

Thames Estuary 2100



Managing flood risk through London and the Thames estuary

TE2100 Plan

Consultation Document

April 2009

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April 2009



David Wardle
Thames Estuary Programme
Executive Manager
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I am pleased to present our Thames Estuary 2100 (TE2100) Plan for consultation. This document sets out our recommendations for flood risk management for London and the Thames estuary through to the end of the century. 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 Foresight¹ 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. 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 that experience it. The summer 2007 floods in the north-east and west midlands, highlighted in the recent Pitt Review², were an unwelcome reminder of the devastation that unpredictable high intensity

"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."

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.

Our Plan is needed to provide confidence to those who live and work in London and the 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 already 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

¹ Foresight: Flood and Coastal Defence, Sir David King, Government Chief Scientific Adviser, April 2004

² Sir Michael Pitt's review of the summer 2007 floods



account of our ideas as we have progressed. I am delighted that the Greater London Authority's Climate Change Adaptation Plan 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, therefore your input through this consultation is vital.

I hope that you will participate fully in our consultation to enable us to develop a TE2100 Plan which is effective in managing flood risk over the next 100 years, is workable and is supported by the community it serves.

A handwritten signature in black ink, appearing to be 'D. Ford'.

How to use this document

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.



Question icon

The following icon is used to denote where we invite your feedback.



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.



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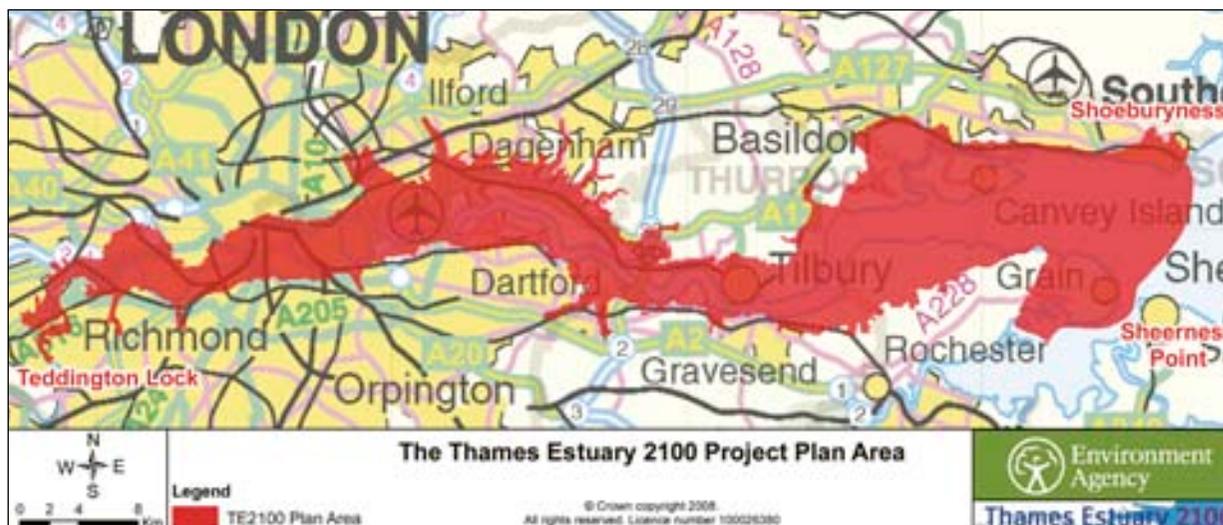
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Thames Estuary 2100

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 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 the past six years we have undertaken 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.

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 (2070) under Government's current climate change guidance.

Why are we seeking your views?

By giving us your views on this plan you have an opportunity to influence how tidal flood risk is managed through this century.

Chapter 1: Introduction and purpose of this consultation

We have already contacted and met many strategic organisations and local interest groups over the last six years and we have drawn heavily on the information and suggestions they have given us. Up until now however we have not presented a full and final picture of how we see tidal flood risk being managed through this century and the actions that need to be taken. In 2005 we consulted on our Plan objectives and our Early Conceptual Options; the many ways of managing rising water levels across the estuary. More recently we consulted on our High-Level Options; the set of options which could manage and adapt to a range of different water levels. We have now completed our studies and taken on board much that you have told us. We are now ready to present our full findings and recommendations before we finalise the Plan and submit it to Government in January 2010.

