Thames Estuary 2100

Managing flood risk through London and the Thames estuary

Strategic Environmental Assessment

Environmental Report Summary

April 2009

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April 2009

Introduction

This is the non-technical summary of the Environmental Report that accompanies the Thames Estuary 2100 (TE2100) Flood Risk Management Plan for Consultation. This consultation runs from **1 April 2009 until 30 June 2009**. You can view this document and the Thames Estuary 2100 Plan for Consultation by logging on to www.environment-agency.gov.uk/te2100

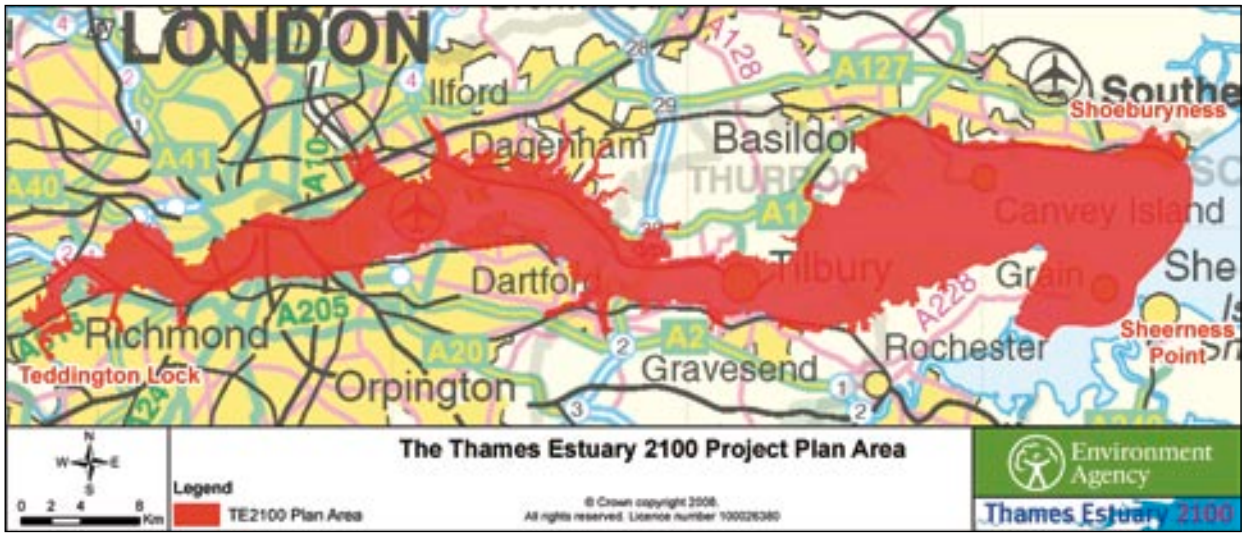
Hard copies of the full TE2100 Environmental Report and the TE2100 Technical Report are available at a location near you. For more information contact us by email on te2100@environment-agency.gov.uk or by telephone on 08708 506 506.

The TE2100 Project

TE2100 is an Environment Agency project to create a long-term flood risk management strategy for the tidal Thames. The TE2100 area includes the Thames Estuary, its tidal tributaries and floodplain from Teddington to a line between Shoeburyness and Sheerness. It covers about 500,000 homes and 40,000 non-residential properties, including key government and financial centres in London. The Estuary is also important environmentally, and is one of the five most important estuaries in Europe for birds.

Today protection against flooding from the sea is provided by walls, embankments, barriers, gates and other flood defence structures. These structures were designed to protect against a 1-in-1,000 year flood in 2030 for most of the TE2100 area; some less developed areas have lower standards, for example Grain, North Kent Marshes and parts of the Southend frontage. Protection against flooding from upstream is provided by walls along the Thames, and walls, culverts and local flood storage along tributaries.

The present flood defences are gradually deteriorating, and will reach the peak of their design lives over the next 20 to 30 years. This, coupled with the potential for an increased frequency and severity of flooding due to socio-economic change and climate change, has led to the development of the TE2100 project. This project aims:



> **"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 and addresses the issues in the context of a changing climate and varying socio-economic conditions that may develop over the next 100 years."**

Our Objectives

The main objectives of the TE2100 Plan are:

- to reduce the risk of flooding to people, and to 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.

The Plan describes a programme of flood management measures for the Thames Estuary which includes:

- our vision for tidal flood risk management for London and the Thames Estuary which seeks to optimise sustainable solutions with multifunctional benefits;
- an action plan and investment programme of strategic flood management options covering the short, medium and long term;
- a clear explanation of how the Plan is adaptable to the uncertainty of a changing future environment – including the changing climate and varying socio-economic scenarios that may develop over the next 100 years.

The Plan provides a strategic framework through to the end of the century together with the strategic direction for flood risk management for all parts of the Plan area. It also provides guidance on the flood risk management activities that will be required over the short, medium and long term.

Our options for future flood risk management

Following a process of screening and use of strategic environmental assessment throughout the early stages of the project, ten estuary-wide options were identified. These have been devised and tested for effectiveness and efficiency in delivering our strategic vision and a rolling programme of construction work and related activities has been defined from 2010 to 2069. These options are shown in table 1 on the following page.

Some additional components would be common to all of the options, including provision of new intertidal and freshwater habitat to make up for the loss of existing habitat, floodplain management such as emergency and spatial planning and the management of increasing fluvial flood risk in West London.

Conclusions following assessment and appraisal

Our appraisal shows that Option 1.4 – maintaining the current system of defences through optimising the defence repair and replacement regime – is the optimum approach for the first 60 years of the Plan under current government guidance on climate change.

