

EXTERNAL DRAFT

LONDON TIDAL FLOOD DEFENCES STRATEGIC ENVIRONMENTAL FRAMEWORK

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GLOSSARY AND ABBREVIATIONS

Glossary

Algae: a diverse group of aquatic plants, including seaweeds and single-celled phytoplankton, which can grow in rivers, the sea and still waters.

Balance Sheet: record of changes in the environmental assets in an embayment resulting from the Agency's tidal defence works.

Compensation: measures taken to replace, or provide an alternative, for the adverse effects of a development of a similar quality. Compensation measures are usually proposed to address residual adverse impacts once mitigation measures have been fully explored.

Embayment: discrete flood cells defined by the area of land that would be flooded in the absence of flood defences during a 1 in 1000 year flood event.

Encroachment: intrusion of development riverward of the flood defences onto or over the foreshore or river channel.

Enhancement: to improve the environment or a particular aspect of it.

Fauna: assemblage of animal species.

Fish fry: young fish.

Flood event return period: the risk of flooding to floodplain areas and property is often described in terms of a return period. Statistical return periods relate to the long term average time interval between events of a particular magnitude.

Flora: assemblage of plant species.

Foreshore: the shore between the high and low water marks.

Frontages: a length of flood defences, often in a single ownership.

Inter-Tidal Zone: the zone subjected to twice daily with the rise and fall of the tide (i.e. between the extreme high and low water mark).

Invertebrates: animals without backbones e.g. insects, worms and spiders.

Lower Zone: the tidal zone between Mean Low Water Spring and Mean Low Water Neap. This zone is submerged by the most tides annually and is continuously exposed for the least number of days.

Middle Zone: the tidal zone between Mean Low Water Neap and Mean High Water Neap.

Mitigation: measures taken in order to avoid and reduce the adverse effects of a development.

Reach: a length of river channel.

Refugia: an area providing shelter for organisms such as fish.

Retreat: the deliberate process of setting back a flood defence line. This is often undertaken in order to restore or recreate a desirable habitat, landscape or amenity feature.

Riparian: relating to or situated on the bank of a river or stream.

Sheet Piling: metal sheets used for vertical bank protection.

Submergence: to be covered by water from the inundation of the tide.

Substrate: the surface or material on or in which any particular organism grows.

Sub-Tidal Zone: the part of a tidal channel that is always submerged even at low water.

Terrestrial Zone: the tidal zone above Mean High Water Spring that is predominately dry.

Tidal: the twice daily rise and fall of water levels due to the attraction of the moon and sun.

Tidal Zonation: the gradient of different physical conditions, and resulting habitats, along the edges of a tidal channel that are created by the rise and fall of the tide. Three main zones can be identified: the Upper Zone (or splash/erosion zone); the Middle Zone; and the Lower Zone.

Upper Zone: the tidal zone between Mean High Water Neap and Mean High Water Spring. This zone is mainly dry but can get splashed, it is submerged by the least tides annually and is continuously exposed for the most number of days.

Abbreviations

AIP: Approval in Principle
BAP: Biodiversity Action Plan
DETR: Department of the Environment, Transport and Regions
DoE: Department of the Environment
EA: Environment Agency
EC: European Communities
GLC: Greater London Council
LDW1: the form used to apply for a MAFF grant for flood defence schemes
LEAP: Local Environment Agency Plan
LPAC: London Planning Advisory Committee
LTFDP: London Tidal Flood Defence Programme
MAFF: Ministry of Agriculture, Fisheries and Food
NRA: National Rivers Authority
PLA: Port of London Authority
RPG: Regional Planning Guidance
RSPB: Royal Society for the Protection of Birds
SEF: Strategic Environmental Framework
SERPLAN: South East Regional Planning Conference
SI: Statutory Instrument
SSSI: Site of Special Scientific Interest
UDP: Unitary Development Plan

LONDON TIDAL FLOOD DEFENCES STRATEGIC ENVIRONMENTAL FRAMEWORK

NON TECHNICAL SUMMARY

This Strategic Environmental Framework has been prepared by the Environment Agency - Thames Region (the Agency) to explain how the environment will be considered as part of works to replace or refurbish London's tidal flood defences. This represents a new approach to strengthen the Agency's management of the Tidal Thames environment. The Agency is seeking the views of interested parties on this version of the Strategic Environmental Framework prior to its submission to Ministry of Agriculture, Fisheries and Food (MAFF).

The Agency is responsible for supervising the tidal flood defences along the River Thames and its tributaries, as well as maintaining and operating the Thames Barrier and other moveable defences. Whilst the Agency is responsible for ensuring the structural integrity of the tidal flood defences in London, individual riparian owners are responsible for replacement and refurbishment of the defences on their frontage. However, it is recognised that riparian owners may not have sufficient means to carry out such work and because the defence provide benefit to a much wider area the Agency may contribute to the works. In such cases the flood defence works will be entered into the Agency's capital programme and it is to these works that this Framework applies.

The Agency's approach to the management of London's tidal defences is based on the concept of discrete flood cells, or embayments, which are defined as the area which would be flooded in the absence of tidal defences during a 1 in 1000 year flood event. There are 22 embayments, each of which are analysed individually as part of the London Tidal Flood Defence Programme.

The Strategic Environmental Framework will be used by the Agency to seek Approval in Principle from the MAFF for the programme of works proposed in each of the embayments. The application to MAFF will also be accompanied by engineering and economic justifications covering each embayment. The Framework will also be used to guide the approach to mitigation and compensation measures associated with individual works to the tidal defences within each embayment.

The Framework presents an overview of the Tidal Thames environment. This covers each of the main environmental 'assets', including: hydrology and geomorphology; fisheries; biology; nature conservation; archaeology and heritage; recreation; landscape; and water quality. For each of these assets an objective is set and indicators presented, against which change can be measured. These indicators will be used to complete an environmental balance sheet to record changes resulting from all the individual works in each embayment. The aim is to achieve a no net loss of environmental assets, and if possible a net increase.

In order to achieve the Agency's aim to conserve, and wherever possible, enhance the environment when undertaking capital works the Agency has developed a 'Mitigation and Compensation Hierarchy'. This is to ensure a systematic and transparent approach to decision-making and the design process for tidal flood defence works. The hierarchy presents a number of sequential stages whereby impacts are avoided, reduced and compensated. The hierarchy defines when compensation measures including restoring assets, creating new assets and improving remaining assets are appropriate.

SECTION 1 INTRODUCTION

1.1 Background to the Strategic Environmental Framework

1.1.1 This Strategic Environmental Framework (SEF) aims to provide an operating framework for the Environment Agency staff responsible for delivery of the London Tidal Flood Defences Programme (LTFDP). It also provides a clear statement of the Agency's objectives and implementation plans to external organisations such as the Ministry of Agriculture, Fisheries and Food (MAFF), statutory consultees including English Nature, English Heritage and the Countryside Commission and non-statutory consultees including the London Ecology Unit and London Wildlife Trust.

1.1.2 The SEF will ensure that the environment is taken into account early in the planning of the LTFDP. It will also ensure that appropriate alternatives are examined and that the impacts, both positive and negative, of preferred options are assessed in terms of their effects across the whole Tidal Thames and over the whole design life. This will have to take into account environmental change, such as sea level rise. The approach is illustrated in Figure 1.

1.2 Objectives of the Strategic Environmental Framework

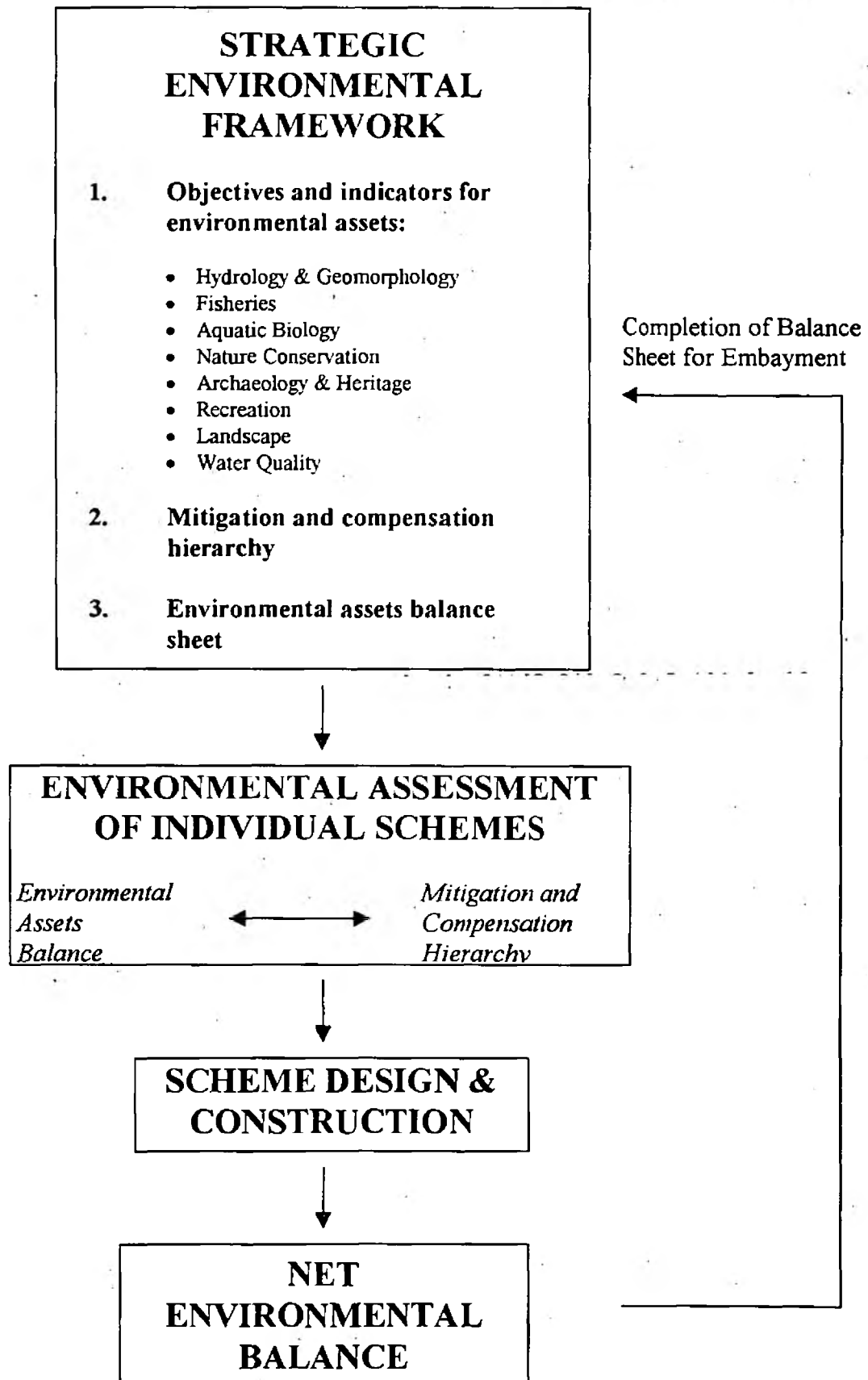
1.2.1 This report is based upon a desk survey of existing sources of environmental information on each of the 22 embayments. The SEF will be used within an embayment to provide a framework for:

- assessing the existing environment for use as a yardstick to compare the impacts on the environment under a range of different flood defence options;
- assessing the potential environmental impacts of tidal defence options and determining the most sustainable approach;
- consulting relevant consultees both within the Agency and within external organisations;
- identifying appropriate mitigation and compensation measures, and opportunities for enhancing the environment;
- recording the changes in the environmental assets of the embayment, and the Tidal Thames as a whole, arising from tidal flood defence works in a balance sheet.

1.2.2 The over-riding aim of the Agency's approach to tidal defence works will be to ensure that scheme options are chosen and projects are designed in a way that:

- a) minimises adverse environmental impact;
- b) allows for mitigation and reinstatement; and
- c) includes reasonable environmental enhancements.

Figure 1: The Strategic Environmental Framework Approach



- 1.2.3 The Strategic Environmental Framework has been prepared to accompany the Agency's applications to MAFF for Grant Aid to finance flood defence works to protect each of the 22 embayments from flooding. It sets out the way in which an Environmental Assessment for individual works should be carried out, as part of an overall strategy. Although it is not an Environment Agency policy, the SEF is intended to provide guidance for Environment Agency flood defence project managers, as well as being broadly applicable to flood defence works undertaken by external developers.
- 1.2.4 The SEF should contribute to the implementation of the environmental objectives for the London Tidal Flood Defences Programme (see section 2.2). It will also provide a framework for the Agency, MAFF and other bodies, such as English Nature, as to the approach to be taken for individual capital works on the Tidal Thames in London. It will also provide guidance to riparian land owners and developers, and in the longer term to the Greater London Assembly.