Who should respond?

This consultation is for everyone who has a professional or personal interest in future tidal flood management and how the actions we are recommending will shape the future of the Estuary.

The Thames Estuary 2100 Plan will set the strategic direction and determine the future actions and expenditure that are needed to manage tidal flood risk through this century. It will

have a direct impact, both now and in the future, on all who live and work in the Thames estuary.

Although our task is to produce a flood risk management plan, we understand that the recommendations we make have the potential to impact on a wide range of interests in the Estuary. These interests include the activities of people who work on the river or enjoy it for leisure activities, the rich variety of natural environments found along the Estuary, and the land owners and people who live in the defended flood plain.

Flood risk management is not just our responsibility. We work jointly with many organisations across the Thames estuary to ensure that people are aware of the flood risk where they live, and that those organisations who help us manage floods have the right information and tools to do their job.

Many of the actions we are recommending are outside our direct responsibilities. Therefore we need to make sure that we have identified the right actions and the right organisations to deliver them.

It will never be possible to satisfy all the varied and competing interests in the Estuary; however by obtaining your views we will produce a Plan which has incorporated, as far as possible, the needs and aspirations of people and

the environment across the Estuary and its floodplain. Where we are not able to incorporate your views and recommendations, we will explain the reason why.

More information on how you can respond and the other information to support this plan for consultation is explained in chapters 10 and 11.

What does this Plan for consultation 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. It contains recommendations on:

- **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.

Chapter 1: Introduction and purpose of this consultation

- **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 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 needs to work with us 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 action plan provides the basis of the long term implementation plan which will form a major part of the final Plan we submit to

Government in January 2010. This is set out in the TE2100 action plan in Chapters 8 and 9.

- **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 squeezed between the river and our existing flood defences resulting in the habitats being washed away. 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 plans in Chapters 8 and 9.