From 2070, the options diverge. It is too early to make a definitive choice now for activities 60 years hence, but our appraisal has examined the options against each other based on today's conditions. There are currently two front-runners: Option 1.4 (optimise defence improvement), which is the preferred environmental option, and Option 3.2 (new barrier at Long Reach) the preferred option identified from the economic appraisal. This has been included in our 100-year Plan – recognising that these end of the century options will have to be reappraised nearer to the time of implementation.

Table 1. Final options that underwent assessment and appraisal

Policy P3. Maintain the current level of flood risk management	**Continuing current flood risk management activity**
Option 1. Improve the existing defences. 1.1. Raise defences when needed. 1.2. Allow for future adaptation when replacing or raising defences. 1.3. Raise defences when they are replaced. 1.4. Optimise the defence repair and replacement regime.	Four different sub-options were considered, involving different maintenance schedules, and different ways of deciding when and by how much walls should be raised.
Option 2. Tidal flood storage.	Storing tidal waters at Erith Marshes, Aveley and Wennington Marshes, Dartford and Crayford Marshes, and Shorne and Higham Marshes during very large surge tides would help to reduce extreme water levels at the Thames Barrier.
Option 3.1. Barrier at Tilbury. Option 3.2. Barrier at Long Reach.	Barriers would be designed to resist the highest surge tides predicted under the Defra climate change scenario. Both options assume that the barrier can only be closed a certain number of times per year, so there would still be a need for defence raising.
Option 4.1. Barrier with locks at Tilbury. Option 4.2. Barrier with locks at Long Reach. Option 4.3. Barrier with locks at Thames Barrier (when closures/year approach 50).	Barriers with locks can have two gates per bay, so that if one fails there is a back-up. As such they are essentially 'fail-safe' and can be closed as frequently as necessary. They would also allow ships to pass when the barrier is closed.

Considerations for implementation of the TE2100 Plan

There are three phases of implementation, each with a different theme. The dates are based on Defra climate change guidance, and could be adapted to future climate, socio-economic or environmental change.

Phase 1: The first 25 years (2010 – 2034) – *"Maintaining confidence and planning together"*

Phase 2: The middle 35 years (2035 – 2069) – *"Renewal and reshaping the riverside"*

Phase 3: The final 30+ years from 2070 – *"Preparing for, and moving into the 22nd century"*

TE2100's approach follows government policy on flood risk management, detailed in *Making Space for Water* (Defra 2004). This requires flood risk management plans to not only be technically robust, but also to integrate socio-economic and environmental factors. It puts greater emphasis on living with and adapting to flood risk and storage of flood water rather than building ever bigger and higher defences to combat climate change. Clearly, TE2100 must consider flood risk to existing people and property, however, the expansion of new homes and jobs planned over the next few decades, will increase the consequences of any flood event.

Our Plan is also guided and constrained by environmental and other legislation. Key amongst these are the Birds and Habitats Directives, which aim to protect the 'integrity' of internationally-important nature conservation sites, and the Water Framework Directive, which aims to maintain and improve the water environment.

Strategic Environmental Assessment (SEA) environmental report

Developing an understanding of the effects on the environment of measures contained in the TE2100 Plan and the steps that can be taken to mitigate these has been achieved by undertaking:

- **Strategic Environmental Assessment (SEA).** This is a systematic process of evaluating the potential environmental consequences of a policy, plan or programme before it is approved.
- **Habitats Regulations Assessment (Appropriate assessment).** This tests whether a plan is likely to have an impact on the integrity of any Special Protection Areas (SPA) for birds, Special Areas of Conservation (SAC) for habitats and species, Ramsar wetland sites or European Marine sites. And,
- **Water Framework Directive Assessment.** This assesses the potential of the plan to cause deterioration in the 'Ecological Potential' of the Tidal Thames Estuary.

All three elements of the assessment are contained in the SEA Environmental Report and its supporting annexes. An SEA is a legal requirement for major projects and strategies such as our TE2100 Plan. 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; preparing an Environmental Report that documents the above information; consulting the public and authorities with environmental responsibilities; and monitoring significant environmental effects of implementing the Plan.

Timing & influence of the SEA process

The SEA was undertaken alongside the development and drafting of the TE2100 Flood Risk Management Plan (FRMP). The first stage involved developing and assessing strategic alternatives, and this work was used to help shape early thoughts on the content of TE2100 Flood Risk Management Plan. At key milestones throughout the development of the Plan interim assessments of policies and options to manage flood risk have been undertaken to highlight key issues for further development. This has helped identify opportunities for policy amendments, environmental mitigations and enhancements throughout the development of the TE2100 Plan, and has been carried forward through to the final plan for consultation. We consulted with the two Statutory Consultation bodies Natural England and English Heritage on the findings of the assessment of alternatives, and the results of the interim assessment of the emerging draft document.

Influence of SEA on the screening of options

As a result of the ongoing strategic environmental appraisal of options several options were rejected at various stages:

- Barriers, or barriers with locks, at Leigh or Shoeburyness were rejected due to high costs and adverse commercial and environmental impacts.
- A tide-excluding barrage at Tilbury was rejected due to its impacts on navigation. It would also have severe environmental impacts.
- Dredging and channel widening in West London was rejected due to its severe ecological impacts.
- Floodplain management alone was rejected as it cannot manage the predicted increase in flood risk.

Steps in delivering the SEA environmental report

For the purposes of this SEA, a broad definition of 'environment' has been adopted, which goes beyond the purely biophysical environment, to include social and economic considerations.