1.3 Background to the London Tidal Flood Defences

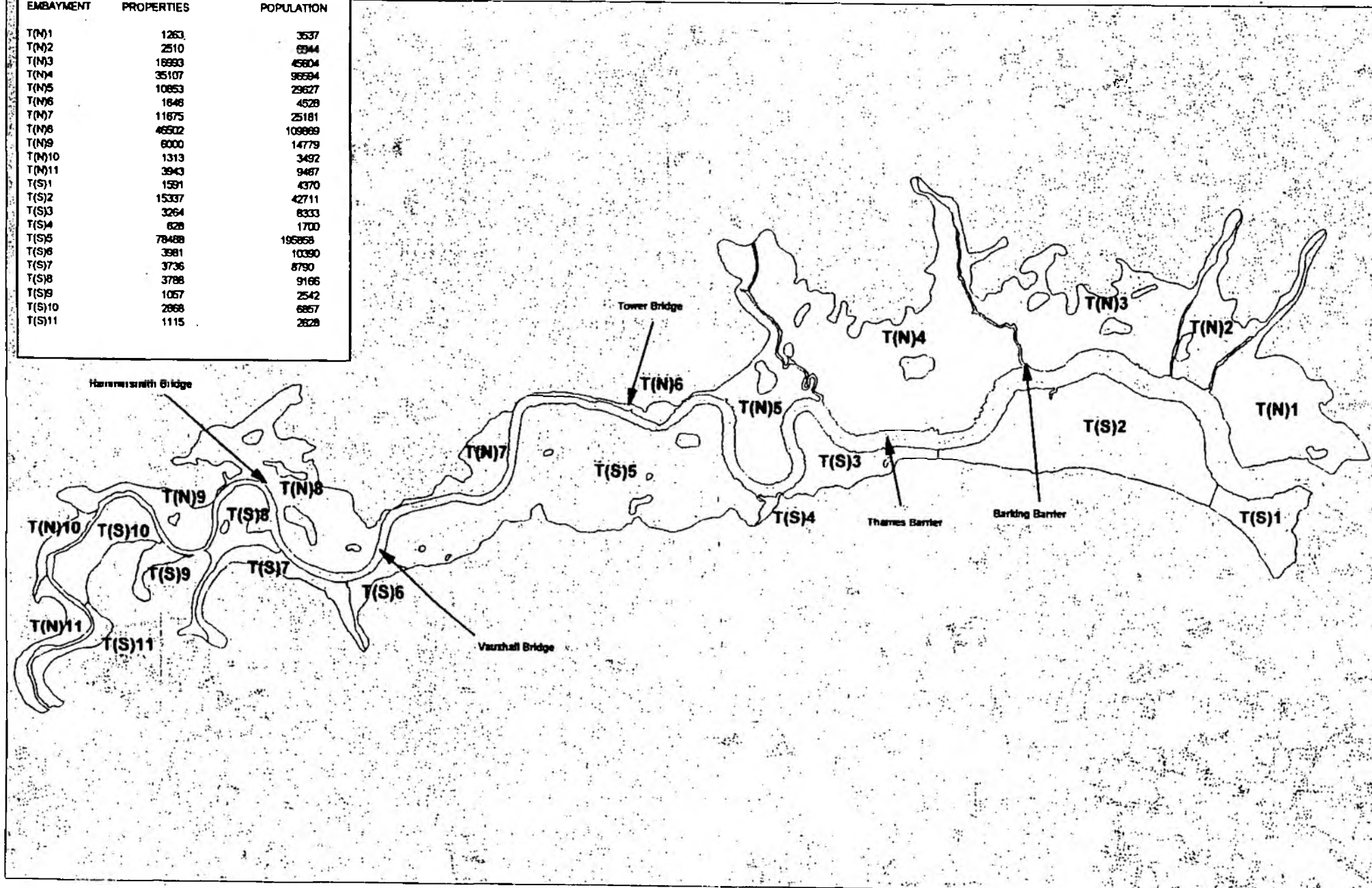
- 1.3.1 In London, the Agency is responsible for supervising 195km of tidal flood defences along the River Thames and its tidal tributaries as well as maintaining and operating the Thames Barrier and other moveable defences. These flood defences protect more than 125km² of the city, including over 1,000,000 people and 250,000 properties, from inundation. Part of the Agency's management of London's tidal flood defences is based on the concept of discrete flood cells, or embayments, defined as the area of land which would be flooded, in the absence of tidal defences, during a 1 in 1000 year flood event. There are 22 embayments, each of which are analysed individually as part of the London Tidal Flood Defences Programme (LTFDP). The area covered by this Strategic Environmental Framework comprises the 22 embayments (see Figure 2).
- 1.3.2 The Agency is responsible for ensuring the structural integrity of the tidal flood defences in London and carries out regular inspections. Individual riparian owners are responsible for the replacement and refurbishment of the defences on their frontages. The necessary works are carried out by the owner following negotiation with the Agency and, occasionally, following enforcement action. However, it is recognised that riparian owners may have insufficient means to carry out such works and that individual frontages cannot be considered in isolation as a breach of the defence could flood not only the adjacent land but also the whole embayment. In recognition of the wider benefits afforded by an individual riparian owner's costs in maintaining flood defences the Agency may contribute towards project managing and part-funding these costs in certain cases. It is for such cases that flood defence works are entered into the Agency's capital works programmes.
- 1.3.3 MAFF has overall policy responsibility for flood and coastal defence in England and regulates the Environment Agency, which is charged with implementing this flood defence policy. The Agency has agreed with MAFF to manage its London Tidal Flood Defences programme on the basis of the 22 discrete embayments. For each embayment MAFF requires the Agency to prepare an economic and environmental justification for its management. If accepted by MAFF, the Agency will be given Agreement in

FIGURE 2:

TIDAL THAMES - 1000 YEAR FLOOD AND EMBAYMENTS

TIDAL THAMES FLOODED AREAS
PROPERTY AND POPULATION BY EMBAYMENT

EMBAYMENT	PROPERTIES	POPULATION
T(N)1	1263	3537
T(N)2	2510	6944
T(N)3	18993	45604
T(N)4	35107	96594
T(N)5	10853	29627
T(N)6	1648	4528
T(N)7	11675	25181
T(N)8	46502	109869
T(N)9	6000	14779
T(N)10	1313	3492
T(N)11	3943	9487
T(S)1	1591	4370
T(S)2	15337	42711
T(S)3	3264	8333
T(S)4	628	1700
T(S)5	78488	195858
T(S)6	3981	10390
T(S)7	3736	8790
T(S)8	3788	9166
T(S)9	1057	2542
T(S)10	2868	6857
T(S)11	1115	2628



Principle (AIP) to proceed with individual flood defence works. Such works will however require formal LDW1 approval from MAFF before grant aid can be paid.

- 1.3.4 Both AIP and LDW1 Approvals must conform to MAFF guidance covering engineering, social and environmental criteria. With regard to environmental criteria this report covers all 22 embayments and will accompany the Agency's application for AIP for each embayment. It will also form the environmental framework and approach to be adopted by the Agency in managing London's Tidal flood Defences. Environmental Assessment will be conducted for individual flood defence works as part of LDW1 applications and in accordance with appropriate Environmental Assessment Regulations (see section 4.2).
- 1.3.5 The current flood defences are based on statutory levels set out in the Metropolis Management (Thames River Prevention of Floods) Amendment Act 1879 between the Thames Barrier and Putney/Chiswick. Upstream and downstream of that reach flood defence levels are advisory. In response to concern over increasing flood risk, powers were obtained in 1972 by the Greater London Council for the construction and operation of the Thames Barrier and associated flood defence works. Interim defence raising, above the statutory and advisory levels, to protect against tidal flooding was carried out in the early 1970s through central London and upstream in advance of the Barrier construction. When the Thames Barrier became operational in 1982 some of these were removed, but others remain to this day.
- 1.3.6 The Thames Barrier and the downstream defences, constructed as part of that comprehensive scheme, were designed to provide protection to the anticipated 1 in 1000 year event of 2030. Upstream of the Thames Barrier the statutory levels, and the advisory levels between Putney/Chiswick and Teddington, have been checked against hydraulic modelling results, and in general would be able to contain the 1 in 1000 year combined fluvial/tidal event with the Thames Barrier in operation.

1.4 Legal Framework

- 1.4.1 The Environment Act 1995 established the Environment Agency (the Agency) as the successor to the National Rivers Authority (NRA) and in April 1996 the Agency inherited the NRA's statutory responsibilities set out in the Water Resources Act 1991. These include:
- powers to provide flood defence;
 - maintenance and improvement of water quality;
 - conservation of water resources;
 - improvement, maintenance and development of fisheries;
 - protection and furthering of conservation;
 - regulation of navigation;
 - promotion of the use of water and associated land for recreation.
- 1.4.2 The Agency has a legal duty under the Water Resources Act 1991 to exercise general supervision over all matters relating to flood defence. The Agency's principle aims in

relation to flood defence are to provide effective defence for people and property against flooding from rivers and from the sea and to provide adequate arrangements for flood forecasting and warning. It is required to carry out surveys to determine the need to construct new works and is empowered to undertake maintenance and improvement works to reduce the incidence of flooding to property. Such work must be undertaken in line with the Agency's duties in the Environment Act 1995.

- 1.4.3 Under the Environment Act the Agency has a duty to further conservation interests wherever possible when carrying out water-management functions (including flood defence). This includes the furthering of the conservation of flora and fauna dependent on an aquatic environment. Included in these duties and powers are requirements to further the enhancement of natural beauty, to consider the impact of its activities upon archaeology and heritage and to promote rivers and water space for recreational use.

1.5 Policy Framework

- 1.5.1 The policies, guidance and initiatives of organisations relevant to flood defence within the LTFDP are outlined below. Table 1 summarises the relevant legislation and guidance. Planning policy is summarised in Table 2.

Environment Agency

- 1.5.2 In order to carry out its legal duties, the Agency has both national and regional policies and guidelines for key areas of responsibility. Key policies and guidelines relating to the LTFDP are summarised in Table 1 and include the following initiatives.
- 1.5.3 The *Thames Estuary Management Plan Draft for Consultation* (July 1996) was produced by the Thames Estuary Project (which includes the Agency, English Nature and the Port of London Authority amongst other organisations). The Plan examines the activities that take place on, and alongside the estuary, and makes recommendations aimed at balancing use, especially where there are potentially conflicting interests. Although a non-statutory document, it aims to influence the statutory development planning framework to ensure strategic management of the estuary. Following consultation on the draft document, a final Management Strategy and Action Plan are due to be published in 1999.
- 1.5.4 The Agency published the *Thames Tideway (Teddington to Tower Bridge) Local Environment Agency Plan Consultation Report* in 1997 which provides an opportunity for consultees to comment on the issues facing the tideway and the Agency's proposed actions to address them. The Plan aims to contribute towards improvements in environmental quality whilst recognising continuing pressure on the tideway, for example riverside development and need to protect London from an increasing flood risk due to the sinking of south-east England and climate change. The Thames Tideway Local Environment Agency Plan (LEAP) Action Plan is due to be published in 1999.
- 1.5.5 The Agency has produced a number of other documents, including: *The Tidal Foreshore* (1997a), *Partnership in Planning* (1997b) and the *Millennium Riverbank Experience* (1997c) which identify the value placed on the environmental assets of the

Tidal Thames and in particular identify means of providing more sustainable flood defences.

Ministry of Agriculture, Fisheries and Food (MAFF)

- 1.5.6 MAFF provides grant aid for certain capital works carried out for flood defence operations. However, it only pays grants to the eligible authorities for such works that fulfil their environmental, economic and technical criteria. MAFF guidance set out in *Strategy for Flood and Coastal Defence in England and Wales* (1993a) cites the need to reduce risks to people and the developed natural environment from flooding and coastal erosion by encouraging the provision of technically, environmentally and economically sound defence measures.
- 1.5.7 Flood defence options can be categorised in terms of 'do-nothing', 'Reduce', 'Sustain' and 'Improve' the standard of flood protection (MAFF, 1992 & MAFF, 1993a). In addition, the 'Reduce' and 'Sustain' options include a 'do-minimum' sub-option. For high density urban areas containing significant amounts of both residential and non-residential property the indicative standard of protection against tidal flooding is set at the 1 in 200 year return period (MAFF, 1993a). However, the high value of land and property in the Tidal Thames embayments means that the 1 in 1000 year standard of protection could be justified for the Thames Barrier and associated downstream defences. The statutory and advisory levels upstream also happen to provide for approximately the same standard of protection with the Barrier operational.