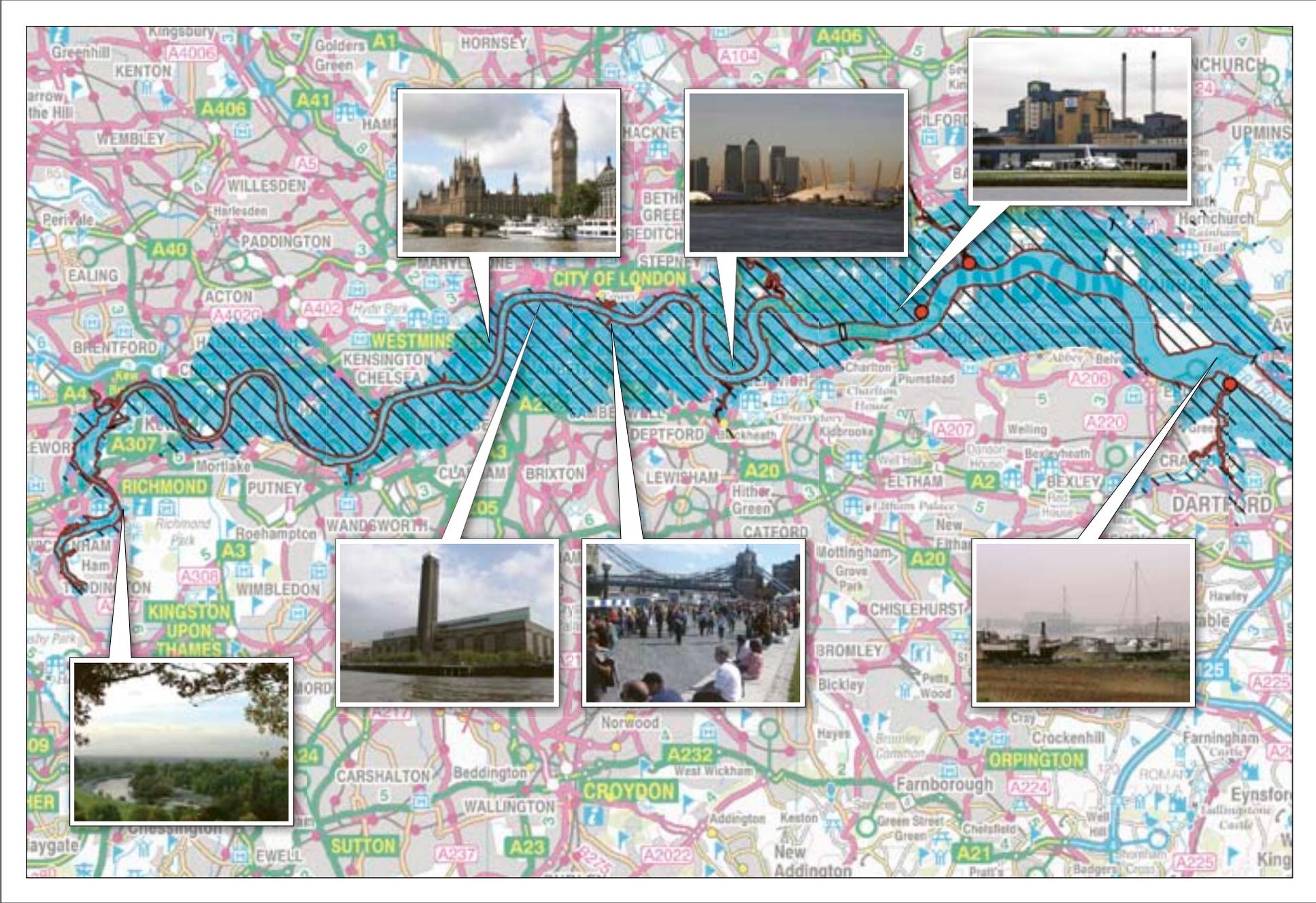
The Plan is explained in Chapter 5 and supported by the TE2100 Technical Report and Environmental Report. 📄 Should you wish to find out more detail about a particular aspect of the Plan these reports can be made available. Details on how to find these are in Chapter 11.

What will the Plan do?

