



Strategy Appraisal Report

Authority scheme
reference

Defra/WAG LDW
number

Promoting
authority

Environment Agency

Strategy
name

Medway Estuary and Swale Strategy (MEASS)



Flooding at Halling Marshes in 2013.

Date

January 2019

Version

2.2

StAR for *Medway Estuary and Swale Strategy*

Version	Status	Signed off by:	Date signed	Date issued
0.1	Early Draft			
0.2	Update following comments and consultation			
0.3	Update following Project Team review			
0.4	Update following change to one option			
1.0	Submission to LPRG	Jeremy Colbeck	20/08/2018	22/08/2018
2.0	Submission following LPRG review	Jeremy Colbeck	10/10/2018	10/10/2018
2.1	Submission following LPRG meeting	Jeremy Colbeck	03/12/2018	03/12/2018
2.2	Submission following LPRG further comments	Jeremy Colbeck	16/01/2018	16/01/2018

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For technical approval of the business case

Environment Agency Region: South East

Project name: Medway Estuary and Swale Strategy

Approval Value: £ 469,392k

Sponsoring Director: Toby Willison **Director of Operations**

Non-financial scheme of delegation

Schedule C, Part 3 of the Non-financial scheme of delegation states that approval of FCERM Strategies/Complex Change Projects, following recommendation for approval from the Large Projects Review Group, is required from the Executive Director of Operations.

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Approval history sheet

APPROVAL HISTORY SHEET (AHS)			
1. Submission for review (to be completed by team)			
Project Title: Medway Estuary and Swale Strategy		Project Code: IMSE100406	
Project Manager: Rebecca Reynolds		Date of Submission: 16/01/2019	
Lead Authority: Environment Agency		Version No: 2.2	
Consultant Project Manager: Beth Riley		Consultant: Mott MacDonald Ltd	
<i>The following confirm that the documentation is ready for submission to PAB or LPRG. The Project Executive has ensured that relevant parties have been consulted in the production of this submission.</i>			
Position	Name	Signature	Date
Project Executive	Jeremy Colbeck		16/01/19
	Job Title:	Senior Project Manager	
2. Review by: Large Projects Review Group (LPRG)			
Date of Meeting(s):		Chairman:	
Recommended for approval: In the sum of £:		Date:	Version No:
3. Environment Agency NFSoD approval <i>Officers in accordance with the NFSoD.</i>			
Version No:		Date:	
Project Approval	By: In the sum of: £	Date:	
4. Defra or WAG approval <i>(Delete as appropriate)</i>			
Submitted to Defra / WAG or Not Applicable (as appropriate)		Date:	
Version No. (if different):			
Defra/ WAG Approval: or Not applicable (as appropriate)		Date:	
Comments:			

**NON FINANCIAL SCHEME OF DELEGATION (NFSoD) COVERSHEET FOR A FCRM
COMPLEX CHANGE PROJECT / STRATEGIC PLAN**

1. Project name	Medway Estuary and Swale Strategy		Start date	Jan 2015
			End date	October 2018
Business unit	Kent and South London	Programme	FCRM	
Project ref.	IMSE100406	Regional SoD ref.		Head Office SoD ref.

2. Role	Name	Post Title
Project Sponsor	Mark Douch	KSL FCRM Manager
Project Executive	Jeremy Colbeck	Senior Project Manager
Project Manager	Rebecca Reynolds	Project Manager

3. Risk Potential Assessment (RPA) Category	Low	<input type="checkbox"/>	Medium	<input type="checkbox"/>	High	<input type="checkbox"/>
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4. NFSoD value	£k
Whole Life Costs (WLC) of Complex Change Project / Strategic Plan	469,392

5. Required level of Environmental Impact Assessment (EIA)	N/A <input checked="" type="checkbox"/>	Low <input type="checkbox"/>	Medium <input type="checkbox"/>	High <input type="checkbox"/>
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6. NFSoD approver name	Post title	Signature	Date
Toby Willison	Executive Director of Operations		
NFSoD consultee name	Post title	Signature	Date
	LPRG Chair		

1 Executive summary

1.1 Introduction and background

- 1.1.1 The Environment Agency has produced the Medway Estuary and Swale Strategy (MEASS) to plan and co-ordinate a technically sound, environmentally acceptable and economically viable proposal for coastal flood and erosion risk management over the next 100 years.
- 1.1.2 MEASS covers 120km coastline in Kent, from the village of Stoke on the Hoo Peninsula, down the River Medway to Aylesford and then along the Medway and Swale Estuaries to the Sportsman Pub in Graveney including the Isle of Sheppey.
- 1.1.3 The coastline includes a mixture of embankments, sea walls, revetments, quay walls, sheet piling and beach and rock groynes, many of which are aging and reaching their residual lives. In some of the rural areas there is a current risk of flooding as low as 50% Annual Exceedance Probability (AEP). Within the more residential areas there is generally a 1% AEP however with sea level rise this will decrease over the next 100 years.
- 1.1.4 The strategy sits under two Shoreline Management Plans (SMPs): Medway Estuary and Swale SMP (approved in 2010) and the Isle of Grain to South Foreland SMP (approved in 2010).
- 1.1.5 A Habitat Regulation Assessment (HRA) was required under the Conservation of Habitats and Species Regulations 2010 and a letter of support has been received from Natural England (Technical Appendix L).
- 1.1.6 The strategy frontages have been divided into 11 Benefit Areas (BAs), which are further divided into sub-benefit areas. These are shown in Figure 1.
- 1.1.7 The strategic objectives of MEASS are to:
- Reduce flood and erosion risk to properties and infrastructure at significant or very significant risk in light of coastal change over the next 100 years.
 - Maintain the integrity of Natura 2000 sites (protected under the Habitats and Birds Directives (92/43/EEC and 2009/1477/EC)) assuming the loss due to coastal squeeze of 113ha of saltmarsh habitat between years 0-20 and a further 140ha of saltmarsh habitat between years 20-50.
 - Favour options that reduce the whole life costs of current defences.
 - Favour options that support delivery of the Thames River Basin Management Plan.
 - Help enable local plan objectives to be realised where possible.
- 1.1.8 Works identified by MEASS will be implemented using powers under the Coast Protection Act, 1949, the Land Drainage Act, 1991 and the Environmental Permitting Regulations 2016. Schemes will be subject to Town and Country Planning regulations and land drainage regulations.