Planning Policy

- 1.5.8 Works carried out to maintain the standard of flood protection, such as work on the London Tidal Defences, are carried out under the Agency's permitted development rights defined in the Town and Country Planning (General Permitted Development) Order 95/418 and therefore do not require planning permission. However, the Agency is required to assess the environmental impacts of works classified as land drainage improvements under the Land Drainage Improvement Works (Assessment of Environmental Effects) Regulations SI 88/1217 (as amended by SI 95/2195).
- 1.5.9 The planning policy context provides the broader setting into which individual Agency tidal flood defence projects should fit. The statutory planning framework relevant to the Tidal Thames is provided by Government Guidance, advice provided by the London Planning Advisory Committee (LPAC), the London and South East Regional Planning Conference (SERPLAN) and the Unitary Development Plan (UDP) produced by the London Boroughs. Although the Agency's flood defence maintenance and improvement works do not require planning permission, there are a range of planning policies and guidance relating to the Tidal Thames which provide a framework within which the Agency should operate. The planning policy and guidance relevant to the Tidal Thames is summarised in Table 2.

1.6 Environmental and Engineering Objectives

- 1.6.1 The previous sections have examined the Agency's duties and roles with regard to flood defence and environmental management. To help determine the approach and

methods to be adopted as part of the LTFDP, the Agency has set the following objectives against which future performance can be evaluated:

- *Engineering Objective:* to ensure the integrity of London's tidal flood defences without adversely affecting river hydraulics.
- *Environmental Objective:* to manage London's tidal flood defences as to conserve, and wherever possible enhance, the overall quantity and quality of the environmental assets of the Tidal Thames.

1.6.2 In managing the LTFDP the issue of sustainability will be of paramount importance. The social, environmental and economic costs and benefits of proposed actions will be assessed and balanced to identify the most sustainable solution. In addition, the precautionary principle will be adopted whereby if there is uncertainty about the precise nature and extent of an impact, the worse case scenario will be assumed and mitigated and compensated for accordingly.

Table 1: Summary of Relevant Legislation and Government Guidance

ORGANISATION	DOCUMENT	KEY ISSUES
Legislation	<p><i>Environment Act (1995)</i></p> <p><i>Water Resources Act (1991)</i></p> <p><i>Land Drainage Improvement Works (Assessment of Environmental Effects) Regulations SI 88/1217 (as amended)</i></p> <p><i>Town and Country Planning (Assessment of Environmental Effects) Regulations SI 88/1199 (as amended)</i></p> <p><i>Metropolis Management (Thames River Prevention of Floods) Amendment Act (1879)</i></p> <p><i>Land Drainage Act (1991) as amended by the Land Drainage Act (1994)</i></p> <p>Other relevant legislation includes:</p>	<p>Established the Agency as the successor to the NRA and transfers the responsibilities to have regard to the desirability of conserving and enhancing flora and fauna, natural beauty, the protection of sites and objects of archaeological, architectural and historic interest, and the preservation of public access and consideration of amenity.</p> <p>Sets out the statutory responsibilities of the NRA (transferred to the Agency).</p> <p>Sets out the requirements for the environmental assessment of certain works classified as land drainage improvements carried out by drainage bodies, such as the Environment Agency.</p> <p>Sets out the requirements for the environmental assessment of certain works requiring planning permission.</p> <p>Upstream of the Thames Barrier as far as Putney on the south bank and Chiswick on the north bank adherence to statutory defence levels provides (in conjunction with the operation of the Barrier) a standard of protection approximately equivalent to that from a 1 in 1000 year combined tidal/fluvial event in 2030. Further upstream advisory levels provide the same degree of protection. Downstream of the Barrier much higher advisory levels provide protection against the 1 in 1000 year estuary levels in 2030.</p> <p>Describes the function of various bodies involved in land drainage and the control over various activities affecting watercourses.</p> <p><i>Thames Region Land Drainage Byelaws, Salmon and Freshwater Fisheries Act (1975), Wildlife and Countryside Act (1981), Ancient Monuments and Archaeological Areas Act (1979) and Control of Pollution Amendment Act (1989).</i></p>
Ministry of Agriculture, Fisheries and Food (MAFF)	<p><i>Project Appraisal Guidance Notes (1993a), Coastal Defence and the Environment (1993b) and Environmental Procedures for Inland Flood Defence Works (1992)</i></p>	<p>Includes MAFF requirements for an operating authority to: protect land, property and people from risks of flooding; ensure flood defences have due regard for environment; ensure that flood defence options are examined strategically; and that an economic justification of money spent on flood defence works is provided.</p>
DoE/MAFF/Welsh Office	<p><i>Code of Practice for Conservation, Access & Recreation (1989)</i></p>	<p>Consolidates and develops best practices for the Environment Agency relating to conservation, access and recreation.</p>

Table 2: Summary of Planning Policy and Other Relevant Documents

ORGANISATION	DOCUMENT	KEY ISSUES
Department of the Environment, Transport and Regions (DETR) (including the former Department of the Environment – DoE)	<i>Regional Planning Guidance for the South East - RPG9 (1994)</i> <i>The Thames Gateway Planning Framework - RPG 9a (1995)</i> <i>Strategic Planning Guidance for London - RPG3 (1989)</i> <i>Strategic Planning Guidance for the River Thames (RPG3: Annex B, Feb. 1997)</i> Policy Planning Guidance Notes (PPGs) <i>UK Biodiversity Action Plan (1994)</i>	Identifies the need to consider leisure, wildlife and heritage issues of Thames-side developments. Provides guidance for the area extending eastward from Docklands in London to Tilbury. It includes visions for enhancing the environment of the Thames, and economic and social regeneration of the area. Identifies the need to maintain and improve riverside public access and consider the visual impact of developments on the Thames and the ecological value of the river and shoreline. Provides a strategic framework for land use planning along the Thames, placing emphasis on the multiple functions of the Thames as a major river complex; a setting for development; an open space and ecological resource; a transport artery; and a recreational, leisure and tourist facility. PPG 9 on nature conservation and PPG 16 on archaeology are relevant. Includes national targets for the protection and restoration of some of the habitats found alongside the Thames. These will be translated to local BAP figures by the London BAP partnership.
London Planning Advisory Committee (LPAC)	<i>Advice on Strategic Planning Guidance for London (1994)</i>	The Thames and riverbanks as nature conservation sites. Promotion of Thames-side recreation and tourism.
South East Regional Planning Conference	<i>A New Strategy for the South East (1990)</i>	SERPLAN's objectives include ensuring that an enhanced quality of life is available to the residents of the South East by seeking to create and conserve an ecologically sound, aesthetically pleasing and pollution-free environment in town and country.
Environment Agency (including former National Rivers Authority – NRA)	<i>The Tidal Foreshore (EA, 1997a)</i> <i>A Recreation Strategy for the Thames (NRA, 1995)</i> <i>Tidal Thames Landscape Assessment and Design Guidelines (EA, 1996)</i> <i>The Tidal Thames River Corridor & Ornithological Survey (NRA, 1994b)</i> <i>Partnership in Planning (EA, 1997b)</i> <i>Thames Tideway (Teddington to Tower Bridge) LEAP Consultation Report (EA, 1997)</i> <i>Policy and Practice for the Protection of Floodplains (EA, 1997)</i>	Describes the environmental importance of the Tidal Thames foreshore and the Agency's opposition to encroachment onto the foreshore by development. The strategy sets out policies to optimise the recreational potential of the Thames, whilst conserving and enhancing the river's ecological, landscape and heritage value. The need to enhance public access to the Thames is identified as a particularly important issue (Policy 6). Provides an assessment of the Tidal Thames landscape, identifies significant issues and provides guidance on the design of works affecting the Thames landscape. Provides a detailed survey of the Thames foreshore and bankside ecology and ornithological interest. Identifies management issues and options. Outlines environmental issues along the Tidal Thames and promotes suitable riverbank designs. The Agency's analysis of the state of the environment in the plan area and the issues that need to be addressed. An action plan is due to be published in 1999. Sets out the Agency's policy on development in floodplains.
Thames Estuary Project	<i>Thames Estuary Management Plan Draft for Consultation (1996)</i>	The plan examines the activities that take place along the estuary and makes recommendations aimed at balancing uses and conflicting interests.
Thames Landscape Steering Group	<i>Thames Landscape Strategy, Hampton to Kew (1994)</i>	The strategy aims to promote, conserve and enhance the River Thames from Hampton to Kew and involves a partnership of several organisations.
Port of London Authority	<i>Access to the River Thames (PLA, 1996)</i>	Access should be allowed to the foreshore where it is suitable for public use. Landing places of historical interest, if still in use, should be maintained.
London Ecology Unit	'Nature Conservation in ...' series (LEU)	A series of guides which detail sites of nature conservation value in London Boroughs and identifies key management issues.

SECTION 2

ENVIRONMENTAL BASELINE AND MANAGEMENT

2.1 Background to the Tideway Environment

- 2.1.1 The Tidal Thames is one of London's greatest assets. The river is an artery for commerce and tourism, provides space and opportunity for recreation and its ever changing appearance enhances the famous buildings which grace its banks. Cleaner and healthier now than it has been for nearly 200 years, the Thames and tidal creeks once again support a wide variety of wildlife.
- 2.1.2 The Tidal Thames supports species and habitats not found elsewhere in the capital, contributing to the biodiversity of London, the outer Thames Estuary and the North Sea. Many of these species are dependent on the rise and fall of the tide, composition of foreshore material, extent of inundation and salinity variations. The intertidal zone supports a mosaic of habitats providing the necessary environmental conditions for a diversity of species.
- 2.1.3 This section describes the Tidal Thames environment, including the riverside and the river channel itself. Firstly, it explains the variation that occurs along the length of the tideway and at different zones within the foreshore. It then describes each of the main environmental assets, including:
- hydrology and geomorphology;
 - fisheries;
 - aquatic biology (including invertebrates and algae);
 - nature conservation (including plants, birds and mammals);
 - archaeology and heritage;
 - recreation;
 - landscape; and
 - water quality.

Habitat Zonation

- 2.1.4 The intertidal zone, or foreshore as it is often called, is the area where different environments of land and river meet and overlap. The flora and fauna that live here have adapted to do so over thousands of years and are either aquatic in origin and tolerate some exposure to the air, or terrestrial and withstand temporary immersion in estuarine water (see paras 2.1.8-2.1.13). Generally it is the aquatic life which has moved towards the land. Those least adapted to exposure to the air live low down on the shore whilst the most specialised live high up and may be only covered by the tide every few of weeks. In between lives a predictable gradient of animals and plants depending on their tolerance to air.
- 2.1.5 A salinity zonation is also found along the axis of the River Thames. At the upstream end are found mostly freshwater animals and the lower end live purely marine. Most migration has occurred from the sea into the river so that the estuarine section in the middle contains a gradient of animals with varying tolerance to freshwater.

- 2.1.6 These two gradients determine the general distribution of animals or plants in the Tidal Thames, the other important constraint is the substrate type. Seaweeds generally need solid rocks for attachment, oligochaete worms need soft muds, some types of shrimps might require sandy substrates whilst others need muds. Where these sediments occur depends upon the particular estuary although most muds occur in the middle and lower reaches and most gravels in the upper to middle reaches.
- 2.1.7 Encroachment usually takes place from the land riverwards, therefore the upper shore habitats are particularly adversely affected compared with those lower on the shore and consequently are more rare.

Tidal Zonation

- 2.1.8 The tide influences many aspects of the ecology of estuaries (Adams, 1990). Zonation based on the tide can be used to reflect these influences. In general total species richness increases with elevation. This reflects factors such as substrate, salinity, hydraulic patterns and frequency of submergence. The highest sedimentation rates at the lowest level of continuous vegetation because of the baffle effect of vegetation in controlling the settling out of sediment.
- 2.1.9 Much attention has been given to the use of tidal zones for defining management zones, particularly for the management of salt marshes (Clark, 1972). In ecological terms a common method of classifying for salt marshes is to separate them into three separate regions (Wiegert et al 1981): the region of emergent shoots in the air; the region of inter-tidal water; and the region of sub-tidal water. Whilst the start of the upper region may be readily recognised by the presence of emergent vegetation, the lower levels cannot so easily be identified by physical changes in the substrate or presence of vegetation and the low tide level is normally adopted as the marker.
- 2.1.10 The use of a system of classification may lead to some arbitrary separations in terms of the environmental functions of tidal zones, however it does provide a mechanisms which facilitates measurement, analysis and management. The Agency has therefore adopted a classification system to facilitate its environmental management of London's tidal flood defences based on tidal zones (see Figure 3).