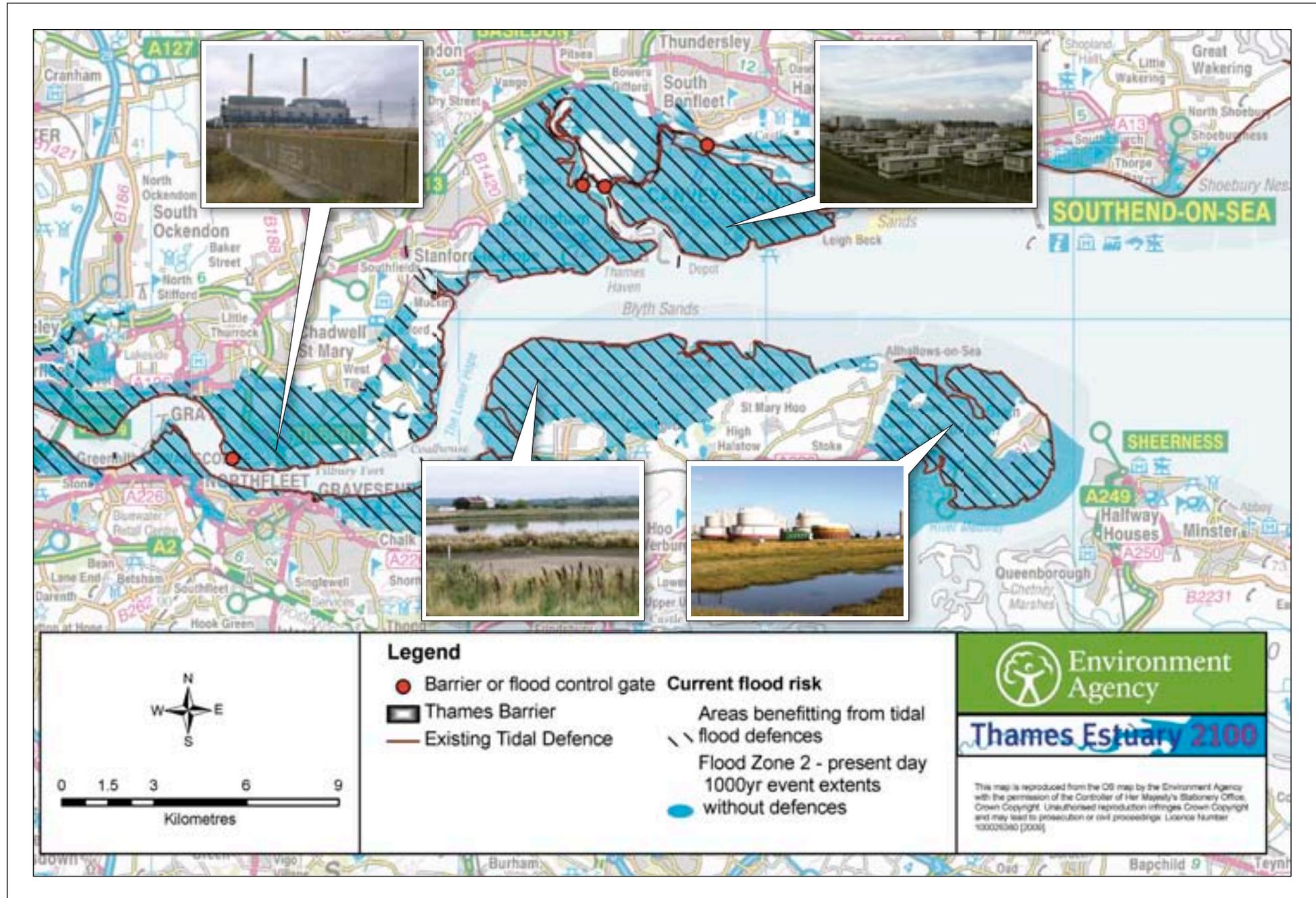
- It will direct our future work on flood warning, flood awareness, and expenditure needed to maintain and replace the 330 km of walls, embankments, flood barrier and gates.
- It will inform the work and expenditure of our partners who are responsible for flood planning and recovery such as local authorities, 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.

The consultation on the Plan will close at the end of June 2009. During the summer and autumn of 2009 we will finalise our Plan and it will be submitted to Government in January 2010.

Chapter 2: The Thames estuary – tidal flood risk today



Chapter 2: The Thames estuary – tidal flood risk today



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 from the deep ocean reaches the relatively shallow parts of the North Sea just outside the Thames estuary. On top of this, strong northerly winds can increase the height of the surge. A surge tide entering the Thames estuary can increase water levels by over 1 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

Chapter 2: The Thames estuary – tidal flood risk today



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
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



Newspaper headline following 1953 flood

Chapter 2: The Thames estuary – tidal flood risk today

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, 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 m.

Source of data: Well placed to deliver? The Lyons Review of Public Sector relocation, HM Treasury, July 2004

What is at stake? 2: Commerce

London is the UK's largest urban cluster of economic activity, contributing some £250 bn 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: GVA estimates from London's Economic Outlook, GLA

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

A large number of London's most significant cultural assets are within the natural Thames floodplain, the defence of which will come under increasing pressure with climate change. The following are examples of assets which lie in the floodplain and which could be affected by a major tidal flood which overwhelms existing defences:

- Westminster Abbey* and Cathedral
- Palace of Westminster* and Parliament Square
- St James' and Battersea Parks
- Tate Gallery and Tate Modern
- Lambeth Palace
- Festival Hall, the South Bank Centre and the Globe
- Tower of London*
- Maritime Greenwich* and the Millennium Dome
- Bishops Park and Fulham Palace
- Royal Botanic Gardens, Kew*
- Chiswick, Syon and Ham Houses



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 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 bn per annum.

Sources: Environment Agency flood mapping; The environment and the economy, GHK Consulting, 2006. Photo: www.westminster-abbey.org

* Part of UNESCO world heritage sites

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 (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.