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1.2 Problem

- 1.2.1 The MEASS area contains assets at risk of coastal flooding and erosion with a present value of £1.3 billion based on damages expected over the next 100 years. This includes risk of coastal flooding and erosion to 17,226 properties, nationally important infrastructure, important heritage assets, recreational sites and internationally designated environmental areas.
- 1.2.2 Many of the defences across the strategy were constructed or refurbished in the 1970s/early 1980s and have only a 10-20 year residual life, with a few areas with less than 5 year residual lives such as the sea walls at Leysdown. Furthermore, with sea level rise, many of the defences will see increasingly regular overtopping and an increased crest level of defences will better protect residential properties over the next 100 years. An example of where a large number of residential properties would be better protected against sea level rise through increased crest levels of defences is at Sheerness.
- 1.2.3 The MEASS area is characterised by designated SPA and Ramsar saltmarsh and mudflat, as well as Priority Habitats. Over the first, second and third epochs of the strategy, 113ha, 140ha, and 308ha of saltmarsh are predicted to be lost from sea level rise and coastal squeeze.
- 1.2.4 Under the Habitats Regulation Assessment, compensation is required for this loss of SPA and Ramsar habitat and therefore managed realignment sites are required as part of the strategic approach.

1.3 Options

- 1.3.1 A long list of options was reviewed for the strategy frontages, and assessed against the objectives of MEASS. The long listed options included:
- No Active Intervention (NAI),
 - Do Minimum - Hold the Line (HTL) through ongoing maintenance,
 - HTL Maintain - keep the current crest height consistent over time,
 - HTL Sustain - upgrade the crest height over time to improve the SoP with sea level rise,
 - HTL Upgrade - upgrade the crest level of the defences in one set of capital works rather than phased over the lifetime of the strategy, and
 - Managed Realignment – a formalised managed realignment site.
- 1.3.2 The short listed options for each section were assessed against an economic assessment as well as environmental, social and technical considerations. A process of working through different draft leading options was undertaken to ensure sensitivities, results from modelling, considerations of compensatory habitat requirements (both intertidal and freshwater) and stakeholder consultation fed into the preferred option decision process.

1.4 Recommended Strategy

- 1.4.1 MEASS preferred option recommends:

- HTL Sustain across 14 frontages,
- HTL Maintain across 3 frontages,

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- Short term maintenance and then NAI in 4 frontages,
- NAI over 9 frontages,
- 8 Managed Realignment sites,
- 6 sites which require freshwater compensation, and
- 4 frontages where HTL is justified through a moderation case due to impacts on internationally designated freshwater habitat.

1.4.2 There are 12 capital schemes for flood and erosion risk management, as well as construction of the Managed Realignment sites, which are proposed for the first ten years of the strategy.

1.4.3 The economic assessment undertaken was in line with Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM-AG) and the appraisal period for economics is 100 years.

1.4.4 The results of the economic assessment show that the preferred strategy options are economically justified. For capital sustain schemes, additional work is required in year 50 to upgrade crest levels which provides an opportunity to review sea level rise figures and assumptions made within the strategy. The economic case for the initial works of the capital schemes will therefore only be 50 years when taken through to OBC stage.

1.4.5 A summary of the strategy economics is provided below.

Table 1.1 Summary of MEASS economics

MEASS economic summary	
Present value whole life costs ¹	£178,175k
Present value benefits	£1,203,220k
Benefit Cost Ratio	6.75
Present value whole life costs for freshwater moderation cases	£43,244k
Present value whole life costs for freshwater compensation ²	£18,364k

¹It is to be noted that this includes the cost for the Managed Realignment sites

²It is to be noted that this number includes costs for compensation for all areas, and does not allow for Great Bells Farm, which is a scheme that was completed in 2013 by the Environment Agency and will likely provide compensatory habitat for three sections. This will reduce this cost by around £7,000k.

1.4.6 Although the benefit cost ratio for the strategy is 6.75, it should be noted that 92% of the frontages require third party funding to allow implementation of the schemes. 70% of frontages have a Partnership Funding score below 50%.

1.5 Environmental and social considerations

1.5.1 A Strategic Environmental Assessment, Habitat Regulation Assessment and Water Framework Directive Assessment were undertaken as part of the strategy.

1.5.2 The results are set out in the Statement of Case (Appendix S). This concludes that there are Likely Significant Effects on Natura 2000 sites from implementation of the Strategy. However, there is an imperative reason of overriding public interest which is related to protection of important properties and infrastructure. Compensation has been identified relating to these impacts.

- 1.5.3 Because of the potential impacts on the SPA and Ramsar sites, under the Habitats Directive, the HRA and Statement of Case was submitted to Defra for review. Comments from an initial review by DEFRA has concluded that the approach appears appropriate and consistent with the SMP.
- 1.5.4 Managed realignment sites are proposed across the strategy to provide coastal squeeze SPA and Ramsar compensation. In addition, a managed realignment site is proposed at Halling to provide mitigation for coastal squeeze of Priority Habitat and create additional intertidal habitat.
- 1.5.5 A total of 823ha of freshwater habitat will need to be compensated due to impacts of increased flooding from No Active Intervention and Managed Realignment policies. In the short term, the compensation will be provided by Great Bells Farm. Over the first ten years of the strategy, additional sites will be identified and procured by the KSL Regional Habitat Programme.
- 1.5.6 A moderation assessment has compared costs for providing compensatory habitat compared to the costs for continuing to maintain defences and effectively protect the habitat from increased flood risk compared to current risk levels. This moderation case showed that in BAs 6.1, 8.2 and 8.3 it will be more effective in the long term to HTL and increase the crest levels overtime with sea level rise to ensure overtopping rates do not increase. Elsewhere, it is considered more sustainable to provide compensatory habitat (see Section 6.3.13).
- 1.5.7 There are a number of opportunities across the strategy to improve biodiversity as well as the heritage and cultural landscape through the capital schemes proposed. These opportunities are highlighted within the Implementation Plan (Technical Appendix H) as well as the Funding Plan (Technical Appendix R).