The SEA process has needed to be flexible to deal with the different levels at which the Plan has considered the issue of flood management in the Estuary, i.e. from high level policy appraisal through to a detailed strategy and action plan setting out options to manage flood risk. This has been reflected in the level of detail and the assessment methodologies used at these various different levels. Table 2, on the following page demonstrates the interrelationship between the overall project and SEA phased outputs. These are described in more detail below.

Table 2. Major project and SEA outputs

Phase	Description		Year						
			02/03	03/04	04/05	05/06	06/07	07/08	08/09
0	Project Preparation		Phase 0						
1	Project Scoping			Phase 1					
2	Understanding the Estuary				Phase 2				
3	Policy & Options Investigation & Appraisal						Phase 3		
4	Plan Finalisation								Phase 4
Outputs	**Project**	**SEA**							
	Project Appraisal Report Phase 1	Environmental Legislative Framework initially scoped							
	Project Appraisal Report Phases 2–4	SEA Screening and Broad Methodology established							
	Phase 1 Report	SEA Progress Chapter							
	Strategy Envelope	SEA Scoping							
	Early Conceptual Options (ECO)	Environmental Assessment (ECO annex R7)							
	Policy Appraisal	Policy Appraisal Packs							
	High Level Options (HLO)	Environmental Assessment (HLO Annex 5)							
	Phase 3 set 1 Options	Multi Criteria Analysis							
	Consultation Plan	Environmental Report							
	Final Plan								

Implementation of the SEA process

Phase 0: During Phase 0, a comprehensive programme of project development workshops and preliminary scoping was undertaken to investigate the current state of knowledge and stakeholder requirements in the Thames Estuary. These workshops helped inform and focus the Phase 1 studies programme. The SEA Directive had not come into force at the commencement of the project, however it was anticipated that the project would not only require the application of SEA but would benefit from its application regardless of the legal imperative. The application of SEA was included in the business case set out in TE2100 Project Appraisal Report.

The **Phase 1** programme focussed on developing the SEA approach and establishing the baseline socio-environmental conditions of the study area. This was essential for predicting the impact of the possible range of flood risk management policies and options that were later assessed. The phase 1 studies programme was developed to provide the information required for the preliminary stages of the SEA process and production of the scoping document.

With regard to the implementation of the SEA studies programme, the key requirements of this stage of the SEA process were implemented as part of the Environmental and Social frameworks studies. The fundamental objective of the studies programme was to gather baseline information to broadly characterise the study area. More detailed studies were also undertaken during phase 1, for areas where a greater level of detail was felt to be required.

In order to determine the broad environmental baseline a number of studies were commissioned to establish the environmental context of the Estuary with regard to its form, function and

legislative context. The form relates to the baseline environmental condition within the Estuary i.e. habitats, species and water quality. The function being, the linkage between the form and the natural estuary processes. It was important to make this distinction, since natural change and most importantly flood management interventions could impact upon the form and function of the Estuary or could change the composition of features of natural interest in the Estuary.

From a social perspective a number of studies were commissioned in phase 1 to scope and establish the social aspects of the Thames Estuary in particular, commercial and recreational use of floodplain and river. The social function

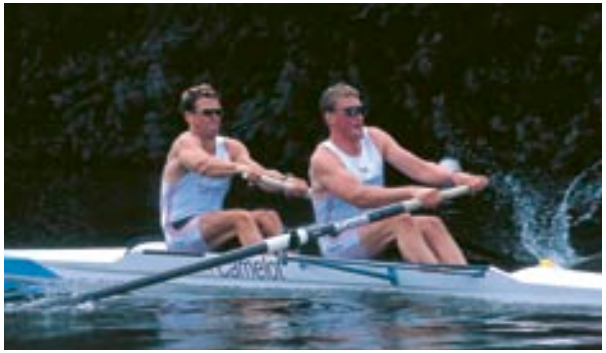
corresponds to the livability requirements of the floodplain and river, as well as the connection of the land to the water space and vice versa.

Phase 2 studies programme March 2004 – March 2006 further developed the Phase 1 baseline and developed a range of sensitivity frameworks (Recreation & Heritage) required for the development and appraisal of options. Production of the Greater Thames Coastal Habitat Management Plan (CHaMP) in collaboration with Natural England began during this studies phase.

The SEA Scoping Report was issued for external Statutory Consultation in November 2005 for a 12-week consultation period. Feedback on the report was received from all three Statutory Consultation Authorities in January 2006. All comments were recorded and taken into consideration in the final Scoping document (June 2006) and finalisation of the SEA objectives used to develop and assess various stages of the plan development.

The SEA objectives shown in table 3 have been used to analyse the effects of the Plan and to compare options, and they will also be used to monitor the actual effects of TE2100.

Phase 3 studies programme March 2006 – September 2008: The Phase 3 studies programme



differed from previous studies programmes as it concentrated on gaining a greater understanding of the implications of the range of Policy and Flood Risk Management options. This Phase of studies completed the development of the project's sensitivity frameworks (Ecological sensitivity) and updated baseline information, particularly land use and landscape. The Greater Thames CHaMP was completed during this phase and the projected habitats gains and losses on the Thames provided a key component for the identification of sites for habitat replacement as a result of the existing alignment of tidal defences.

Options prediction and evaluation method

Throughout the project key milestone reports have been subjected to an interim assessment against the SEA objectives to highlight key issues for further development. These have included:

- Early Conceptual Options (June 2006)
- High Level Options (March 2007)
- Phase 3 Options (March 2008)
- Consultation draft Options (December 2008).