Figure 3: Tidal Zonation for the Management of London's Tidal Foreshore and Flood Defences

Terrestrial Zone

_____ *Mean High Water Spring (MHWS)*

**Upper Zone
(Splash/Erosion Zone)**

_____ *Mean High Water Neap (MHWN)*

Middle Zone

_____ *Mean Low Water Neap (MLWN)*

Lower Zone

_____ *Mean Low Water Spring (MLWS)*

Sub-tidal Zone

- 2.1.11 Figures 4 and 5 demonstrate how this zonation applies to different scenarios on the Tidal Thames in London. Figure 4 illustrates an idealised section where the tidal zones define sections of the foreshore. Figure 5 illustrates a section where the flood defences have encroached into the river to the extent that the upper zone no longer falls on natural or semi-natural substrate but entirely on flood defence wall. Submergence is a critical environmental factor and will have a considerable affect on the potential distribution and quantity of flora and fauna, as well as preventing a continuous sequence from sub-tidal to terrestrial habitats.
- 2.1.12 Two key factors control the ecological value of these tidal zones – substrate/habitat and submergence. The type of flood defence can affect both of these. Extreme encroachment, such that the whole tidal range is expressed in the vertical plane tends to remove habitat potential. This will be further affected by the nature of construction material with organic materials providing more habitat potential than inorganic materials.
- 2.1.13 Table 3 includes a brief description of the environmental characteristics that are likely to be present in the different zones.

Figure 4: Theoretical Tidal Zonation

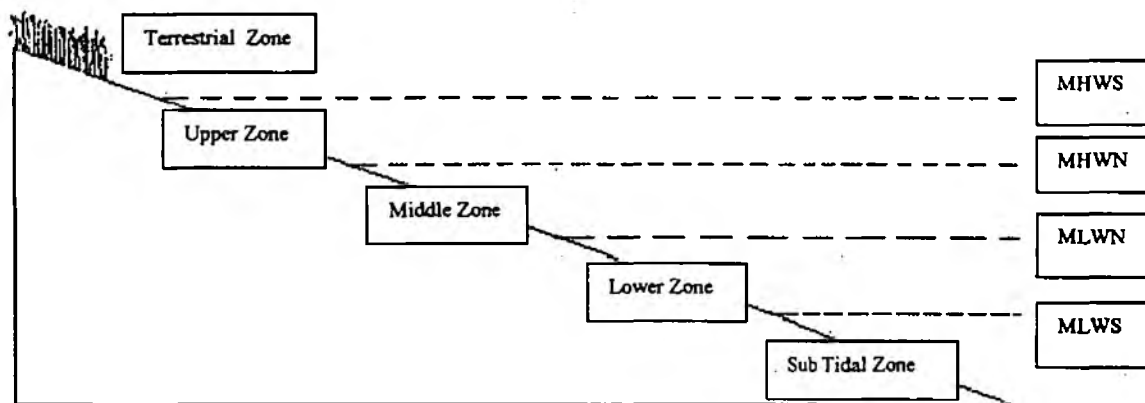
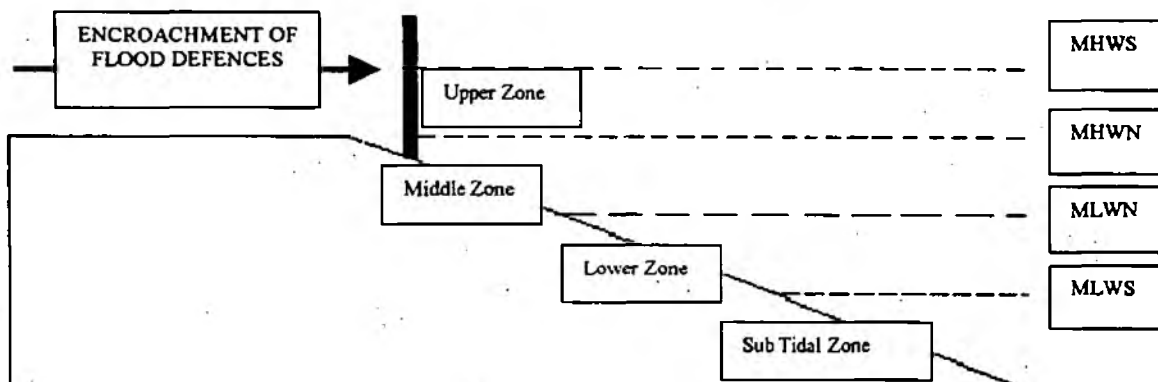


Figure 5: Tidal Zonation with Encroachment



2.2 Environmental Assets

2.2.1 The following sections describe the environmental assets of the Tidal Thames. For each of these assets a state-pressure-response format is used to describe the asset, the forces acting upon it and actions being taken to manage it. Indicators against which future change can be measured and a LTFDP objective are also included for each asset. A summary of the indicators and objectives are included in Table 4. The indicators will be used to complete the environmental asset balance sheet (see section 4.5).

Table 3: Summary of the Environmental Characteristics of the Tidal Zones

Zone	Invertebrates and Algae	Fish	Plants	Birds	Archaeology
Terrestrial Zone	Terrestrial species present such as wasps, flies and spiders.	N/A	Predominately terrestrial species including tall herb, scrub and tree species.	High water roost site for shore birds. Feeding and nesting site for dryland species.	Buildings and structures relating to riverside industry.
Upper Zone (Splash/ Erosion Zone)	Species present that are tolerant to exposure to the air, such as beetles, snails and algae. Most important zone for algae.	Fish fry and juveniles will use this zone for shelter and refugia provided by shingle, pools and reed fringes.	Pioneer species can establish down into the Middle zone and species such as phragmites and sea aster will spread into the lower Terrestrial zone. Saltmarsh and reed plant species. Saltmarsh plants are dynamic and these zones migrate up the slope with accretion.	Wildfowl and waders feeding and roosting amongst vegetation. Reed beds at higher levels are also used for resting (e.g. reed warblers).	Most likely to include riverfront defences, access points, wharves jetties, bargebeds, cranes, gridirons, artefact scatters and vessels. Particularly likely to include features of post-medieval date.
Middle Zone	Species present such as worms, ragworms, snails, shrimps, algae.	Adults and sub-adults of many species will use this zone opportunistic-ally for feeding. Fish fry and juveniles will use this zone for shelter and refugia.	Some reed and saltmarsh species which are able to tolerate longer periods of inundation.	Wildfowl and waders grazing on algae or eating the salt marsh plants.	This zone may include features found in the upper and lower zone depending on local conditions.
Lower Zone	Species present such as worms, snails and shrimps. Least algae as turbid water prevents photosynthesis.	Adults and sub-adults of many species will use this zone opportunistic-ally for feeding.	Less important zone for plants.	All zones are used for feeding depending on the species. Wildfowl and waders predominately feed in the middle, lower and sub-tidal (see above).	Most likely to include earlier remains and artefacts including palaeo-environmental materials such as peats and submerged forest, prehistoric structures and medieval fishtraps.
Sub-tidal Zone	Species present that are suspended in the water column. Some algae live on the riverbed.	Adults and sub-adults of all species will spend the majority of their life cycle in this zone.	Less important zone for plants.	Waders probing and sieving for invertebrates and small fish.	

- 2.2.2 The indicators that are proposed in this Strategic Environmental Framework for used in the Asset Balance Sheet have been selected because the data required is currently readily available. The Agency has existing baseline data including the Tidal Thames River Corridor Survey and Ornithological Survey (NRA, 1994b), Tidal Thames Landscape Assessment and Design Guidelines (Environment Agency, 1996) and the results of fisheries surveys and water quality monitoring. Where there is insufficient environmental baseline data that is considered appropriate and necessary, the Agency may undertake baseline surveys to assist in the planning and design of tidal defence works and to facilitate post-project appraisal. As more data becomes available on the Tidal Thames, for example the results of mapping using Compact Airbourne Spectrographic Imager (CASI) that is currently ongoing and will provide information on habitats along the Tidal Thames, this can be used to inform the environmental assessment process and could result in additional indicators to be included in Framework.

2.3 Hydrology and Geomorphology

State - Hydrology and Geomorphology

- 2.3.1 Over the centuries, urbanisation has had an increasing impact on the river as it makes its way through London. The Thames is now far narrower than it was when the Romans first settled on its banks. Vertical concrete and sheet pile walls now confine much of the river down to the flat grazing marshes of the lower estuary.
- 2.3.2 Any encroachment onto the foreshore constricts the river channel and causes water levels to rise. Although this may be by very small amounts for individual development proposals, the cumulative effect, over a period of time, will increase water levels. Unless flood defences are raised to compensate for these effects, there will be a greater risk of flooding.
- 2.3.3 Moreover, any kind of constriction causes the river to flow more quickly. This increased speed of flow causes 'scour', the erosion of material from the riverbed or foreshore, and deposition. The material deposited elsewhere in the channel forms banks or bars which further change the physical characteristics of the river and its behaviour. These obstructions can cause eddies and turbulence that help to move the displaced material around further, depositing silt or undercutting walls, banks and structures, thereby threatening the stability of tidal flood defences as well as losing areas of foreshore.

Pressure - Hydrology and Geomorphology

- 2.3.4 Riverside development sites in London are at a premium and the Agency often receives proposals that include development on the foreshore. The pressure for 'encroachment' onto the foreshore through development and the repair of flood defences is likely to continue despite the Agency's promotion of its policy on encroachment. Encroachment not only reduces the environmental value of the Tidal Thames, but also interferes with river flows and pattern of deposition and erosion of sediment potentially increasing the risk of flooding and results in the loss or restriction of foreshore access.

Response - Hydrology and Geomorphology

- 2.3.5 The effects of any proposal on river flows and geomorphology need to be thoroughly assessed. The Agency has produced a policy document on encroachment on the tidal foreshore (1997a) along with riverbank design guidance for the Tidal Thames (1997b).

LTFDP Hydrology and Geomorphology Objective: To maintain, and if possible increase, the channel capacity of the Tidal Thames and minimise obstructions to avoid increased flood risk and the adverse effects of sedimentation and erosion.

Note: *this cannot be achieved sustainably by deepening to compensate for narrowing caused by encroachment.*

Indicator 1: Change in channel capacity (m^3) in any reach.

Indicator 2: Change in cross-sectional area (m^2) at critical points.

2.4 Fisheries

State - Fisheries

- 2.4.1 In 1957 it was reported that there were no resident fish populations between Kew and Gravesend (Wheeler, 1978). However, the Tidal Thames now supports an increasing fish population with a total of 116 different species recorded. This recovery in fisheries reflects considerable improvements in water quality brought about by investment in sewage treatment and stricter pollution prevention controls.
- 2.4.2 The river now supports important recreational and commercial fisheries. It is one of the largest estuarine commercial eel fisheries in the UK and is gaining recognition as one of the most important nursery areas for young marine fish in the North Sea. Indeed it is the premier nursery for Dover sole in the UK. The smelt, which is considered rare in the British Isles and is described as vulnerable in Europe, has returned in strength. This is unlike most estuaries where it is declining and several British populations have been lost in recent years to pollution. Smelt are abundant in the Thames estuary and are now one of the largest migrations which occur. This involves adult spawning migrations from below Gravesend to Wandsworth, and then fry migrations throughout the estuary. Smelt are extremely fastidious in terms of water quality and habitat requirements. Research into their biology within the estuary is proposed with a view to their future use as an indicator species for habitat and water quality monitoring purposes.
- 2.4.3 Twait shad have been found in the lower tideway in very low numbers for the past two decades. Recent evidence suggests a possible increase in numbers in both the lower Tidal Thames and Medway during the winter months. Proof of a resident spawning population in the Thames would be extremely important. The species is listed under the EC Habitats Directive, and could invoke Special Area of Conservation status for the estuary.

- 2.4.4 Numbers of adult grey mullet and bass in the estuary below Woolwich have been rising in recent years. This, in combination with improving access, has led to much more angling in the river between Greenwich and Erith. In the past angling here was extremely unusual.

Pressure - Fisheries

- 2.4.5 Whilst the considerable improvements in water quality have been instrumental in improvements to the Tidal Thames fisheries, there are potentially limits to continued improvements brought about by incremental degradation and/or loss of inter-tidal habitats.
- 2.4.6 Most fish species in the Thames feed across the foreshore area so their continuing abundance is dependent upon the retention of this valuable resource. Selective tidal transport permits large scale migrations upstream of the very early life stages of several fish species during the spring and summer months. Too small to be able to swim against the stream, small fish float up in the water column on the flooding tide and seek the bed and margins during the ebb. A continuous foreshore is an essential requirement for these migrations.
- 2.4.7 Refugia and shelter may be provided across the foreshore in shingle or stone areas, pools and reed fringes. Flood defences may themselves provide suitable shelter where designs are appropriate. Vertical walls and smooth defences provide limited shelter and may cause a washout of small fry during the ebb tide. Each new encroachment tends to make mitigation more difficult by removing existing refugia and increasing local scour and velocity. Inappropriate new defences which encroach into the river can have multiple negative impacts, both locally and globally.
- 2.4.8 Water quality is a critical pressure upon the Tidal Thames fisheries. The LTFDP can contribute to the protection of water quality by preventing the pollution of surface waters by contaminated land that is frequently found behind flood defences. This is an important potential environmental benefit. Assuming that this occurs the LTFDP is unlikely to affect water quality in any other significant manner.

