, buildings, infrastructure and public services. For example, in the event of heavy rainfall (the source) flood water may propagate across the floodplain (the pathway) and inundate housing (the receptor) that may suffer material damage.

TE2100 Plan Glossary

Term	Description
Receptor Responses	A set of actions that aims to reduce the consequences of flooding. 'Receptors' are people that live, work or play in the floodplain, the buildings we sleep or work in and the infrastructure and services that support us; for example roads, water and electricity. How we respond to flood risk and how we adapt buildings and infrastructure is described as 'Receptor Responses'.
Riparian Owner	Owner of property or land alongside a natural watercourse, i.e. banks of a river or adjoining land. Under common law they possess rights and responsibilities relating to the stretch of the watercourse which falls within the boundaries of their property or land.
Risk Assessment	The overall process of estimating the magnitude of risk and deciding whether or not the risk is tolerable or acceptable.
Shoreline Management Plan (SMP)	A large-scale planning document that identifies policies for coastal defence for a specified length of coast, taking account of natural coastal processes and human and other environmental influences and needs.
Spatial Planning	Refers to the methods used to balance demands for development with the need to protect the environment and to achieve social and economic objectives.
Storm Surge	Difference between actual and predicted sea water level, due to the action of wind stress and atmospheric pressure on the water surface, which may be positive or negative.
Strategic Environment Assessment (SEA)	A process of assessing the environmental opportunities and restrictions of a project and identifying and managing its implications. An SEA is a legal requirement of certain plans and programmes, under the Environmental Assessment of Plans and Programmes Regulations 2004.
Strategic Flood Risk Assessment (SFRA)	Looks at flood risk at a strategic level on a local planning authority scale. It is the responsibility of those allocating land for building to demonstrate that the flood risk to and from that development will be acceptably safe throughout the lifetime of the proposed development, taking account of climate change. Local Planning Authorities (LPAs) prepare SFRAs in consultation with the Environment Agency and other stakeholders to determine local flood risk.

The TE2100 Plan has been developed through a programme of three public consultations, the final one being held between April and July 2009.

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