The environmental assessment of flood risk management options involved:

- identifying environmental constraints and opportunities;
- establishing associated strategic environmental objectives;
- identifying the probable effects, and magnitude of these, that would arise from flood risk management options. This includes both negative and positive effects;
- evaluating the significance of these predicted environmental effects;
- proposing strategic mitigation measures to offset negative effects and enhancement measures to maximise positive effects.

Table 3. SEA objectives and linked policies, plans and environmental objectives

SEA objectives	Linked policies, plans, objectives
To reduce the risk of flooding to people, and minimise the adverse impacts of flooding to property and the environment	
To avoid adversely affecting human health; to maintain, and where possible enhance, safety	PPS25 Development and Flood Risk; Thames Catchment Flood Management Plan; Defra Sustainable Flood Risk Management – Making Space for Water; East of England draft RSS SS14; Draft South East Plan CC2; London Plan 4C.2; Civil Contingencies Act
To reduce flood risk to properties	
To ensure equity of access and impacts	South East Plan S1
To adapt to the challenges that we will face from climate change	
To reduce and manage water levels and flood risk resulting from climate change alone or in combination with other responses	Climate Change – UK Programme; London Plan 4A.15; East of England draft RSS ENV6; Draft South East Plan CC2; London Climate Change Partnership and GLA Adaptation Strategy
To avoid imposing a significant constraint on future choices in integrated flood risk management	Draft South East Plan; East of England draft RSS; London Plan
To support & inform the land use planning process to ensure appropriate, sustainable & resilient development in the tidal Thames floodplain	
To protect, and where possible enhance, water resources	Water Framework Directive; Catchment Abstraction Management Strategies: South Essex, Medway, London, Roding/Beam/Ingrebourne, Darent
To avoid adversely affecting existing land uses, and promote flood-resilient and compatible land uses within the Estuary	Draft South East Plan NRM1; NRM3; CC; London Plan 4C.5: resist impounding of rivers; London Plan 4C.7: development set back from flood defences; East of England draft RSS ENV6
To protect the cultural and commercial value of the tidal River Thames, its tidal tributaries and its floodplain	
To maintain, and where possible improve, the opportunities and facilities for recreation on the Estuary, both formal and informal	Countryside and Rights of Way Act; PPG17 Sport and Recreation; Draft South East Plan C4; TSR7; S3; East of England draft RSS TG/SE4, ENV1; C4; London Plan 3C.20, 3D.5, 3D.7-11, 4C.16-19; Sustrans Connect2
To avoid adversely affecting employment and commercial interests within the Estuary	London Plan 3D.14
To protect, and where possible enhance, the historic environment of the Estuary	Ancient Monuments and Archaeological Areas Act; PPG15 Planning and the Historic Environment; PPG16 Archaeology and Planning; London Plan 4B.10-14, 4C.3, 4C.10-11; East of England draft RSS ENV5

(continued overleaf)

SEA objectives	Linked policies, plans, objectives
(continued) To enhance the landscape character and visual amenity	PPG2 Green Belts; Draft South East Plan C3; London Plan 4B2, 4C.4, 4C.20; London Landscape Strategies, Hampton–Kew, Kew–Chelsea; Thames Strategy East
To enhance and restore estuarine ecosystems to contribute to biodiversity targets and maximise the environmental benefits of natural floods	
To maintain, and where possible enhance, ecological functions within the Estuary and key ecologically relevant processes	Bern Convention; Bonn Convention; Ramsar Convention; Habitats Directive; Birds Directive; Water Framework Directive; UK Biodiversity Action Plan; Wildlife and Countryside Act; PPS9 Biodiversity and Geological Conservation; Coastal Habitat Management Plans: Essex Coast, North Kent Estuaries and Marshes; Draft South East Plan NRM4; London Plan 3D.12, 4C.3
To protect, and enhance, biodiversity within the Estuary	
To maintain, and where possible improve, water quality	Water Framework Directive; Shellfish Water Directive; Water Resources Act 1991; London Plan 4A.12-13, 4A.16; East of England draft RSS ENV3

Prediction in SEA is based on assessing to what extent each option would comply with the agreed strategic environmental objectives, by analysing their effects on the baseline, using indicators. This methodology is based on the widely accepted source-pathway-receptor (SPR) model and is broken down into four stages:

- Stage 1 Predicting environmental effects using the source-pathway-receptor model.
- Stage 2 Documenting the predicted effects of each of the strategic options in tables, matrices or documents.
- Stage 3 Evaluating the significance of effects by comparison with the environmental objectives.
- Stage 4 Aggregating impact significance to allow a comparison between strategic options.

The likely significant effects on the environment were predicted using a combination of:

- modelling studies
- expert knowledge groups
- workshops
- scoping consultations
- environmental framework studies
- socio-economic studies.

Summary tables were used to document impacts of each flood risk management option. The prediction of environmental effects, both qualitative and quantitative, on receptors, formed the basis for evaluating the significance of impacts. It should be noted that as the impact categories (environmental/social/economic) vary, so do the criteria used to assess the significance of the associated impacts. Where significance criteria were already established (for example for recreation and heritage sensitivity) these were incorporated within the assessment process. In other areas, where no standard set of significance criteria existed, they were developed by expert judgement.

In defining the magnitude of impacts, consideration was given to any legislative or policy standards or guidelines, and the following factors:

- The degree to which the environment may be affected, e.g. whether the quality may be enhanced or impaired;
- The scale of the change, e.g. the size of land area or number of people affected and degree of change from the existing situation; and
- Whether the effect may be temporary or permanent.