Response - Fisheries

- 2.4.9 Given increasing recognition of the value of intertidal habitats including the foreshore and flood defences themselves in providing, feeding, sheltering and spawning opportunities it is critical that these habitats are recognised as valuable for fisheries and both protected and enhanced as a result of the Agency's LTFDP. Practical measures including preventing foreshore encroachment, providing sloping or stepped rather than vertical defences, organic rather than inorganic defences and enhancing habitat value of the flood defences through appropriate planning or tendering.

LTFDP Fisheries Objective: To conserve and, wherever possible, enhance intertidal and sub-tidal habitats of value to fisheries for food, shelter and spawning.

Indicator 1: Change in the quantity and quality of natural or semi-natural intertidal and sub-tidal habitats (Tidal Zonation Balance).

Indicator 2: Change in the quantity and quality of flood defences providing suitable fisheries habitats (Flood Defence Characteristics).

2.5 Aquatic Biology

State – Aquatic Biology

- 2.5.1 The invertebrate and algae distribution of the Tidal Thames estuary closely reflects the salinity gradient and habitat diversity of the estuary. More than 350 freshwater, estuarine and marine invertebrates have been recorded over recent years. In the upper Thames estuary (Teddington to London Bridge) where the substrate tends to be gravel with some fine deposits of mud, typical freshwater species such as insect larvae, nymphs and molluscs occur with decreasing diversity downstream attributed to the reduction in habitat diversity and increasing saline penetration. In the mid Thames estuary (London Bridge to Gravesend) oligochaete worms are dominant with a downstream sequence of species associated with salinity. Typical estuarine species such as the crustacean *Corophium volutator* and the polychaete worm *Nereis diversicolor* are also present, particularly on the intertidal mud banks. Some sites within this area show a high degree of stress and an impoverished invertebrate community.
- 2.5.2 The invertebrate populations of the river are vitally important as a food source for fish and bird population associated with the Tidal Thames. Invertebrate density and diversity is dependent on both water quality and habitat. The issue of habitat is particularly important because some invertebrates, like fish, migrate up and down the Tidal Thames during stages of their lifecycle. Consequently they are dependent upon the availability of shelter points on the banks and bed of the river during such migrations.

Pressure – Aquatic Biology

- 2.5.3 The invertebrate populations of the Tidal Thames are particularly dependent upon water quality and habitat during their lifecycles. Increasing development pressures on the Tidal Thames coupled with new flood defence construction threatens invertebrate populations where it destroys or degrades invertebrate habitats particularly in the splash/upper zone.

Response – Aquatic Biology

- 2.5.4 Given that invertebrate populations form the lower tiers of a complex Tidal Thames food web, it is essential that their numbers and distribution are both conserved and

enhanced through appropriate intertidal habitat management and maintenance of water quality.

LTEDP Aquatic Biology Objective: To support invertebrate populations for the benefit of the Tidal Thames ecology by protecting and, wherever possible, enhancing intertidal and sub-tidal habitats for the benefit of invertebrate populations.

Indicator 1: Change in quantity and quality of natural and semi-natural intertidal and sub-tidal habitats (Tidal Zonation Balance).

Indicator 2: Change in quantity and quality of flood defences providing suitable invertebrate habitats (Flood Defence Characteristics).

2.6 Nature Conservation

State - Nature Conservation

- 2.6.1 The Tidal Thames represents the largest continuous habitat in Greater London. The river corridor supports a rich diversity of habitats and species not found elsewhere in the Capital. This status is recognised in the designation of the river as a site of Metropolitan Importance for Nature Conservation. There are also riverside Sites of Special Scientific Interest (SSSIs) at Syon Park and Rainham Marshes.
- 2.6.2 The ecological value of the Thames corridor is dependent upon the habitats, which it supports, and in turn the plants and animals associated with it. Important habitats include reed fringes, mud flats, shingle foreshore, rock pools, grazing marshes, open water and wet woodland. Tidal creeks, islands and dock basins provide further specialised habitats. This mosaic of habitats spread along the River form a linear corridor or 'wildlife superhighway' which enables animals to move freely along its length.
- 2.6.3 Much of the river has been embanked and although not as valuable, can still contain some unusual plant species such as pellitory-of-the-wall and hemlock waterdrop wort. The 'Landscape' section below describes the proportion of different bank types along the Tidal Thames, which is also of critical importance to nature conservation value. The Tidal Thames is also an important over-wintering site for over 10,000 wildfowl and waders. The inter-tidal mudflats along the lower reaches provide valuable feeding areas for oystercatcher, dunlin, redshank and teal. At high water adjacent areas of grazing marsh and open water provide important roost and breeding sites. In more urban reaches, redundant structures and barges provide valuable roost sites for gulls, cormorants and heron.
- 2.6.4 Foreshore, the inter-tidal areas that exist between low and high water mark, represent the most ecologically rich habitat. Foreshore is predominantly shingle in the upper reaches and becomes progressively muddier in the lower reaches below Greenwich. Foreshore provides important habitat for invertebrates and fish (see sections 2.4 and 2.5). In addition to the foreshore, the river banks particularly in the upstream part of the Tidal Thames form a valuable terrestrial habitat.

Pressure - Nature Conservation

- 2.6.5 As for the Tidal Thames fisheries and invertebrate communities, other wildlife are dependant on the improvements in water quality and the quality and quantity of intertidal habitats. The protection and enhancement of these habitats is essential for the continued success of the Tidal Thames' wildlife.

Response - Nature Conservation

- 2.6.6 As stated for the response to the fisheries and invertebrate assets, the value of intertidal habitats is being increasingly recognised. Practical measures to protect and enhance this resource include preventing foreshore encroachment and providing enhanced habitat value through flood defences works.

LTFDP Nature Conservation Objective: To support plant, bird and mammal populations by conserving and enhancing appropriate habitats.

Indicator 1: Change in the quantity and quality of natural or semi-natural intertidal and sub-tidal habitats (Tidal Zonation Balance)

Indicator 2: Change in the quantity and quality of flood defences providing habitats for plant, bird and mammal populations (Flood Defence Characteristics).

2.7 Archaeology and Heritage

State - Archaeology and Heritage

- 2.7.1 The Thames foreshore is London's longest archaeological site. It provides the means to trace the development of the river from the time when people first inhabited its banks and its growth into one of Europe's busiest waterways. Archaeological remains exposed on the foreshore include: submerged prehistoric wetland and forests; London's earliest (Bronze Age) bridge; Anglo-Saxon fishweirs; the remains of numerous historic defences; access points; wharves and jetties, including those associated with several riverside palaces. The remains of London's maritime industries also survive including: slipways, gridirons and the remains of the vessels that they produced.
- 2.7.2 The character of the Thames is strongly influenced by the wide range of architectural styles, building forms and patterns of open space. There are numerous historic buildings, parks, gardens and other heritage features along the river. The Palace of Westminster and the Tower of London are two of the UK's World Heritage Sites and there are numerous other listed buildings, such as Syon House, Kew Royal Botanic Gardens, Lambeth Palace and the Houses of Parliament. A large number of bridges across the Thames are also listed structures.

- 2.7.3 The London Boroughs, English Heritage and other organisations such as the Museum of London hold and collate information on the archaeological and heritage assets in London. The Environment Agency now has baseline archaeological information produced by the Thames Archaeological Survey covering the Greater London foreshore. The survey will be complete and reported in April 1999. The Tidal Thames Landscape Assessment and Design Guidance (Environment Agency, 1996) includes details of the contribution of heritage to the character of the landscape in the different reaches along the Tidal Thames.

Pressure - Archaeology and Heritage

- 2.7.4 Archaeological remains are fragile and are being constantly degraded by the daily ebb and flow of tides. Disturbance of the foreshore and encroachment can damage or destroy these valuable remains and may increase the erosive power of the river.
- 2.7.5 The river walls themselves can also have visual and heritage value which can be lost when the walls are repaired or replaced. New development can also affect the setting and visual quality of the historic riverside environment.

Response - Archaeology and Heritage

- 2.7.6 The detrimental effects on the archaeological or heritage remains of any new flood defences must be carefully considered so that adequate measures can be taken to ensure the survival of this unique and irreplaceable resource.
- 2.7.7 Measures to protect archaeological or heritage resources include the commissioning of appropriate archaeological site works and post archaeological site works, preparation of Watching Briefs and artefact protection. Where possible, artefacts should be protected in situ. Watching Briefs ensure that flood defence works undertaken in the vicinity of known or potential archaeological remains incorporate adequate recording of finds for research and educational purposes.

LTFDP Archaeological and Heritage Objective: To give full consideration to archaeological and heritage issues when designing and implementing new flood defences including the protection or preservation of artefacts and the implementation of appropriate desktop studies, evaluation and excavation.

Indicator 1: The preservation or loss of archaeological remains and heritage features, as appropriate, so they continue to be part of our in situ heritage when flood defence works are implemented.

Indicator 2: The successful completion of the archaeological works, including on site and post site works, to the satisfaction of Greater London Archaeological Advisory Service.

2.8 Recreation

State - Recreation

- 2.8.1 The Thames Estuary is one of the busiest water recreation areas in the UK. It supports a range of water and land based sports and recreational pursuits with considerable potential for further development. Within the LTFDP area, the Thames and its tributaries draw people attracted to the water's edge and the foreshore. They use the rights of way network for walking, cycling and fishing as well as passive activities such as birdwatching or sightseeing to places of heritage interests. In many localities the rivers most valuable recreational asset is open space. The river itself provides opportunities for sailing, wind surfing, pleasure boating, rowing and canoeing. The flood defences within London therefore have considerable user potential in facilitating river-related recreation and in providing the backdrop for such activity.
- 2.8.2 Initiatives to develop the recreational potential of the Tidal Thames and its tributaries include the Thames Path National Trail that runs from the Thames Barrier to the source of the Thames. Linking into this national trail are a large number of strategic rights of way promoted and developed by the London Boroughs, London Walking Forum and Sustrans. Riverside access points including steps, stairs and slipways, number 228 in the LTFDP area (PLA, 1996). The Agency supports appropriate recreational use of the foreshore where this can be achieved safely and without prejudice to other interests such as sensitive habitats. The Agency is currently investigating opportunities to repair or improve access points at Blackwall and Glengall, Charlton Bank Stairs as well as providing new access points at the Millennium site in Greenwich as part of the LTFDP.

Pressure - Recreation

- 2.8.3 Public perception of the recreational potential of the Tidal Thames is poor, with a general perception that it is of limited recreational interest. The recreational impacts of new developments or flood defence works are consequently often ignored. The loss of riverside access steps, for instance, even where they are in disrepair, removes their future potential.

Response - Recreation

- 2.8.4 Built development and new flood defences should not restrict or compromise existing recreational resources or future opportunities. Where appropriate they should maximise or enhance recreational opportunities. The Recreation Strategy for the River Thames (NRA, 1995) presents the Agency's approach to the management and enhancement of recreation associated with the Thames.

LTFDP Recreation Objective: To protect and wherever possible enhance recreational opportunities along the Tidal Thames and its tributaries.

Indicator 1: Change in the length of riverside paths and access routes (m).

Indicator 2: Change in the number of access points to the river and foreshore providing safe and appropriate access.

Indicator 3: Change in the quantity of riverside public open space (m²).

2.9 Landscape

State - Landscape

- 2.9.1 Historically the River Thames has profoundly affected the development of London's landscape. However, in some parts of London it is possible to be right beside the river and yet be unaware of its presence. In order to provide an analytical overview of the landscape of the Thames through London, the Agency undertook a survey of the Tidal Thames between Teddington and Dartford Creek – *The Tidal Thames Landscape Assessment and Design Guidance* (1996). This classified a total of 21 generic river landscape types which fall into seven broad categories. These landscape types tend to be defined by existing land use but they are also determined by the scale and massing of buildings, the architectural styles and the presence and degree of enclosure by vegetation and buildings.
- 2.9.2 Many of these landscapes have a very strong sense of place, such as the City landscapes of Westminster and the City of London or the historic riverside 'villages' which have now coalesced within London. The River Thames forms a unifying element which provides continuity between these places but which also demonstrates inappropriate land use and site planning, and mundane design to the river user. It is clear that in many parts of London the need to consider the river as a key environmental resource is not being understood and acted upon.
- 2.9.3 The Tidal Thames Landscape Assessment found that nearly 30% of the Thames-side landscapes were green space – this is a surprisingly high figure until the location of this space is taken into account. At each end of the Tidal Thames there are landscapes of a semi-natural character which consist of marshland, riverside meadows and vegetated eyots together with formal parklands, public open space and riverside gardens. These green spaces provide a vital backdrop to the built-up areas, giving Londoners places to rest and relax and providing the necessary habitat for wildlife that utilises the Thames to co-exist in close proximity to highly developed urban areas.
- 2.9.4 At a more intimate level the treatment given to the riverbanks of the Thames, both in terms of bank profile and the materials used, is an important determinant of the landscape quality of the Thames corridor. Only some 1% of the Tidal Thames still has natural earth and vegetated banks, sloping banks constructed using artificial materials account for around 32% of the river banks while vertical banks (mostly walls) account

for a further 59%. The remaining 8% consists of wharves or a juxtaposition of various slopes and materials in close proximity, as found in residential areas.