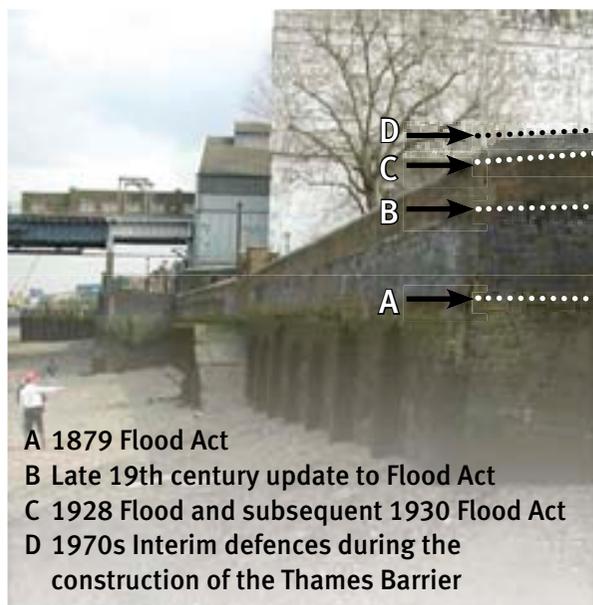
Sources of data and photo: Port of London Authority

What 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 five metre 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



Response to floods past: river wall at Greenwich

London Flood Acts was passed following a series of damaging floods in London during the 19th century.

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.

Chapter 3: Current flood risk management

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.

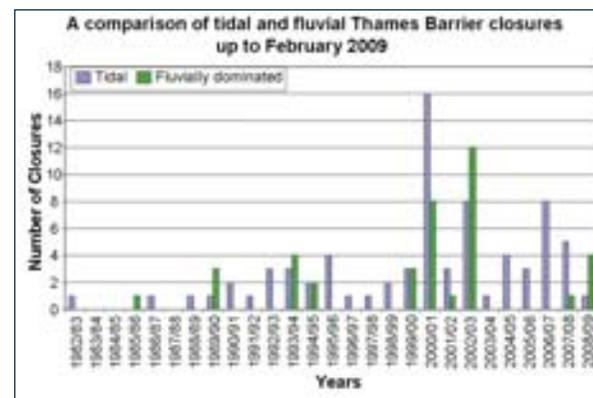


We, the Environment Agency are responsible for delivering sustainable flood and coastal erosion risk management solutions and for overseeing the delivery of local solutions by others. Our job includes:

- 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:

- 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.



25 Years of Thames Barrier closures

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 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.

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 uncertain³. In addition, freshwater flood flows from tributaries that drain into the Estuary will increase through 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 project⁴ 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.

³ For example, A 20th Century acceleration in global sea level rise. Church, J A & White, N J Geophysical Research Letters, 33 L01602, 10.1029/2005GL024826

⁴ Foresight – Future flooding, Scientific summary: Volume II Managing future risks, Team led by E P Evans on behalf of the Office of Science and Technology, April 2004

Chapter 4: The Thames estuary is changing

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 Planning Policy Statement 25 on Development and Flood Risk 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

Chapter 4: The Thames estuary is changing

Responding to the changing estuary

In responding to these challenges our aim is to develop a flood management system that does not become a burden for future generations and 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 provide 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 measures and options against differing climate change scenarios so that if we face an acceleration in water levels, beyond current predictions, we will know how effective these options will be and whether we would 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

Chapter 4: The Thames estuary is changing

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.

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 20cm and 90cm.
- 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 by around 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. 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 will also inform the Marine section of the forthcoming UK Climate Projections 2009 Report (UKCP 09).

Climate change mitigation: The more extreme the climate change scenario, the more costly will be the flood risk management measures to adapt to it. 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 and there is not a great deal to choose between the options, but it is important to recognise publicly the need for a “carbon footprint-aware” culture.

Without effective mitigation future generations in London and the Thames estuary may have to deal with climate change which exceeds our +2.7 m extreme scenario by 2100.