Impacts are categorised as being either High, Medium or Low, Positive or Negative or Neutral. Finally, the impacts between strategic options are compared by aggregating the significance of impacts on receptors. Further details on the prediction and evaluation methodologies used can be found in Chapters 4–14 of the Technical Environmental Report.

The full Strategic Environmental Assessment report

Structure

The first three chapters of our Environmental Report provide background information on TE2100 and the SEA process. The report then considers the main impacts of TE2100 in the following chapters:

- Biodiversity, flora, fauna and soils – chapter 4
- Commerce and economy – chapter 5
- Health and social – chapter 6
- Historic and cultural – chapter 7
- Infrastructure – chapter 8
- Land use and landscape – chapter 9
- Recreation and open space – chapter 10
- Water and hydrogeomorphology – chapter 11.

Chapter 11 contains the results of the Water Framework Assessment of Plan options. Information from the Habitats Regulations Assessment, which is required by the European Habitats Directive, is presented in chapter 12. The Report concludes by pulling together all of this data into a comparison of options and information about key impacts of the TE2100 Plan: these are shown in chapter 13.

The Environmental Report summarises information from a wide range of background reports prepared over the Plan's evolution and uses a 'topic-based' approach. For each topic e.g. biodiversity, the Report answers a series of questions (see table 4).

Table 4. Assessment questions and relationship to requirements of the SEA directive

Questions for each topic	Key requirement of the SEA directive	
What is the policy context?	Relationship of the Plan with other relevant plans and programmes (Annex I(a))	Annex 1(a)
What are the key sustainability objectives we need to consider?	Environmental protection objectives and how they have been taken into account during Plan preparation	Annex 1(e)
What is the situation now?	Relevant aspects of the current state of the environment; environmental characteristics of areas likely to be significantly affected	Annex 1(b) and (c)
What will be the situation without the Plan?	Likely evolution of the environment without implementation of the Plan	Annex 1(b)
What would be the situation under TE2100?	The likely significant effects of the Plan on the environment	Annex 1(f)
How can we mitigate/ enhance effects?	Measures envisaged to prevent, reduce and as fully as possible offset any significant adverse effects on the environment of implementing the Plan	Annex 1(g)

Table 5. Summary of significant impacts of all the Plan options

Short- and medium-term impacts
All options: Short-term, localised negative impacts on health/wellbeing, commerce/economy, recreational access and biodiversity as a result of implementing the options.
Long-term impacts
Continuing with the current management of flood risk (Policy P3): Over time, increasing flooding of houses, businesses and infrastructure, to the point of significant negative impacts. Loss of intertidal habitat due to coastal squeeze.
Improving the existing system (Option 1): Long-term increased flood risk and decreased water quality due to increased need for barrier closure; long-term effect on views and access to and from the river in many areas. Loss of intertidal habitat due to coastal squeeze.
Introducing tidal flood storage areas (Option 2): As for option 1, though could delay the need for some new wall raising upstream of the Thames Barrier.
Creating a new barrier at Tilbury or Long Reach (Option 3.1 or 3.2): Significant long-term negative impacts on biodiversity, water quality and commercial use of the river associated with increasing barrier closures. Less need for wall raising upstream of the new barrier means that health/wellbeing, recreation and landscape will be less negatively affected than under options 1 or 2. Minor long-term health/wellbeing and landscape disbenefits for people living downstream of the barrier. Loss of intertidal habitat due to coastal squeeze.
Barriers with locks at Tilbury or Long Reach (Option 4.1 or 4.2): Fewer impacts on commercial use of river than option 3.1, but water quality and biodiversity impacts could happen sooner due to no limit on the frequency of barrier closures.
Temporary impacts
Improving the existing system (Option 1): Loss of access to/from the river is possible, but could be mitigated.
Introducing tidal flood storage areas (Option 2): Temporary impacts to biodiversity, landscape and access to flood storage areas during and after flood events. Loss of access to/from the river is possible, but could be mitigated.
Permanent impacts
Improving the existing system or introducing tidal flood storage areas (Options 1 or 2): Possible permanent loss of historical/cultural interest or ecological habitats, depending on the footprint of the wall and sensitivity of the receiving environment. Permanent reduction or loss of views and access to and from the river in many areas, particularly from the water side.

(continued)

(continued)

Creating a new barrier at Tilbury or Long Reach or barriers with locks at Tilbury or Long Reach (Options 3.1, 3.2, 4.1 and 4.2): Permanent landscape/visual impacts of a new barrier: could be positive if iconic structure, negative if not. Permanent change to the hydrogeomorphology and biodiversity of the Estuary in the medium to long term (faster if there are more barrier closures); these may be very significant for sites of international nature conservation importance.

Converting Thames Barrier to incorporate locks (Option 4.3): As for option 4.2. Negative impact on the iconic structure of the Thames Barrier and on the landscape context of the Woolwich Arsenal works.

Secondary impacts

All options except continuing with the current management (Policy P3) promote/support further development in the TE2100 area. This would be beneficial economically and socially if the defences are not breached, but increased development potentially increases the consequences in case of a breach. Further housing increases the need for further employment and vice versa.

All barrier options (Options 3.1, 3.2, 4.1, 4.2 and 4.3): These options further promote/support development upstream of the barrier.

Brief overview of the SEA report findings

Table 5 summarises the significant impact of all the plan options, and table 6 overleaf gives a more detailed assessment which includes the various impact categories. The impacts are graphically summarised using a traffic light system. For more in depth analysis of the impact of the options please refer to the full Environmental Report.