- 2.9.5 The accessibility of the riverbank is also an important factor in determining the ability of the public to enjoy the river both at specific locations along the corridor and as a continuous unit (see section 2.8).

Pressure - Landscape

- 2.9.6 The design of riverside development and the river walls and defences, along with the management of the key visual features such as those of ecological and heritage interest, all have an impact on the landscape character of the Tidal Thames.

Response - Landscape

- 2.9.7 The Tidal Thames Landscape Assessment provides the guidance necessary for the effective planning and management of the riverside development. The relevant key issues that need to be considered include those relating to: the river channel; riverside green space and associated habitats; visual and environmental quality; riverside urban design; and access and activity. In addition to the Tidal Thames Landscape Assessment, part of the Tidal Thames is covered by the *Thames Landscape Strategy, Hampton to Kew*. There is a proposal to extend a similar initiative downstream between Kew and Chelsea.

LTFDP Landscape Objective: To conserve and wherever possible enhance the riverside of Tidal Thames and its tributaries.

Indicator 1: Change in river landscape quality based on the allocation of an appropriate value class (see Tidal Thames Landscape Assessment and Design Guidance).

Indicator 2: Change in river channel quality based on the allocation of an appropriate value class (see Tidal Thames Landscape Assessment and Design Guidance).

Indicator 3: Change in the quantity and aesthetic quality of the flood defences (Flood Defence Characteristics).

2.10 Water Quality

State - Water Quality

- 2.10.1 The Tidal Thames is divided into three reaches for water quality management purposes: freshwater; brackish; and marine. Each of these reaches has a different salinity range and supports different biological communities, however these zones are not static and their boundaries fluctuate with the tide and changes in flow. Water quality objectives are applied to the Tidal Thames which reflect its potential ecological and amenity value. Appropriate chemical and biological standards have been set in

order to achieve the overall water quality objectives. These standards incorporate Regional targets for dissolved oxygen and temperature along with statutory limits imposed by EC Directives for various dangerous and polluting substances. Compliance with these standards is assessed on a quarterly basis.

- 2.10.2 Following rainfall, discharges from London's combined drainage system can produce rapid decreases in dissolved oxygen (DO) levels. The severity of the resulting DO 'sag curve' depends on such factors as rain intensity and duration, river temperature and freshwater flow at Teddington.

Pressure - Water Quality

- 2.10.3 Water quality is a critical pressure upon the wildlife and conservation value of the Tidal Thames. As highlighted above (see section 2.2.2), the LTFDP can contribute to the protection of water quality by preventing the pollution of surface waters by contaminated land which is frequently found behind flood defences. This is an important potential environmental benefit. Assuming that this occurs the LTFDP is unlikely to affect water quality in any other significant manner.

Response - Water Quality

- 3.10.4 In order to sustain the improvements in water quality, the pressures on the tideway are closely monitored and interactively managed. Crucial to the management of the dissolved oxygen levels in the summer months is the Operating Agreement between Thames Water and the Agency. This Agreement covers improved sewage treatment work effluent standards, operation of the Thames Bubbler and Vitality for alleviation of the effects of storm discharges and the suspension of abstraction above Teddington in order to provide extra flow in the tideway at critical times.

LTFDP Water Quality Objective: To avoid adverse impacts upon water quality arising from disturbance of contaminated land by LTFDP.

Indicator 1: Number of sites where contamination is contained/remediated.

Table 4: London Tidal Flood Defences Programme - Environmental Objectives and Indicators

Environmental Assets	LTFDP Objectives	LTFDP Indicators (Measuring change)
Hydrology and Geomorphology	To maintain, and if possible increase, the channel capacity of the Tidal Thames and minimise obstructions to avoid increased flood risk and the adverse effects of sedimentation and erosion.	<ul style="list-style-type: none"> • Change in channel capacity (m³) in any reach. • Change in cross-sectional area (m²) in critical points.
Fisheries	To conserve and, wherever possible, enhance intertidal and sub-tidal habitats of value to fisheries for food, shelter and spawning.	<ul style="list-style-type: none"> • Change in the quantity and quality of natural or semi-natural intertidal and sub-tidal habitats (Tidal Zonation Balance). • Change in the quantity and quality of flood defences providing suitable fisheries habitats (Flood Defence Characteristics).
Aquatic Biology	To support invertebrate populations for the benefit of the Tidal Thames ecology by protecting and, wherever possible, enhancing intertidal and sub-tidal habitats for the benefit of invertebrate populations.	<ul style="list-style-type: none"> • Change in the quantity and quality of natural and semi-natural intertidal and sub-tidal habitats (Tidal Zonation Balance). • Change in the quantity and quality of flood defences providing suitable invertebrate habitats (Flood Defence Characteristics).
Nature Conservation	To support plant, bird and mammal populations by conserving and enhancing appropriate habitats.	<ul style="list-style-type: none"> • Change in the quantity and quality of natural or semi-natural intertidal and sub-tidal habitats (Tidal Zonation Balance). • Change in the Quantity and quality of flood defences providing habitats for plant, bird and mammal populations (Flood Defence Characteristics).
Archaeology and Heritage	To give full consideration to archaeological and heritage issues when designing and implementing new flood defences including the protection or preservation of artefacts and the implementation of appropriate desktop studies, evaluation and excavation.	<ul style="list-style-type: none"> • The preservation or loss of archaeological remains and heritage features, as appropriate, so they continue to be part of our in situ heritage when flood defence works are implemented. • The successful completion of the archaeological works, including on site and post site works, to the satisfaction of Greater London Archaeological Advisory Service.
Recreation	To protect and wherever possible enhance recreational opportunities along the Tidal Thames and its tributaries.	<ul style="list-style-type: none"> • Change in the length of riverside paths and access routes. • Change in the number of access points to the river and foreshore providing safe and appropriate access. • Change in the quantity of riverside public open space.
Landscape	To conserve and wherever possible enhance the riverside of Tidal Thames and its tributaries.	<ul style="list-style-type: none"> • Change in the river landscape quality based on the allocation of an appropriate value. • Change in the river channel quality based on the allocation of an appropriate value. • Change in the quantity and aesthetic quality of flood defences (Flood Defence Characteristics).
Water Quality	To avoid adverse impacts upon water quality arising from disturbance of contaminated land by LTFDP.	<ul style="list-style-type: none"> • Number of sites where contamination is contained/remediated.

SECTION 3

FLOOD DEFENCE OPTIONS

3.1 Background

3.1.1 The range of flood defence options for the Tidal Thames are briefly discussed below. These options will have to be assessed by the Agency on technical, economic and environmental grounds. At the feasibility stage of any individual flood defence scheme the environmental impact assessment is commenced, so that the results can feed back and influence the recommended option to be taken forward to design. At the same time a range of engineering solutions will be examined, to assess their whole-life costs, and thus the cost-effectiveness of the solution. Note that none of this detail can proceed unless previous work, in the form of an embayment study, has justified the need for the engineering works in terms of the potential benefits of flood damage avoidance. In the case of works being carried out by riparian land owners, reference should be made to the Agency's Tidal Thames Contribution Policy.

3.1.2 Potential flood defence strategies for the Tidal Thames embayments are:

- do nothing;
- minimum level of investment;
- low level of investment;
- high level of investment;
- strategic options.

3.2 Flood Defence Options

Do Nothing

3.2.1 No work would be carried out to prevent flooding from the River Thames and tributaries. As the frontages forming the tidal defences fall into disrepair they would be allowed to fail. Eventually certain areas of an embayment would be flooded twice daily, and property in all areas below the 1 in 10 flood level would be likely to be written off. There would be recurrent property and infrastructure damage to areas beyond the 1 in 10 year flood envelope. There is a significant risk that, at the time of an extreme event, multiple frontage failures could occur posing a serious threat to human life.

Minimum Level of Investment

3.2.2 With the minimum level of investment no works would be carried out until actual failures occur, to absolutely maximise the life of each frontage. This would be beyond the estimated useful life of a frontage, which is the life at which some form of failure (not necessarily total collapse) is likely to occur. Whilst this option could minimise the average annual capital cost of renewals, there are other factors to take into account, namely:

- cost of emergency works to make safe a failed defence - this could include closures of the Thames Barrier on each tide for a number of days following failure;
- actual damage to property behind and adjacent to the failed frontage;
- once failure has taken place a repair to prolong the life is not an option.

3.2.3 In addition, there may be concerns from local residents and businesses that the Agency is not acting soon enough, and therefore is not carrying out its responsibilities satisfactorily.

Low Level Investment

3.2.4 This would involve regular inspections to monitor the state of the flood defences. They would not be replaced until signs of distress became obvious and the end of their useful life was reached. These signs could include movement of the wall, cracks in concrete, rotted timber, or similar deterioration. At this point action would be taken to safeguard the defences, although whether this solution would be high capital/low maintenance or low capital/high maintenance engineering works would be left for the detailed engineering feasibility study for each frontage.

3.2.5 This study would be required to consider the costs over a given period after initial works were carried out on site, for example 60 years. With this option repairs to extend the useful life may be a realistic possibility, although ultimately renewal of the frontage would be necessary. At the embayment study stage, when the potential benefits and phased costs to all frontages are assessed, it must be assumed that a low-level investment will defer, but not obviate, the need for full renewal of a flood defence.

High Level Investment

3.2.6 A high level investment would adopt a policy of replacing each frontage when it nears the end of its anticipated useful life, but before failure actually occurs. In most cases repairs would not be considered due to the uncertainty of the remaining life of the various components comprising the frontage. Whilst this is the lowest risk option for the Thames flood defences, it does not maximise the life of each frontage, and as such would lead to a higher annual investment than other options.

Strategic Options

3.2.7 In certain areas it may be possible to examine a strategic option for flood defences, possibly involving a total realignment of the defences. An example could be on a peninsula, where a new line of defence across the neck could be more cost-effective than protecting the perimeter of the peninsula. Another example may be a totally realigned defence behind land that could be permitted to flood on occasions, such as some recreational land. In each case a full comparison of the costs and the benefits both with and without the strategic option would be required, in order to see whether such an option would be economically justifiable.

3.3 Delivery of Options and Environmental Appraisal

3.3.1 The embayment studies are intended to justify the expenditure of funds on the flood defences protecting an embayment. The studies are based on a visual survey of frontages and assumed flood defence options resulting from that survey. Once such a justification has been made, the actual option adopted for an individual frontage will depend on the particular circumstances of that frontage, following more detailed site investigation. Such options may include sub-options, both in terms of alignment of the defences and the type of design and/or materials to be used.

3.3.2 In terms of alignment, the sub-options include:

- **retreat** - install the new flood defences behind (inland) of those existing. This option may have environmental benefits by increasing the area of foreshore if the old defence is removed;
- **online** - replace the existing flood defences along the same alignment. In the short term this is likely to cause damage, but it should be possible to mitigate for this. In the long term, this option is likely to be neutral in environmental impact terms;
- **encroach** - install new defences in front of those existing. This option would have adverse environmental impacts, primarily the encroachment onto the foreshore thereby decreasing habitat area and losses of river channel capacity. This option will require more extensive compensation.

3.3.3 The Agency's preferred approach is to retreat flood defences, as has been achieved at the Millennium site, Greenwich, and the least preferred approach is to encroach. Where social, economic and technical factors do not allow retreat to be achieved the online or even encroach options may have to be adopted. In these cases any damage should be measured and mitigated, in accordance with the 'Mitigation and Compensation Hierarchy' and the balance sheet approach (see sections 4.4 and 4.5).

3.3.4 Where new defences are required and space is available, there are a range of sub-options that increase the area of the colonisable habitat, such as foreshore re-creation or stepped revetments, as indicated in *Partnership in Planning* (1997b). The most appropriate materials and design will have to be assessed on a case by case basis to maximise the amenity and habitat potential, options include steel sheet piled, timber piled, concrete and rock-filled gabion baskets. Additional options include timber fenders, brick/rock facing and planting shelves.