1.6 Risks

Table 1.2 High level risk schedule and mitigation

Key project risk	Adopted mitigation measure
Achieving required third party funding.	The KSL Area Team will specifically focus on the requirements for third party funding over the first five years of strategy implementation. An Integrated Landscape and Green Infrastructure Study is proposed to be undertaken within the first 3 years of the strategy to inform the work to identify wider opportunities and partnership funding.
Creating required intertidal compensatory habitat for SPA and Ramsar losses of saltmarsh in the estuary due to coastal squeeze.	Managed realignment sites have been identified to provide compensatory habitat. Precautionary figures have been used from modelling results to estimate saltmarsh creation within the site. There will be ongoing monitoring of the sites. There is a risk in MEASS that if one or two of the managed realignment sites cannot be taken forward, that there is limited alternative space and options for other managed realignment sites. The Project Team have identified that there are potential opportunities to provide compensation from outside of the Strategy area, should this risk arise.
Providing required compensatory habitat due to adverse impacts on freshwater designated habitat from increased flooding or overtopping.	Freshwater habitat compensation has been identified (most of it likely to be Great Bells Farm for the first 10 years), however costs to provide freshwater compensation elsewhere has been included in the case that Great Bells Farm is not suitable.
A high quantity of spend and resources are required to undertake the schemes proposed initially in the strategy.	An exercise has been undertaken with the KSL Area Team to prioritise schemes initially identified to be undertaken over the first three years of the strategy. These have now been phased over the first 10 years of the strategy. Appendix H Implementation Plan details the priority of schemes so if they need to be moved forwards or backwards key requirements are clear to inform these decisions.

The proposals for the Solar Farm at Cleve Hill are progressed.	Chetney Marshes adaptation policy could be accelerated with additional management/ breaches to create intertidal habitat earlier.
Impacts on BAP habitat at Wouldham Marshes due to NAI policy.	Assessment of the alternatives at Wouldham Marshes show that there is no funding available to continue to maintain the defences. Future opportunities to mitigate damage from flooding will be reviewed as part of the KSL Habitat Creation Programme.
Uncertainty regarding landowner management plans in NAI areas – impacts on coastal squeeze and freshwater compensation requirements.	A precautionary approach has been adopted here and requirements for both coastal squeeze compensation as well as freshwater habitat compensation has still been calculated in areas of NAI.
Tailness Marsh modelling - impact on surrounding saltmarsh is greater than the expected gains.	If Tailness Marshes not taken forward, the compensation would only be short by under 1ha. This could be provided within existing sites through additional landscaping.
Achieving funding for the moderation cases.	The moderation cases require funding to maintain defences, despite the low value of benefits in the area. Early discussions with NPAS and LPRG should be undertaken to ensure the development of the business cases are presented in a clear and concise way to allow a quick programme for approval and development of the schemes.

1.7 Implementation

- 1.7.1 Following recommendation for approval of this strategy by the Environment Agency Large Projects Review Group, and approval by Defra, the Implementation Plan for the strategy will commence. This involves a number of activities including some upfront habitat surveys, third party funding discussions and taking forward capital schemes.
- 1.7.2 The capital schemes to be taken forward over the next ten years are phased according to priority markers such as condition of defences, number of OM2s and OM3s to be realised and whether significant third party funding is required.
- 1.7.3 The strategy total cash costs over 100 years are outlined in Table 1.3.

Table 1.3 Strategy cash costs (£k) over 100 years

Item	Cash cost (£k) across the strategy
Appraisal studies	3,675
Detailed design and surveys	10,689
Construction	107,481
Freshwater compensation	33,311
Managed Realignment schemes	34,647
Contingency (60% optimism bias)	113,882
Inflation (2.5%)	4,745
Total Capital Cost	308,430
Future construction cost	70,948
Future maintenance cost	29,653
Future contingency (60% optimism bias)	60,361
Whole life cash cost incl maintenance but without inflation	469,392

2 Introduction and background

2.1 Purpose of this report

- 2.1.1 The purpose of the Medway Estuary and Swale Strategy (MEASS) is to plan and co-ordinate a technically sound, environmentally acceptable and economically viable proposal for coastal flood and erosion risk management over the next 100 years. Furthermore, it is to identify broader environmental, social and economic opportunities throughout the strategy area. This submission seeks approval to a new strategy for managing coastal flooding and erosion risks.
- 2.1.2 The MEASS area covers the coastal estuaries of the Medway and Swale, approximately 120km of frontage. MEASS extends from the village of Stoke on the Hoo Peninsula, down the river Medway to Aylesford (the tidal extent of MEASS) and then along the Medway and Swale Estuaries to the Sportsman Pub in Graveney including Milton, Conyer and Oare Creeks, and the whole coastline of the Isle of Sheppey.
- 2.1.3 MEASS considers the longer-term implications of coastal change, climate change and sea level rise. MEASS will support business case applications for Grant in Aid (GiA) applications, in accordance with Flood and Coastal Resilience Partnership Funding (PF). Future capital schemes will need to be implemented over the next 100 years to manage the coastal flood and erosion risks to people and the developed, natural and historic environments.