- Positive or neutral impact
- Significant negative impact
- Severe significant negative impact

Table 6. Detailed assessment of significant impacts

Impact/topic categories	Option P3 Maintain the existing	Option 1 Improve the existing	Option 2 Tidal Flood Storage	Option 3.1 Tilbury Barrier
Biodiversity	Likely progressive change to existing biodiversity with a more brackish and saline floodplain environment expected in the outer Estuary; and higher groundwater levels in areas adjoining the upper Estuary river channel. Sea level rise results in coastal squeeze and loss of intertidal habitat (designated in the outer Estuary).	Where space allows, walls can be set back to create intertidal habitat, and also designed to increase biodiversity interest or other sustainability considerations. For the most part the line of defence will remain as it is today and due to sea level rise there will be increased losses of intertidal habitat.	Due to infrequent use of areas of flood storage, existing freshwater interest are likely to be maintained. Could delay the need for new wall construction upstream. Loss of intertidal habitat will continue due to sea level rise and coastal squeeze.	Potential adverse effects on wintering shore bird populations (due to reduced tidal range and intertidal exposure) and fish movements (from poor water quality) when frequency of closure is very high. Loss of intertidal habitat will continue due to sea level rise and coastal squeeze.
Commercial & Economic	Flooding will increase over time affecting infrastructure and reducing commercial viability (exacerbated by Regeneration of Thames Gateway). No significant impact on commercial use of the river, although developments which use the river may themselves be vulnerable.	No significant effect.	Minor impact on agricultural use of flood storage sites. Loss of opportunity to use those sites for commercial and economic activity.	Barriers would support upstream economic activity regeneration but also increase risk if the barrier fails. Barrier closures would restrict river-based commercial traffic, particularly in the long term.
Health & Social	As flood risk increases over time, the risk to life increases, with associated issues of health and well-being, psychological issues of living with flood risk, recovery after flood risk, loss of property, loss of community spirit and sense of place. Social infrastructure such as hospitals and community centres is also more likely to be affected by flooding over time.	Increasing enclosure and loss of view makes the area less pleasant to live in, with consequent impacts to people's health and wellbeing. The greater differential between the river level and the landward side ground level would make the impact of the breaching/floods more severe.	As for Option 1. Flood storage areas can also bring flooding closer to areas not currently subject to flooding, yet increase opportunities for access to open space, with associated benefits for health and wellbeing, and increase people's awareness of flood risk and hence their precautionary behaviour.	Broadly as Option 1 for residents downriver of Tilbury (although slightly more so), and in West London due to fluvial flooding. Areas upriver benefit from either no or lower scale of wall raising. Barriers would promote upstream development thus supporting social benefits of increased housing where people want to live but also increased risk to lives if the barrier fails.
Historic & Cultural	As risk increases through the century, risk to historical and cultural assets (e.g. Kew Gardens, Greenwich Maritime) also increases.	No significant effect.	Any archaeology in areas that will be used for flood storage could be further affected from wetting and drying. Process of emptying the storage areas after flooding could expose and wash away historic interest.	Marginal reduction in flood risk for historic and cultural interest upstream of Tilbury. In time, use of river as transport corridor and working tidal river would be affected due to increasing number of barrier closures.

Option 3.2 Long Reach Barrier	Option 4.1 Tilbury Barrier with Locks	Option 4.2 Long Reach Barrier with Locks	Option 4.3 Thames Barrier with Locks
As for Option 3.1.	As for Option 3.1 but likely to result in higher risk of impacts occurring due to increased closure frequency.	As for Option 4.1.	Progressive change to a freshwater ecological system.
As for Option 3.1 but over a smaller area.	Impacts to commercial uses of the Estuary kept to a minimum by inclusion of barrier locks. However, shipping may be affected at times of high volume or maintenance of structure. Barriers would support upstream economic activity but also increase risk if the barrier fails.	As for Option 4.1 May support the development of less floodplain (i.e. between Long Reach and Tilbury, depending on risk tolerance).	As for Option 4.1 Would not support additional development (depending on risk tolerance).
As for Option 1 for residents downriver of Long Reach , and those (in West London) affected by fluvial flooding. Fewer homes protected than Tilbury; more require greater wall raising.	As for Option 3.1; greater security if there are no failures to the structure. However if there is a failure, then impacts would be much worse than 3.1.	As for Option 1 for residents downriver of Long Reach , and those (in West London) affected by fluvial flooding. Fewer homes protected than under Option 4.1; more require greater wall raising. Greater security upstream of Long Reach if there are no failures to the structure; however if there is a failure, then impacts would be much worse than Option 3.2.	As for Option 1 for residents downstream of Thames Barrier and those (in West London) affected by fluvial flooding. Greater security upstream of the barrier if there are no failures to the structure; however if there is a failure, then impacts would be much worse than Option 1.
Marginal reduction in flood risk for historic and cultural interest upstream of Long Reach. In time, use of river as transport corridor and working tidal river would be affected due to increasing number of barrier closures.	As for Option 3.1.	As for Option 3.2.	Impacts positive or negative depending on design. **(continued overleaf)**