3.3.5 The constraints that affect the alignment include:

- current land use and land value on the landward side of the defence;
- buried hazards, contamination and buried obstructions landward of the defence;
- quality and quantity of the environmental assets, their rarity and distribution;
- alignment of adjacent frontages and criticality of river cross section.

3.3.6 The technical variables that determine the flood defence construction type and materials include: defence loading; height; foreshore slope; river velocity; current materials; and condition of current defences.

SECTION 4 ENVIRONMENTAL MANAGEMENT OF FLOOD DEFENCE WORKS

4.1 Background

- 4.1.1 This Strategic Environmental Framework covers all 22 embayments and will accompany the Agency's application for AIP for each embayment. It will also form the environmental framework and approach to be adopted by the Agency in managing London's Tidal flood Defences. Environmental Assessment will be conducted for individual flood defence works as part of LDW1 applications and in accordance with appropriate Environmental Assessment Regulations.

4.2 Environmental Assessment

- 4.2.1 Flood defence works carried out by the Agency are subject to the Land Drainage Improvements Works (Assessment of Environmental Effects) Regulations 1988 (SI No. 1217, as amended by SI No. 95/2195), if they are improvements to existing works. If they are new works, they are subject to the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI No. 1199, as amended) and require planning permission. The vast majority of works carried out by the Agency in the LTFDP fall under SI 88/1217. These Regulations implement European Council Directive on the 'assessment of the effects of certain public and private projects on the environment' (85/337/EEC).
- 4.2.2 Both sets of Regulations require the preparation of an Environmental Statement where the impact of the project is likely to be significant. Where the impacts are not predicted to be significant the Agency nonetheless produces an Environmental Report. Whether an Environmental Statement or Report is produced, land drainage improvements are advertised in accordance with the requirements of SI 88/1217 and sent to English Nature, English Heritage and the Countryside Commission as well as non-statutory consultees who may have an interest in the scheme.
- 4.2.3 Note that a new EC Directive (97/11/EC) which amends the original Directive (85/337/EEC) on environmental impact assessment must be implemented in the member states by 14 March 1999. The DETR and MAFF have consulted interested parties on replacement Statutory Instruments covering planning projects and land drainage improvements respectively and it is anticipated that new Regulations will be in place from this date.
- 4.2.4 The Agency's LTFDP is managed by a Project Management Team reporting directly to the Flood Defence Client. The Project Managers draw upon the Agency's internal environmental specialists through the Regional Environmental Assessment Team to assist in project design from project inception through to post-construction audit. In particular, all projects in the LTFDP undergo environmental assessment including a mandatory Scoping phase to advise upon:
- investigation of environmental effects of appropriate alternatives;
 - survey requirements;
 - choice of preferred option;

- impact prediction;
- mitigation, compensation and enhancements;
- detailed design issues;
- post-project monitoring and appraisal.

4.2.5 The linkages between the Agency's Project Management and Environmental Assessment processes are shown in Figure 6. These are critical to ensure that environmental issues are fully considered during project design. The critical feature of this system is the twin tracking of technical issues alongside environmental design throughout the project life.

4.2.6 An important aspect in the decision-making process and design of new flood defences is adherence to the Agency's LTFDP 'Mitigation and Compensation Hierarchy' which aims to support delivery of schemes which avoid or minimise adverse environmental effects with provision of appropriate mitigation and compensation. The Hierarchy is described in detail in section 4.4.

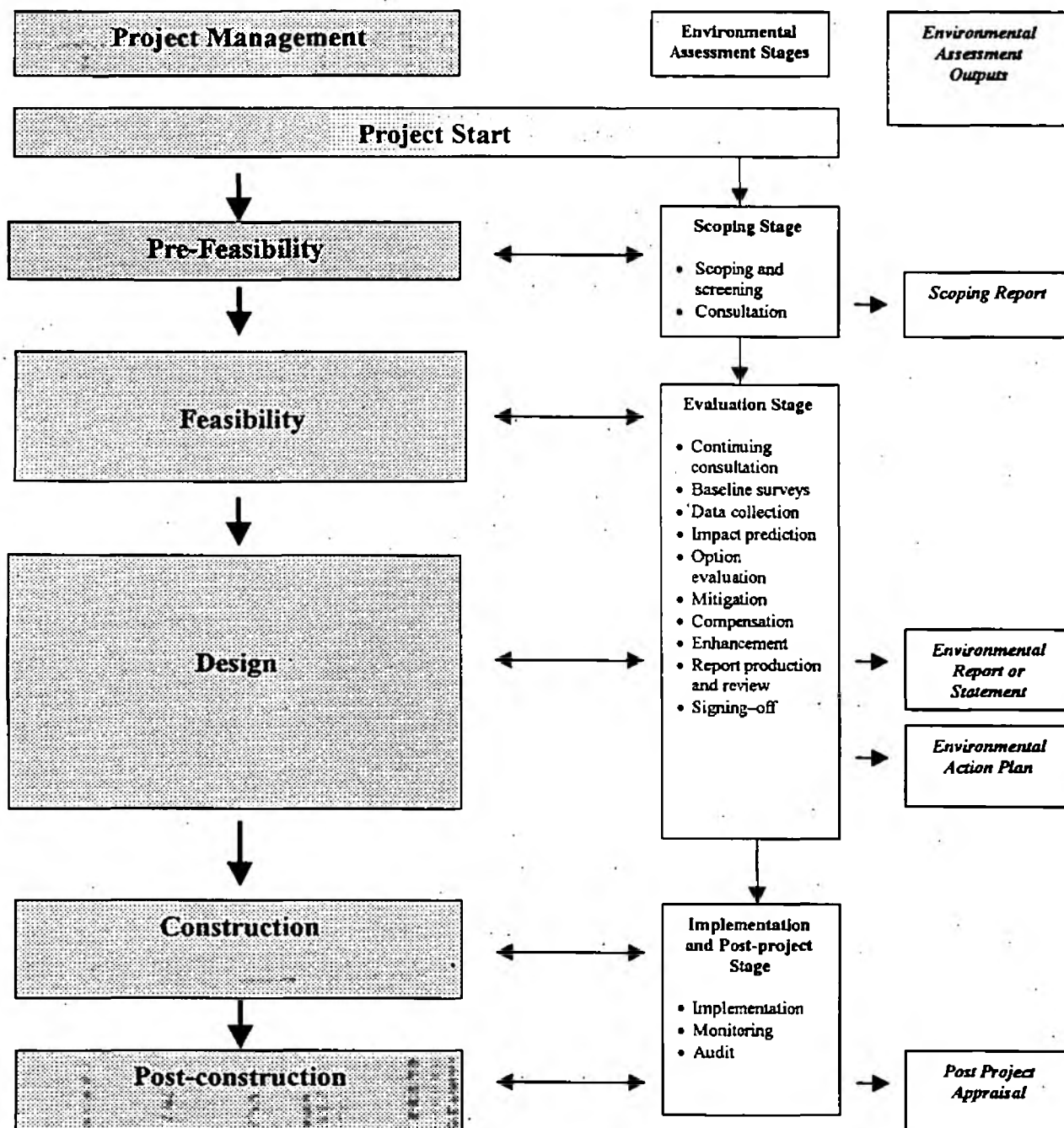
4.3 Consultation

4.3.1 The Strategic Environmental Framework was the subject of internal consultation within the Agency before the current external consultation exercise. Specialists in the fields of biology, conservation, fisheries, development control, flood defence, geomorphology, ground and surface water quality, landscape, pollution control, recreation and archaeology were all involved.

4.3.2 The following statutory and non-statutory consultees are being consulted on this version of the SEF: English Nature, English Heritage, Countryside Commission, MAFF, London Ecology Unit, Museum of London/Thames Archaeological Survey, London Wildlife Trusts, RSPB, Port of London Authority and London Walking Forum. The Agency have also placed advertisements in newspapers stating that the SEF has been produced, where copies can be obtained from and inviting comments.

4.3.3 Formal consultation under the Land Drainage Improvement Works (Assessment of Environmental Effects) Regulations SI 88/1217 as amended will take place as part of the environmental assessment process for any individual works that are proposed within individual embayments.

Figure 6: The Project Management and Environmental Assessment Processes



4.4 LTFDP Mitigation and Compensation Hierarchy

- 4.4.1 The Agency aims to conserve and, wherever possible, enhance the environment when undertaking capital works. Therefore, as part of the LTFDP the Agency aims to pursue a no net loss of environmental assets approach. Given that the environmental assets of the Tidal Thames, particularly the foreshore, are increasingly at risk from *ad hoc* and piecemeal encroachment by flood defence works and new development the Agency has developed a 'Mitigation and Compensation Hierarchy' to ensure a systematic and transparent decision-making and design process for tidal flood defence works.
- 4.4.2 Critical to the effective implementation of the hierarchy is recognition that it provides a framework only and that each case will need to be examined on a site by site basis allowing individual site issues to determine the final approach. In addition to the provision of suitable mitigation and compensation outlined in this hierarchy the Agency will also seek to identify opportunities for environmental enhancements through its capital works programme.
- 4.4.3 This mirrors approaches being pursued in both the UK and USA (Hutton, 1998 & Hugget, 1998). The hierarchy is illustrated in Figure 7 and described below. The hierarchy is designed to be sequential, with the primary objective being the avoidance of adverse environmental effects.

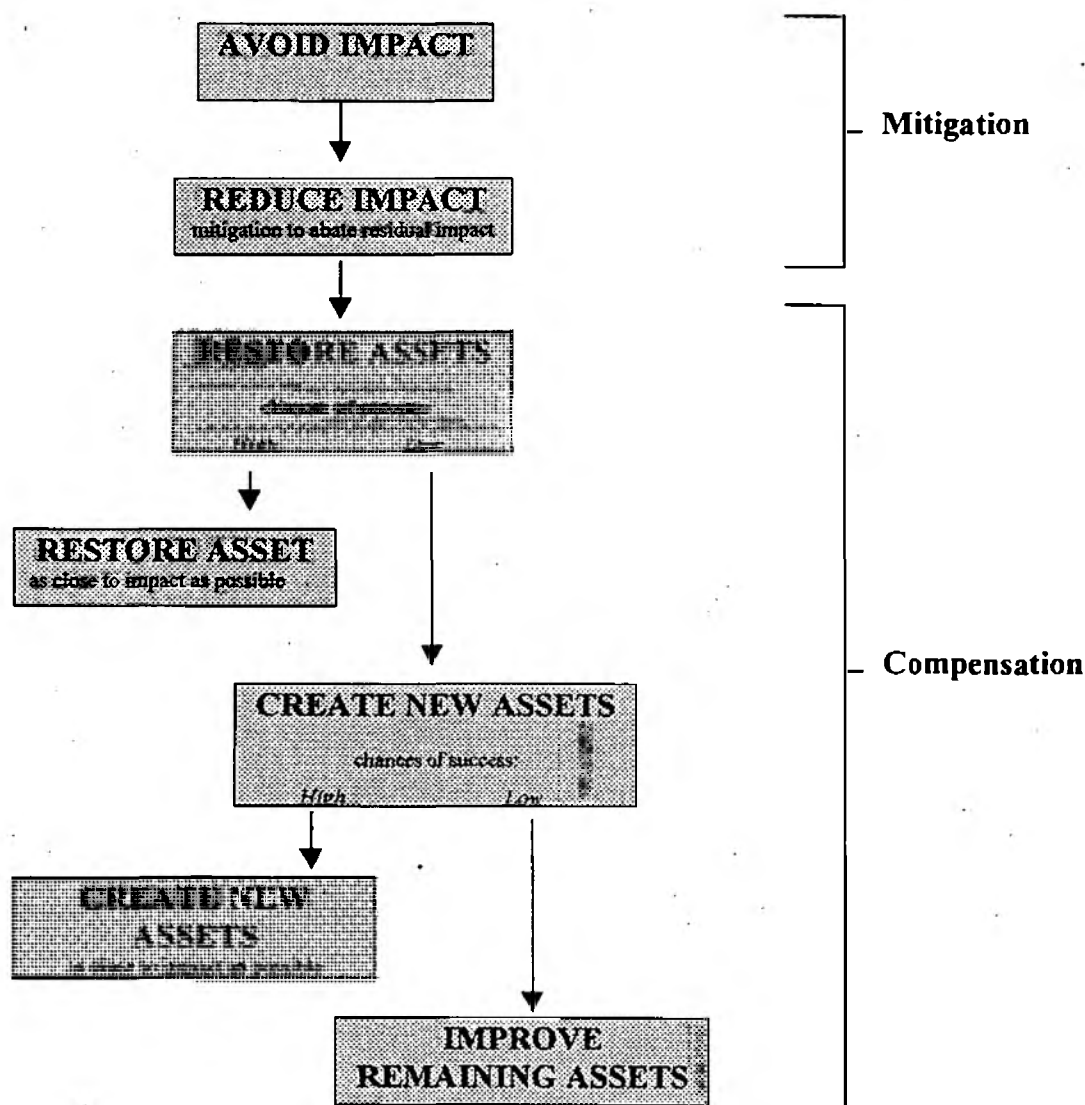
Avoid Impact

- 4.4.4 This includes the do-nothing or do-minimum options and in the case of tidal flood defence works could involve 'patch and repair' to a flood wall or a new wall constructed on the same alignment thus avoiding the adverse impact of foreshore encroachment. However, even if the works do not cause an encroachment they will also have to ensure that the habitat or aesthetic value of the flood defences is not affected.
- 4.4.5 There will be some assets that are considered to be of such value that it is not acceptable to mitigate or compensate for their loss or damage. Impacts on these assets, which can be referred to as 'critical natural capital' (e.g. nationally and internationally protected sites and species), should therefore always be avoided.