2.2 Background

Strategic and legislative framework

- 2.2.1 MEASS builds upon two previous Shoreline Management Plans (SMPs); Medway Estuary and Swale SMP (Halcrow, 2010) and the Isle of Grain to South Foreland SMP (Halcrow, 2010). A variety of options were recommended in the SMPs including Hold the Line, Managed Realignment, and No Active Intervention. A review of these policies was undertaken and generally the recommendations of the SMPs have been taken forward in MEASS. However, additional options were developed in areas where it was deemed there could be requirements previously not considered or opportunities to amend or update the policies.
- 2.2.2 The Environment Agency is the Operating Authority for the majority of the strategy area except BA2: Medway Towns (Medway Council), BA10: Minster Cliffs and part of BA9: Leysdown (Swale Borough Council). There are also some areas where defences are maintained by third party landowners.
- 2.2.3 MEASS has been carried out in accordance with the Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM-AG) (Environment Agency, 2010), and associated Environment Agency policies, procedures, guidance, and best practice. The Environment Agency has worked in conjunction with Natural England, Swale Borough Council, Medway Council, Tonbridge and Malling Council and other stakeholders to develop MEASS.

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- 2.2.4 A Strategic Environmental Assessment (SEA) has been produced in consultation with statutory consultees. A Habitat Regulations Assessment (HRA) and Water Framework Directive (WFD) Assessment have also been carried out regarding the preferred options, meeting the EC Directives. The Environment Agency are the Competent Authority for the HRA with responsibility for consideration of potential impacts on designated environments. The SEA (including the WFD) and HRA reports are included in Technical Appendices J and K respectively.
- 2.2.5 MEASS does not address fluvial issues and there is minimal overlap with tidal and fluvial flood risk. MEASS only assesses the tidal section of the River Medway. The recommendations of MEASS do not impact the future implementation of preferred policies of the Catchment Flood Management Plan to the upstream sections of the River Medway.
- 2.2.6 Works identified by MEASS will be implemented using powers under the Coast Protection Act, 1949, the Land Drainage Act, 1991 and the Environmental Permitting Regulations 2016. Schemes will be subject to Town and Country Planning regulations and land drainage regulations.

Previous studies

- 2.2.7 The SMPs previously developed (2010) estimated that there were nearly '18,000 residential properties' at risk of flooding over the next 100 years. MEASS was therefore commissioned to develop a series of management options to reduce this risk. In addition to the SMPs, various related studies and strategies have been taken into account whilst producing MEASS.
- 2.2.8 In addition to the SMPs, the strategy has been developed in line with a number of studies and policies, including the "A Green Future: Our 25 Year Plan to Improve the Environment" (DEFRA, 2018) and the Environment Agency's FCRM Asset Maintenance Strategy (2017 to 2022).
- 2.2.9 Relevant studies include (but are not limited to):
- Greater Thames CHAMP (APB Mer and Natural England, 2008)
 - Outline Review of the Proposed Great Bells Farm and Elmley Habitat Creation Projects (ABP Mer, 2009)
 - Outline Scheme Design Review of the Proposed Cleve Hill Habitat Creation Project (ABP Mer, 2010)
 - North Sheppey Erosion Strategy (Canterbury City Council, 2011)
 - Medway Estuary and Swale Estuary Habitat Study, Initial Scoping Phase (Greening the Gateway Kent and Medway, 2011)
 - Preliminary Flood Risk Assessment (Kent County Council, 2011)
 - Medway Flood Defence Strategy - High Level Appraisal of Potential Solutions to Manage Flood Risk in the Urban Medway (Scott Wilson, 2011)
 - Kent Habitat Survey (Kent County Council, 2012)
 - Swale Surface Water Management Plan (Halcrow, 2012)
 - North Kent Coastal Modelling – Volume 2 (Report) (2013)
 - Defining the coastal change management area for Swale (Swale Borough Council, 2013)
 - Kent County Council local flood risk management strategy (Kent County Council, June 2013)
 - Kent State of the Environment (Kent County Council, 2015)
- 2.2.10 Whilst predominantly building upon the two SMPs and the above studies, MEASS specifically provides a review and update of the results of the SMPs to

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take account of the changes to Partnership Funding guidance following the approval of the SMPs. Under the new guidance, it is important to consider third-party funding which is generally required to enable a scheme to be implemented and fully funded. This is a potential challenge in some areas as there are limited funding sources, and has been considered in further detail in Technical Appendix R.

Social and political background

- 2.2.11 MEASS covers three different local council areas including Swale Borough Council, Medway Council, and Tonbridge and Malling Borough Council. The local MPs are engaged with FCRM issues raised by their constituents which includes the maintenance and upgrading of coastal defences to protect both residential and commercial areas, agricultural land and infrastructure from coastal flood and erosion risk.
- 2.2.12 The main areas of high population density in the MEASS area include:
- The Medway Towns,
 - Sheerness,
 - Sittingbourne,
 - New Hythe,
 - Faversham, and
 - Aylesford.
- 2.2.13 The areas of smaller population density include:
- Snodland,
 - Queenborough,
 - Leysdown, and
 - The various villages and hamlets along the coastline.
- 2.2.14 In addition to the various assets at risk from flooding and erosion, there are a number of development sites which have been considered throughout the development of MEASS and linked through to the Local Development Plans for the different local authorities. The strategy identifies general policies for these areas but does not prescribe the short term flood defence heights required to enable residential developments. Wider opportunities can be identified through this link and are considered in the Funding Plan in Technical Appendix R.
- 2.2.15 Further to the requirement to mitigate the coastal flood and erosion risk to communities there are also legal requirements to mitigate the impacts on internationally and nationally designated habitats due to coastal change.
- 2.2.16 To work collaboratively with different organisations and landowners, stakeholder engagement events have been held with environmental bodies (such as Natural England, RSPB and Kent Wildlife Trust), the Local Authorities, National Farmers Union, and other key stakeholders through the Stakeholder Engagement Group (SEG) (see Technical Appendix L).