Table 6. Detailed assessment of significant impacts

Impact/topic categories	Option P3 Maintain the existing	Option 1 Improve the existing	Option 2 Tidal Flood Storage	Option 3.1 Tilbury Barrier
Infrastructure	As flood risk increases through the century, effects on infrastructure increase.	No significant effect.	No significant effect.	Minimal; the design of the barriers would minimise the disruption to wharves, jetties and piers.
Land use & Landscape	More frequent inundation would change character of historic landscape.	Significant and permanent local effects on landscape, particularly in West London (wall raising changes the natural riverbank to a man-made one) and the relatively open/clear views of some historic buildings (e.g. in Greenwich).	Landscape in areas used for flood storage would change from open to more enclosed. Flood storage areas deter development and may defer the need to raise walls elsewhere, and reduce landscape impacts.	Less wall raising needed upstream of barrier than for Options 1 or 2. Option would support further development in the area, which would also have landscape impacts.
Recreation & Open Space	Over time recreational open spaces become inundated with increasing regularity through overtopping of defences and are no longer available. Water-based recreational facilities (e.g. rowing clubs) would be flooded with increasing regularity, and may become unviable over time.	Positive impacts for land-based recreation where land is protected by well-designed walls, including foot and cycle paths along the defences. Impact on water-based recreation could be negative if new defences limit access to land or change the hydromorphology (e.g. for fishing).	Land lost during flooding but very infrequently. Some wall raising required as Option 1. Flood storage defences can be used to improve recreational access to riverside areas. Flood storage areas can be used for improved amenity.	Protection afforded by barrier means more land can be used for recreation. Barrier open: no significant effect on water-based recreation; Barrier closed: access to up/downstream recreation would be prevented. Impact increases over time as barrier closed more frequently.
Water & Hydromorphology	Coastal squeeze ongoing, driven by sea level rise and existing line of defences. Where contaminated areas are exposed to increased frequency of flooding, potential for contaminants to be mobilised and redistributed. Outer Estuary becomes more brackish and saline. In later epochs major water quality impacts likely in upstream reaches due to inputs from STWs and increased frequency of closures of the Thames Barrier.	Broadly as for P3, but coastal squeeze exacerbated if encroachment occurs; lower potential for contaminant mobilisation; and reduced risk of water quality impacts in the upstream reaches due to lower frequency of barrier closures with this option. In later epochs frequency of closures increases as does the concomitant risk.	As for Option 1.	As for Option 1. Structures in the river may lead to impacts on the integrity of the Thames Estuary Marshes SPA. Water quality risks derive from both discharges from sewage treatment works and thermal discharges from power stations.

Option 3.2 Long Reach Barrier	Option 4.1 Tilbury Barrier with Locks	Option 4.2 Long Reach Barrier with Locks	Option 4.3 Thames Barrier with Locks
No significant effect.	Locks in barriers would allow ships to pass through even when the barrier is shut, but likely to have residual effects on port operations upstream of Tilbury.	As for Option 4.1 but does not affect port operations so much, and favoured by Port of London Authority over Option 4.1.	As for Option 4.2 but does not affect port operations so much.
Broadly as for Option 3.1, but more wall raising and supports development over a smaller area, with consequent landscape impacts.	As for Option 3.1, but less wall raising needed upstream of Tilbury because of assumptions about fail-safe nature of barrier with locks. Slightly higher walls needed downstream of barrier than for Option 1.	As for Option 4.1, but would reduce need for wall raising between Thames Barrier and Long Reach, and require slightly higher wall raising downstream of Long Reach.	Would require slightly higher wall raising downstream of Thames Barrier. Negative effect on an iconic landmark (Thames Barrier) and on the landscape context of the Woolwich Arsenal works.
Broadly as for Option 3.1. Less wall raising needed upstream of barrier than for Options 1 and 2; more than for Option 3.1.	Localised (potentially significant) impact to recreation from disruption to riverside path near to structure under construction and from wall raising, to a lesser extent than Option 1. As for Option 3.1 for water-based recreation.	As for Option 4.1, but would require wall raising over longer distance downstream. This would reduce the possibilities for access/egress from the river, and would enclose the riverside more, thus less recreational benefit.	As for Option 4.2, but would require wall raising over still longer distance downstream. This would reduce access/egress considerably more than 4.2, and would enclose the riverside even more.
As for Option 1. Structures in the river may affect local hydrogeomorphology. Water quality risks derive from discharges from sewage treatment works into smaller mixing volume than Option 3.1.	As for Option 3.1 but increased risk of water quality impacts due to more frequent barrier closures.	Broadly as for Option 3.2, but increased risk of water quality impacts due to more frequent barrier closures.	Hydromorphological change driven by sea level rise and existing line of defences causing coastal squeeze and reduction of total intertidal exposure. Increased risk of water quality impacts upstream of structure compared to Options 4.1/4.2 due to smaller mixing volume.

SEA report conclusion

The conclusion of the SEA and HRA (Appropriate Assessment) and WFD (Water Framework Directive) process is that the environmentally-preferred option is Option 1.4 – improving the existing defence system through optimising the defence repair and replacement regime – both pre- and post-2070. The post-2065 preferred option identified by the Multi Criteria Analysis – Option 3.2 Constructing a new barrier at Long Reach – would, on existing evidence, most likely fail a WFD assessment because all the clauses of article 4.7 of the Directive could not be applied. The likely deterioration of the water body would therefore not be defendable under the terms of the Directive.

This is due to the fact that the costs of the options are all similar in magnitude and there is only a slight cost/benefit advantage to Option 3.2 over the other options. This, coupled to the fact that all of the post-2065 options deliver a similar benefit for FRM, means that the project cannot demonstrate that the other options are disproportionately costly, nor technically infeasible. If however, the situation changes as a result of a reduction in the uncertainty in climate and socio-economic change, along with greater certainty in the costs and performance of the barrier options, then it is possible that these tests may be passed in the future. For this reason the plan proposes two front-runners rather than a single preferred option post-2065.