Reduce Impact

- 4.4.6 Where adverse impacts cannot be avoided the Agency aims to reduce the impact to the absolute minimum. A typical LTFDP scenario would be the existence of severely contaminated land preventing adoption of an 'on-line' flood defence alignment and requiring the new defences to be placed in front of the existing defences. Clearly this would have an adverse impact upon foreshore habitat and in such a case the Agency would aim to reduce the level of encroachment to an absolute minimum. Whilst the impact will have therefore been reduced there will nonetheless be an adverse environmental effect and the Agency will seek to compensate for this residual effect (see below). Another example of how the impact of the new defences can also be reduced is by the reuse of old timbers removed as non- structural components.

Figure 7: Tidal Thames Mitigation and Compensation Management Hierarchy



Compensation Measures (Restore, Create, Improve)

- 4.4.7 The remaining three Hierarchy options, restore, create and improve the environmental assets, relate to the provision of compensation for residual adverse impacts once the avoid and reduce options have been fully explored. Compensation for residual adverse environmental impacts can be extremely difficult as the compensation must aim to restore both the quality and quantity of the environmental assets damaged or lost.
- 4.4.8 In determining the preferred approach for each of the compensation measures (restore, create, improve) both the quality and quantity of the asset needs to be considered. The most desirable option provides a matching quality (e.g. diversity and numbers of species and dependencies) and quantity (e.g. area of foreshore) of compensation as close to the site of loss as possible. Conversely, an off-site option some distance away offering a smaller area, with lower productivity and value would be the least acceptable option. However, whilst a

'same site' preference will help to ensure foreshore continuity in strategic terms there may be advantages in identifying off-site locations for compensation.

- 4.4.9 Each project will need to be assessed on a case by case basis considering the strategic management of the intertidal zone as a resource across the whole of the Tidal Thames. Establishing an 'environmental asset balance sheet' for the Tidal Thames, which accounts for losses and gains, over time, of foreshore attributes (e.g. accessible foreshore, spawning grounds, reed beds) and ensures that no net loss is achieved will be desirable.
- 4.4.10 The risks associated with the compensation option chosen must also be assessed. Re-creating habitat, for instance, is not always successful and although theoretically an ideal form of compensation it may not be acceptable if the likelihood of successful re-creation is low.

Restore Assets

- 4.4.11 As a compensation measure, this option aims to restore the functions and value of a degraded or lost environmental asset. To achieve this the Agency will seek sites where such an asset once existed and restore it to its former condition.

Create New Assets

- 4.4.12 Where opportunities to restore environmental assets to their former condition do not exist it may be appropriate to try to recreate environmental assets. In terms of recreation for instance this could include construction of a new riverside footpath on a flood defence wall. This example has a high chance of success, but it may be more difficult to create new, fully functioning habitat at a site where it has not existed before.
- 4.4.13 Clearly to pursue this compensation option, the Agency would be required to undertake detailed surveys and wide and thorough consultation to improve the chances of success. What is critical is that the newly created environmental asset, as far as possible, replicates the functions of the asset that has been lost.
- 4.4.14 The Millennium site at Greenwich is an example of creating new assets. In this example, 500m² of foreshore that was lost through encroachment has been compensated for by the creation of 5584m² of new intertidal habitat. In addition, 1,173m of new riverside path and one new safe access point to the foreshore have been created.

Improve Remaining Assets

- 4.4.15 Where a residual adverse environmental impact cannot be compensated for by restoring former or creating new environmental assets (and thereby maintaining the quantity as well as the quality of assets) the Agency will implement the 'improve' compensation option. This will not result in the maintenance of the overall stock of the asset (the quantity) which is in fact reduced but, by improving the quality of the asset that remain, the overall value (in terms of quality but not quantity) of the asset can be maintained or increased. For example, where the Agency's flood defence works lead to

encroachment onto the foreshore that cannot be compensated by the 'restore' or 'create' options the Agency may consider improving the asset that remains, in the case the foreshore. This could include planting reed beds to improve its functional value in terms of providing increased niches for invertebrates, fisheries and birdlife. In addition, the aesthetic value of the frontage could be improved. The overall quality would therefore be increased, whilst the quantity may be reduced.

Summary of Mitigation and Compensation Hierarchy

- 4.4.16 The Hierarchy offers a pragmatic approach to dealing with the very real problem at some sites of the necessity to encroach onto the foreshore. The hierarchy of avoid impact, reduce impact, restore assets, create new assets and improve remaining assets must be strictly applied in this sequence in order to avoid allegations that the foreshore is tradable. This requires a clearly documented justification each time a step down the hierarchy is taken.
- 4.4.17 The ultimate aim of the hierarchy is to achieve selection and design of tidal flood defence schemes that offer the Best Practicable Environmental Option (BPEO). Ideally, mitigation and compensation measures will be implemented close to the site of adverse impact and, wherever possible, within the embayment. However, there may be instances where appropriate mitigation or compensation cannot be provided within the embayment itself and it has to be provided elsewhere along the London Tidal Thames.
- 4.4.18 To ensure adequate monitoring and assessment of the LTFDP the Agency intends to determine the effects of individual flood defence works upon the tideway as a whole through the use of an Environmental Assets Balance Sheet (see section in section 4.5).

4.5 LTFDP Environmental Assets Balance Sheet

- 4.5.1 Integral to the effective management of environmental assets is proper accounting. An asset cannot be properly managed if it is not known how much of it exists and whether it is increasing or decreasing in quality and quantity. The Agency is carrying out a variety of baseline surveys to increase understanding of the environmental assets.
- 4.5.2 The Agency intends to use this approach to manage environmental assets on the Tidal Thames, such as foreshore access points, archaeological sites and areas of foreshore habitat, to ensure that the Agency's LTFDP contributes to the SEF objectives. The balance sheet measures changes (both positive and negative) to environmental assets resulting from flood defence works carried out by the Agency. It is also hoped that works carried out by external developers can also be included in the balance sheet to provide a complete picture and that these developers can be encouraged to provide the information required. This mechanism provides a pragmatic and systematic approach to environmental management whereby schemes are assessed not only on the effect that they have on an individual locality, but also on the Tidal Thames environment as a whole.
- 4.5.3 This approach acknowledges that where, having followed the mitigation hierarchy, some adverse impact is inevitable it allows for compensation locally off-site. This is the very heart of sustainability for it accepts that social and even economic factors may take precedence in some instances over environmental factors. However, it ensures

that environmental losses are not ignored but are compensated for. The ultimate aim is a balance sheet whose net balance which shows a net gain in environmental assets, or at least, no net loss.

4.5.4 The Agency will produce a balance sheet for each of the 22 embayments. These will identify the trends in the quantity and quality of assets and which ideally will show a net improvement or no change. However, there may be embayments where the balance for some assets proves negative, this should be offset by gains in other embayments when the 22 embayments are totalled as a whole. Any trade-offs will be considered carefully to ensure that assets in certain reaches are not degraded irreversibly. This approach will also help the Agency to prioritise future enhancement funding to turn a trend of a net loss to a net gain. Changes to the environmental assets arising from the LTFDP will be monitored for each embayment using the environmental indicators identified in section 2.

4.5.5 Post-project appraisal and R&D should form an essential element of any works, to avoid the repetition of ineffective strategies, designs and procedures. The Agency recognises that our understanding of natural and physical processes and systems is still not complete and that an element of uncertainty exists in terms of the baseline environment and impact mitigation and enhancement measures. The Agency will therefore undertake post-project appraisal in order to allow amelioration of any reported and unforeseen environmental problems and to improve the design and implementation of future schemes. Appraisal will examine the impacts of tidal defence works and the efficacy of mitigation and enhancement measures both on-site and in the wider area.

Table 5: Environmental Balance Sheet (Embayment:)
changes in the environmental assets of the embayment arising from the Agency's actions

TOTAL CHANGE											LOCATION	ENCROACHMENT (+ or - metres over distance)		TIDAL ZONATION
												Quantity (m ²)	TERRESTRIAL	
											Type			
											Quantity (m ²) <td>UPPER ZONE</td> <td></td>	UPPER ZONE		
X											Type			
											Quantity (m ²) <td>MIDDLE ZONE</td> <td></td>	MIDDLE ZONE		
X											Type			
											Quantity (m ²) <td>LOWER ZONE</td> <td></td>	LOWER ZONE		
X											Type			
											Quantity (m ²) <td>SUB TIDAL</td> <td></td>	SUB TIDAL		
X											Type			
											Length of vertical (m) <td rowspan="4">FLOOD DEFENCE CHARACTERISTICS</td> <td></td>	FLOOD DEFENCE CHARACTERISTICS		
											Length of sloped (m) <td></td>			
											Length of terraced (m) <td></td>			
X											Type			
											Length of riverside path (m) <td rowspan="3">RECREATION</td> <td></td>	RECREATION		
											No. of safe access points (incl. improvements) <td></td>			
											Quantity of riverside public open space (m ²) <td></td>			
											Preservation in situ (yes/no) <td rowspan="2">ARCHAEOLOGY / HERITAGE</td> <td></td>	ARCHAEOLOGY / HERITAGE		
											Works completed to GLAAS satisfaction (yes/no) <td></td>			
											River landscape value class & strategy <td rowspan="2">LANDSCAPE</td> <td></td>	LANDSCAPE		
											River channel value class & strategy <td></td>			
											Channel capacity (m ³) <td rowspan="2">RIVER HYDROLOGY</td> <td></td>	RIVER HYDROLOGY		
											Cross-sectional area (m ²) <td></td>			
											Contamination contained/remediated (yes/no) <td rowspan="2">WATER QUALITY</td> <td></td>	WATER QUALITY		

Balance Sheet Key

Tidal Zonation

Type: F: fine (muddy)
M: medium (sandy)
C: coarse (gravel)
R: very coarse (rock)
V: vegetated
NH: new inter-tidal habitat

Flood Defence Characteristics

Type: EP: earth bank – protected (revetment etc)
EV: earth bank – vegetation only
SSP: steel sheet piled
TP: timber piled
B: brickwork
M: masonry
C: concrete
R: rock armouring, rock-filled gabions and mattresses
+f: plus fendering
+b: plus brick/rock facing
+s: plus planting shelf

Landscape Evaluation

value class:

- 1: mostly positive attributes
- 2: a mix of positive and negative attributes
- 3: mostly negative attributes

SECTION 5

THE WAY FORWARD

- 5.1.1 It is intended that an Environmental Balance Sheet will be produced for each of the 22 embayments. As schemes in the London Tidal Flood Defences Programme are developed, the Agency's various environmental specialists will provide the necessary data as part of the environmental assessment process to complete a line for each scheme in the balance sheet covering the relevant embayment. Note that each of these individual scheme will have been subjected to environmental assessment prior to their development.
- 5.1.2 The Agency's Regional Environmental Assessment section will be responsible for receiving the returns and collating and updating the balance sheets. Once the balance sheets for the individual embayments are complete, the data will be combined to produce a single balance sheet annually for the whole of the Tidal Thames.
- 5.1.3 Having implemented the mitigation and compensation hierarchy and the balance sheet approach for the Agency's tidal flood defence works it is intended that a similar approach will be promoted to third party developers. The tidal flood defence works undertaken by the Agency only represent part of all the works that are carried out and therefore it is necessary to ultimately incorporate these works to produce a comprehensive measure of the status of each asset.
- 5.1.4 It is aimed that as a result of tidal flood defence works there will be a no net loss of environmental assets. The completed balance sheets will be used to influence future works to achieve this aim.
- 5.1.5 Where gaps in the available data have been identified, the Agency will aim to work towards filling these gaps. As our understanding of the Tidal Thames increases, the approach in this Strategic Environmental Framework including the objectives and indicators will be reviewed as appropriate.

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