Location and designations

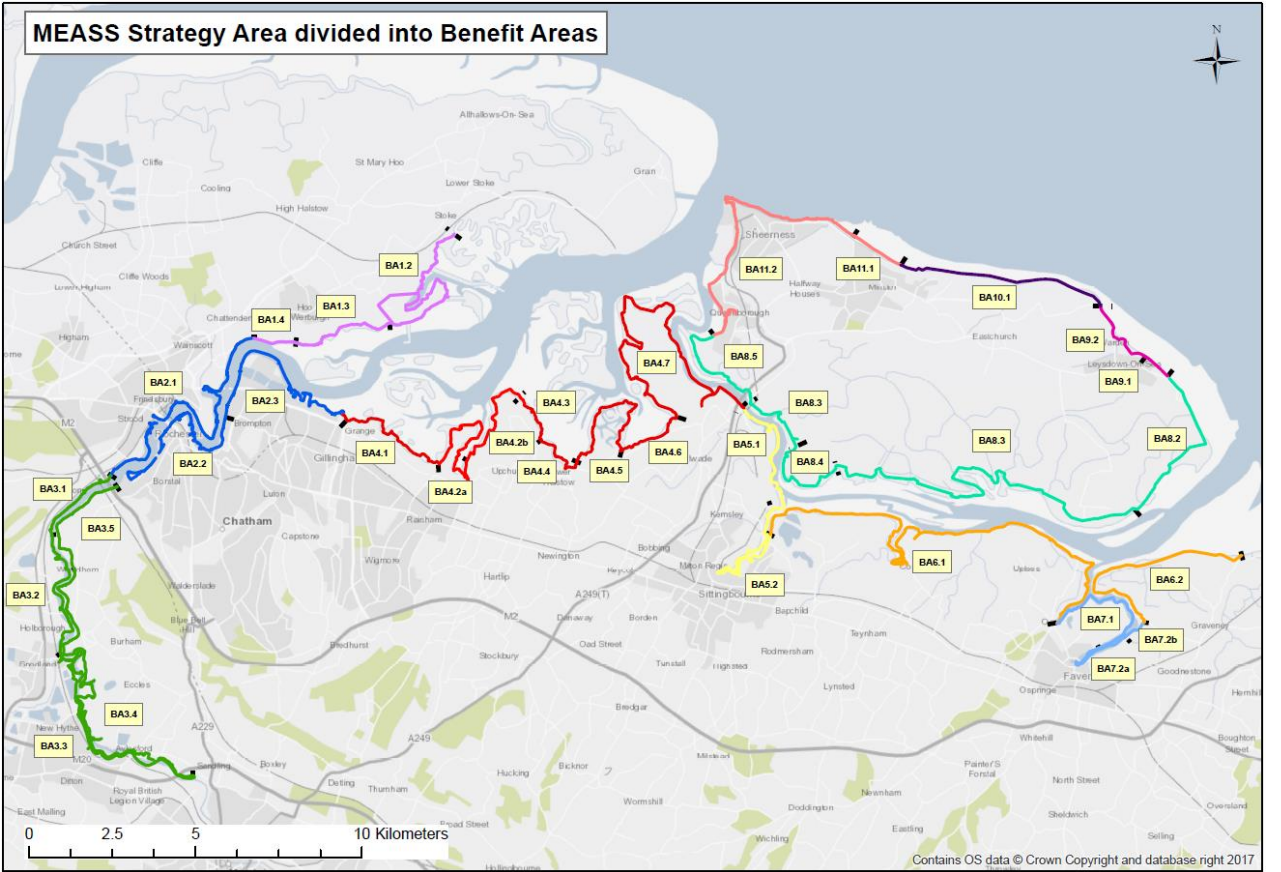
- 2.2.17 MEASS covers the north-east of Kent and includes the Isle of Sheppey, the tidal extents of the Medway estuary and the Swale estuary. The boundaries of the strategy area are Allington Sluice as the upstream tidal limit of the Medway; the

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village of Stoke on the Hoo Peninsula; and the Sportsman Pub on Cleve Marshes near Faversham.

- 2.2.18
- The strategy ties into the TE2100 strategy on the Hoo Peninsula. BA1.1 was once part of the MEASS however from a review of the flood paths it was determined that this frontage is part of the TE2100 strategy, and so was included in the TE2100 strategy. To the east the strategy ties into the section of frontage that is currently managed by Canterbury City Council. Considerations on the compatibility of MEASS and the TE2100 strategy have been undertaken throughout the strategy.
- 2.2.19
- MEASS encompasses the large urban areas of the Medway Towns including Rochester, Strood, Chatham and Gillingham; major industrial and commercial areas along the estuaries; and large swathes of rural farmland and extensive salt marsh and mudflats. Many of the rural areas are highly designated and protected for their heritage, landscape and environmental value.
- 2.2.20
- As the MEASS frontage is approximately 120km in length, and there are complex interactions between the different land uses, MEASS has been broken down into a series of BAs based on the extent of discrete flood cells. These BAs have been broken down further into 35 sub-Benefit Areas based on the SMP Policy Units shown in Figure 1.

Figure 1 Map of the MEASS Area and Benefit Areas



- 2.2.21
- MEASS also contains numerous international and nationally designated environmental sites. These sites include:
- The Medway Estuary and Marshes SPA, Ramsar, and SSSI;
 - The Swale SPA, Ramsar, and SSSI; and
 - Peter's Pit SAC.

- 2.2.22 Adjacent to the MEASS area are the Thames Estuary and Marshes SPA and Ramsar; and the Outer Thames Estuary SPA.
- 2.2.23 In addition, there are a further 9 SSSIs, 2 National Nature Reserves (NNR), numerous Local Wildlife Sites and extensive areas of Biodiversity Action Plan (BAP) Habitats within the area.