Impact mitigation and enhancement

The assessment process also identified several key ways of minimising adverse effects of the options and enhancing positive ones. Some are relevant to all of the options and some to specific options only. These include:

All options:

Construction of defence structures: During construction activity associated with all options, every effort should be made to deliver/transport construction materials by river where possible; and planned activities should be consulted on and signposted to residents in advance of planned works.

Floodplain management: During operation of all options, consideration should be given to the need for floodplain management. In particular this would include, flood warning, emergency planning, spatial planning and building design, and including secondary defences, as appropriate. Specific measures are likely to be needed for vulnerable populations. For example:

- warnings about, and assistance during and after flood events for older people, people with small children, and people with health problems;
- information about flood risk for people who are less aware of such risks, notably those who have recently moved into a floodplain; people renting; people in socio-economic groups C2, D and E; and people aged below 35 and over 55;
- information about flood risk and flood management provided in the main foreign languages, to assist those people who do not speak English fluently.

Environmental improvements: Managed realignment areas and enhancement of existing habitat on the floodplain can provide an important habitat for fish, birds and invertebrates. The maintenance and improvement of these habitats could provide economic benefits to the Estuary from enhancement of recreational and commercial fisheries. Setting back defences during renewal can also provide opportunities to enhance riverside habitats and improve river access and views where appropriate.

Option 1 (wall raising): Mitigation of visual and access related impacts can be achieved by considering the use of demountables where appropriate, particularly in West London. On a

positive note, opportunities exist to maintain and improve rights of way and access to the river by coordinating new routes with local authorities' green infrastructure plans and other similar initiatives and create new biodiversity habitats on or beside the defences.

In areas of important historical landscape (e.g. Richmond, Greenwich), it may be necessary to ensure that the design and location of any raised walls matches the historic character of the area. Consultations will need to be carried out with English Heritage, the Museum of London and other appropriate authorities and stakeholders.

Option 2 (flood storage): A long-term scheme to safeguard and manage land for flood risk management purposes should be established, as has been done for previous managed realignment projects carried out in Essex, if this option were to be selected. The Farm Payments Scheme may offset the costs of managing land for flood storage; sites could be enhanced to provide recreation and amenity benefits. Loss of development potential could be mitigated through the provision of alternative sites.

Options 3 and 4 (barriers): Major effects arise in relation to biodiversity, visual impact and water quality (due to impoundment of polluted waters). In addition, there will be impacts on the movement of vessels associated with the barrier with locks options.

As mitigation, consideration should be given to the development of an iconic structure for the barrier or a low-lying one with minimal visual impacts. Water quality issues may possibly be addressed by use, when necessary, of artificial oxygenation techniques, improved treatment standards at sewage treatment works, and enhanced protection of contaminated sites adjacent to the Thames. In terms of vessel movements, management strategies to enable the movement of vessels of different sizes (e.g. tankers, dinghies) through the locks should be prepared in advance of the use of such options.

Monitoring

Timely adaptation of the plan in response to changes in how the Estuary responds to both climate change and the flood risk management approaches requires monitoring of the system. We will monitor the significant effects of our Flood Risk Management Plan on the environment. To do this we will use information from existing environmental monitoring. We will also identify and establish our new monitoring needs as appropriate. A summary of the existing monitoring we are likely to use to help monitor the significant environmental effects of implementing the draft plan is set out below.

- Monitoring the impacts of flood risk management measures and sea level rise will provide an indication of the biodiversity effects of our actions, and help determine whether habitat replacement measures are correctly aligned with the rate and scale of habitat loss.
- The effects on water quality will be monitored, in particular dissolved oxygen levels.
- The health and stability of the intertidal habitat zone will be monitored by recording changes in the area and extent of intertidal habitat.
- Monitoring of erosion and sediment deposition would track the stability of the current morphology of the Estuary. This in turn will inform our understanding of the sustainability of habitats and flood defences in the Thames.
- The changes to landscape character will be monitored against objectives of the landscape strategies.

- Effects on the historic environment will be monitored using the state of historic structures or those potentially affected by changes resulting from flood risk management activities.
- Climatic factors will be monitored by measuring mean sea level rise, peak surge tide level, peak river (fluvial) flood flows.

The full list of monitoring indicators will be finalised following the results of the Plan consultation.

Conclusion

The HRA to date shows all options to have a significant impact on designated features on the Thames. Replacement and compensation for these has been built in to the Plan to maintain integrity of the Natura 2000 network.

In summary, improving the existing defence system through optimising the defence repair and replacement regime (Option 1.4) is the preferred environmental option throughout the three phases of the Plan. The economic appraisal has identified Options 1.4 and 3.2 (Constructing a new barrier at Long Reach) as front-runners for the period beyond 2070, with Option 1.4 being preferred before then. The SEA/HRA process has concluded that Option 1.4 is the environmentally-preferred option both pre- and post-2070.

Although this might suggest that the overall preference would be for Option 1.4, current information suggests that Option 3.2 might be the better economic option by a small margin post-2070. Based on current information, this margin is not sufficient for Option 3.2 to be permissible under EU environmental legislation (in particular, the Water Framework Directive). But this may change in the future; the presence of uncertainty in the appraisal suggests it would be wise to keep options open at this early stage.

Overall, the conclusion of the combined (economic and SEA) decision support approach is that Options 1.4 and 3.2 should be promoted as front-runners for the period beyond 2070, with Option 1.4 being promoted for the period before then.

Notes

Notes

Have your say

For comments on this plan for consultation and to find out more about how we are planning for a changing estuary:

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