History of the Flooding and Coastal Erosion

- 2.2.24 The contemporary forms of both the Medway and Swale estuaries have been significantly influenced by anthropogenic activity over hundreds of years. The enclosure of former saltmarsh areas by construction of defences has taken place periodically since the Roman times. This has led to the existence of extensive areas of reclaimed land along much of the Medway and Swale shorelines.
- 2.2.25 The Medway and Swale Estuaries are dominated by mudflat and saltmarsh habitats which have continually changed and been adjusted over history. Erosion of the seaward edge of saltmarsh occurs widely in the high energy locations of the larger estuaries as a result of coastal processes. There is evidence that this process is exacerbated both by the isostatic tilting of Britain towards the south-east, and by climatic change leading to a relative rise in sea level and to increased storminess. Many areas of intertidal habitat are being 'squeezed' between an eroding seaward edge and fixed flood defence walls (JNCC 2016).
- 2.2.26 Due to the reclamation of land a lot of the MEASS area is at risk of flooding should the current defences fail. The main mechanisms which could cause tidal and coastal flooding within the MEASS area are described below:
- Overtopping of defences – This is a particular risk to MEASS because the defences are relatively old and have not been designed with the latest sea level rise estimates.
 - Breach in defences - Similar to the risk of overtopping, in MEASS some of the defences are in poor condition, so the risk of a breach is increased and the low lying land, particularly in the Swale Estuary, mean the impacts will be extensive.
 - Storm surges - Kent is particularly vulnerable to storm surges, and this is one of the key concerns to local residents and business owners. In Kent, there are two main mechanisms which cause storm surges: westerly surges generated by depressions in the Atlantic and easterly surges generated in the North Sea.
 - Flooding in undefended areas - Some areas along the MEASS coastline are not defended by man-made structures and therefore inundation can occur during high tides and/or high water levels. However, the impacts of this are minimal as there is limited infrastructure and assets within these areas.
- 2.2.27 The last major catastrophic surge event in the MEASS area was the 1953 North Sea Storm Surge which flooded around 2,000ha of land in Kent. The surge was the equivalent of a 0.83% AEP flood event in many places along the east coast, although impacts were significant due to the low crest levels of the flood defences along the east coast at the time. The Isle of Sheppey was particularly hard hit, with old air-raid sirens activated and at Sittingbourne cranes and locomotives toppled over and were buried in the mud.
- 2.2.28 During the more recent storm surge of December 2013 properties were flooded in Faversham, and there were isolated reports of flooding in the Medway area. The peak surge did not coincide with high tide and the winds were offshore at

the peak of the surge so the surge levels were reduced. Approximately an 8.3% AEP water level was recorded at Sheerness. However in many areas across the strategy, the water levels neared the top of the current defences, demonstrating a real risk here.

History of flooding in the Medway Estuary

- 2.2.29 The Medway Estuary has a long history of flooding. In Medway during the 1953 event, a low level tidal flood was recorded with levels at the Rochester Bridge reaching 4.84m above Ordnance Datum (AOD). Records available to the Environment Agency for the same datum point show that flooding events occurred in 1927 (3.92m AOD), 1949 (4.54m AOD), 1960 (3.80m AOD), 1965 (4.60m AOD) and 1978 (4.51m AOD). In more recent times a tidal surge in December 2005 caused low level flooding of Strood with Cuxton Marina, Jane's Creek and Canal Road affected by inundation. Strood Pier recorded peak levels of 4.22m AOD (Medway Council, 2006).

History of flooding in the Swale Estuary

- 2.2.30 In the Swale Estuary, the most significant tidal flood events occurred in 1953 and 1978. In February 1953, overtopping and breaches of tidal defences occurred at Sheerness and along the western border of the Isle of Sheppey, either side of the Swale near Sittingbourne, at Warden, and around the Isle of Harty. Extensive flooding of property is known to have occurred.
- 2.2.31 In January 1978, the tidal defences were being raised at the time and as works were not complete, overtopping occurred at areas of lower crest levels in the defences. This included overtopping along the western marshes (Barksore, Chetney and Horsham), as well as the defences north of Faversham. In addition, the tidal defences around the Isle of Harty breached resulting in flooding around the Isle of Sheppey. The defences were breached/failed east of The Lilies with flooding occurring along Conyer Creek.
- 2.2.32 Additionally, both in March 2002 and on the 10th February 2009 a low order tidal event caused flooding south of the Creek in Faversham.

History of erosion to the north of the Isle of Sheppey

- 2.2.33 Along the exposed coastline of the Isle of Sheppey, the London clay cliffs are eroding rapidly and producing large amounts of fine-grained sediments, which are vital to the accretion of the intertidal habitats in the Thames Estuary. The cliffs are eroding through both wave attack at the toe and sub-aerial weathering. The toe erosion is more rapid than the weathering, and results in a cycle of deep seated landslides that occur on average at 30-40 year intervals (Canterbury City Council, 2011). Based on historic mapping from 1896 to present time the average erosion rates of the cliffs range from 0.11m/yr to 1.42m/yr, with the trend generally indicating an increasing rate of retreat in an easterly direction i.e. the greatest rates of retreat are recorded at Warden Bay (Canterbury City Council, 2011). A number of significant failure events have been noted including at Warden Point in 1971 which resulted in cliff retreat of 30m; Ashcroft Caravan Park in February 1980 which also resulted in 30m of cliff retreat and the loss of two caravans; and a failure event in 2010 at Warden Bay which caused 3m of retreat.

2.3 Current approach to flood and erosion risk management

Measures to manage the probability of flood and erosion risk

- 2.3.1 The Environment Agency, along with other coastal risk management authorities, manage and maintain coastal flood and erosion risks in the MEASS area. The various activities undertaken to manage the flood and erosion risks are listed below.
- 2.3.2 Development control – advice to the Local Planning Authorities on new developments. An Environmental Permit (formerly a Flood Defence Consent), must be obtained from the Environment Agency if any works are undertaken which may increase flood risk.
- 2.3.3 Habitat and nature reserve management – parts of the coastline are protected habitat areas and these are run and managed by a number of bodies, namely Natural England, RSPB, Kent Wildlife Trust and the Local Authorities.
- 2.3.4 Coastal flood and erosion defences - the frontage is currently defended in many places by a combination of defences including embankments, walls, sheet piling and flood gates. Other areas are defended from flooding by natural high ground. The flood risk management (FRM) structures in the area are summarised in Table 2.1. The condition grade of the defences in the area are displayed in Figure 2.
- 2.3.5 The FRM defences provide varying standards of protection across the MEASS area. However, some rural sections of MEASS have very low standards of protection at 50%AEP. The current flood risk has been presented in Figure 3 (showing results of the numerical modelling undertaken) and the standard of protection for each BA section is presented in Table 2.2.

Table 2.1 The length of different coastal flood and erosion defence structures within MEASS.

Structure	Total Length (km)
Beach Recharge	1.20
Concrete Revetment	2.14
Culvert	0.31
Demountable	0.02
Earth Embankment	161.57
Flood Gate	0.39
Retaining Wall	72.02
Rock Armour Stone	8.32
Sheet Piling	9.04

Figure 2 The current condition of the FRM defences in the MEASS area

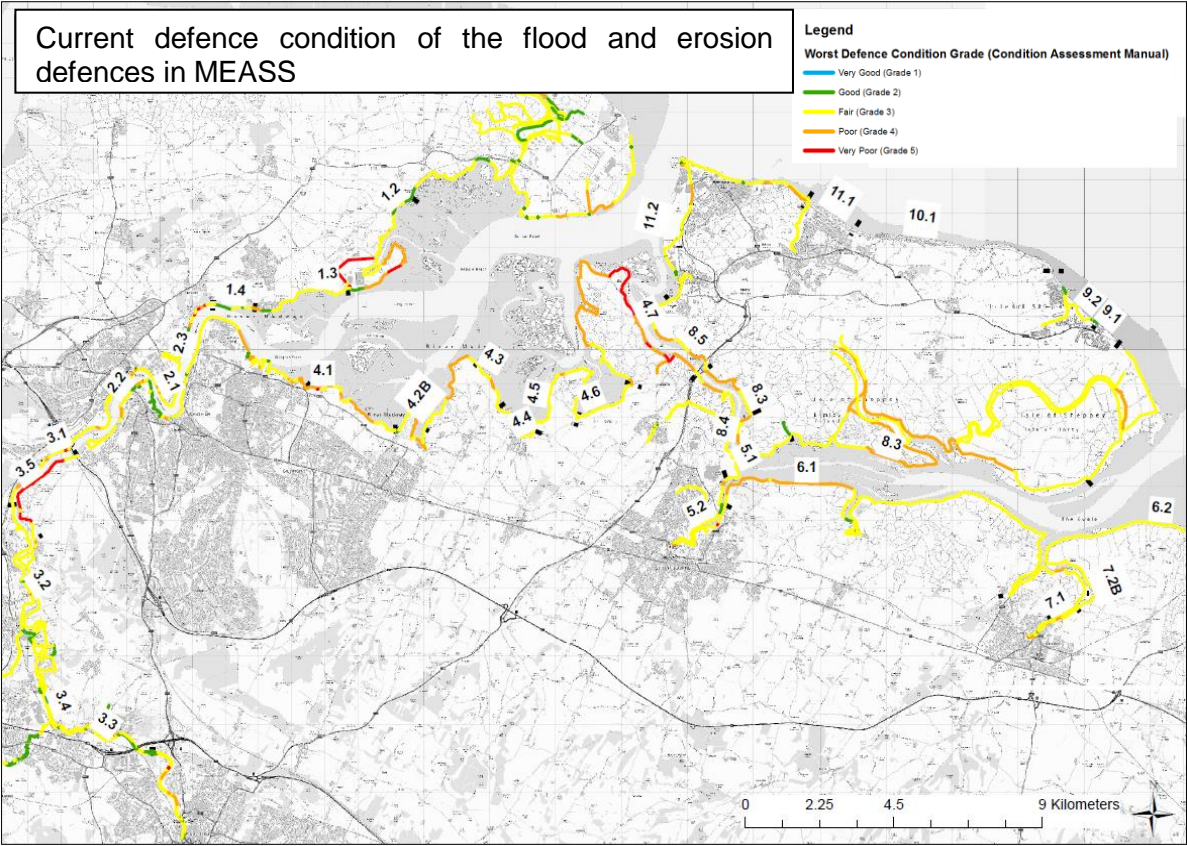


Figure 3 The current standard of protection offered in the different areas of the strategy (flood modelling results showing present day water levels under different flood event scenarios with current defences in place).

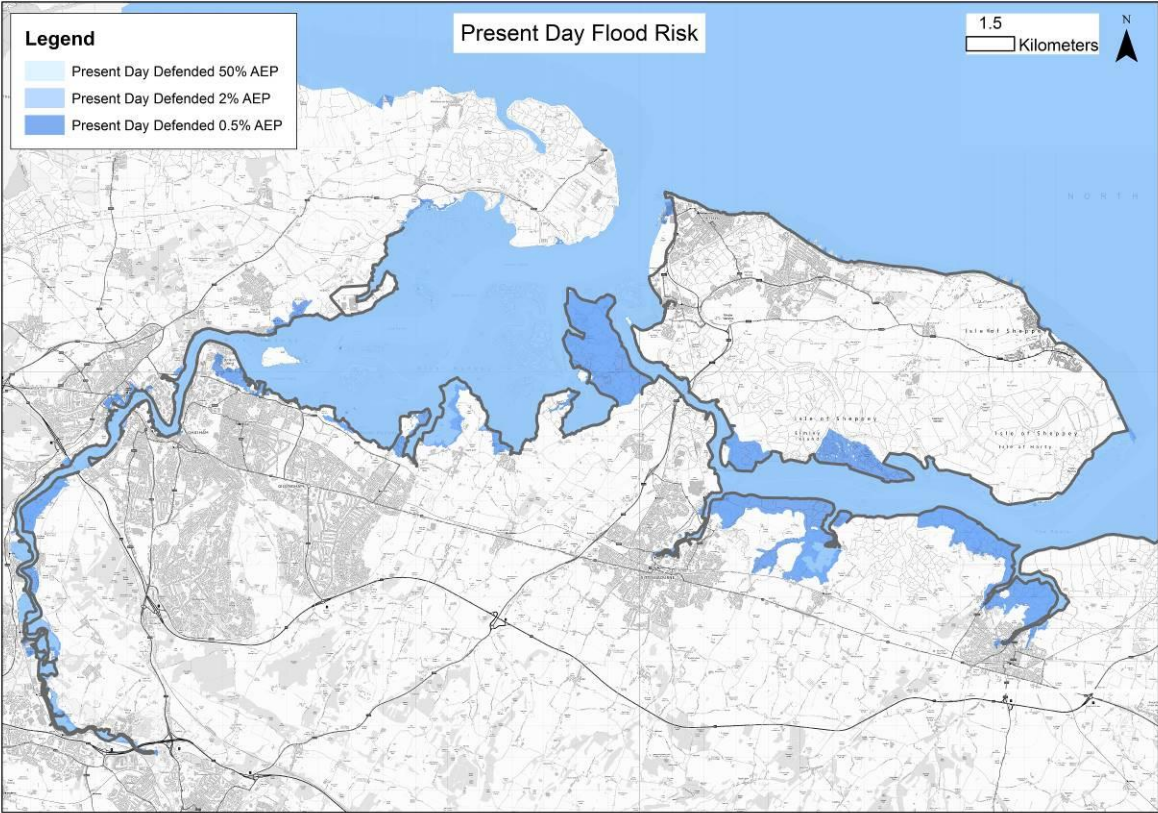


Table 2.2 The standard of protection of defences in the MEASS area currently and under a Do Nothing scenario

Benefit Area	Minimum SoP (%AEP where defences are overtopped under present day water levels)		%AEP at point of flooding to properties (under present day water levels)	
	Do Nothing	Present defences	Do Nothing	Present defences
BA01 - Hoo Peninsula	>50%	50%	>50%	0.1%
BA02 - Medway Towns	>50%	50%	50%	5%
BA03 - Upper Medway	>50%	50%	>50%	50%
BA04 - Medway Marshes	>50%	50%	>50%	5%
BA05 - Milton Creek and Sittingbourne	>50%	50%	>50%	2%
BA06 - Swale Mainland	>50%	50%	>50%	50%
BA07 - Faversham Creek	>50%	50%	>50%	5%
BA08 - South Sheppey	>50%	4%	>50%	1%
BA09 - Leysdown	>50%	4%	5%	0.5%
BA10 - Minster Cliffs	N/A – erosion only frontage			
BA11 - Sheerness	>50%	5%	>50%	0.1%

Measures to manage the consequences of flood and erosion risk

- 2.3.6 The Environment Agency's Flood Warning System covers the MEASS area, and the Environment Agency have locally promoted this to encourage participation. Management of flood risk through development control is undertaken to regulate development and to avoid putting new assets at risk in accordance with the National Planning Policy Framework (NPPF).
- 2.3.7 A coastal adaptation study was undertaken on the cliffs on the north of the Isle of Sheppey to look at coastal erosion risk by Canterbury City Council (2011). This study recommended that a roll-back policy was introduced into local planning policy and that regular monitoring of the cliffs should be undertaken. As such MEASS has taken account of these recommendations when developing the options for BA10.1, together with specific guidance such as Swale Borough Council Planning Guidance of the erosion risks along the North Sheppey coast and the Coastal Change Management Areas (CCMA).
- 2.3.8 Emergency planning is a vital part of managing the risks to coastal communities and the relevant authorities constantly update their procedures to account for changing circumstances. It will be necessary to ensure that the outcomes of MEASS and any identified risks are fed into the local emergency planning systems.

3 Problem definition and objectives

3.1 Outline of the problem

- 3.1.1 There are currently coastal flooding and erosion risks to the communities and landowners around the Medway and Swale Estuaries. Much of the topography is generally very low lying and flat, particularly in areas such as the south of the Isle of Sheppey. This means that should a breach in the current defences occur, or should they be overtopped, a very large expanse of land is at risk from coastal flooding.
- 3.1.2 Across MEASS, the current standard of protection offered by the defences is low, with some rural areas having only a standard of protection to a 50% AEP. Aging defences, rising sea levels and climate change mean that coastal flood and erosion risk to people, properties, habitats, and agricultural land will significantly increase in the coming years. Over the next 100 years it is predicted that 17,226 properties will be at an increased risk of tidal flooding (up to a 0.1%AEP event) within the MEASS area. A further 979 properties are at risk of erosion over the next 100 years.
- 3.1.3 MEASS features many important residential and commercial areas, and as such it is important to continue to 'Hold the Line' of defences in these areas. However, the area is also important for high quality intertidal mudflat and saltmarsh habitat. If the defences continue to be held over the next 100 years, it is predicted that there will be a loss of saltmarsh habitat through coastal squeeze. This is summarised in Table 3.1.
- 3.1.4 Further to the important intertidal habitat, there are a number of sites of freshwater designated and nationally significant habitat, which unless protected and crest levels of defences raised with sea level rise, could become increasingly exposed to overtopping over the strategy period.

Table 3.1 Potential loss of saltmarsh habitat over the three epochs

	Predicted loss in saltmarsh habitat (ha)		
	0 – 20 years	21 – 50 years	51 – 100 years
Saltmarsh habitat loss	113	140	308
Hectares of the above which is within SPA/Ramsar designations	110	135	290

3.2 Consequences of doing nothing

- 3.2.1 At the start of MEASS, a review of the potential impacts under a Do Nothing scenario was undertaken. During this assessment, the potential impacts on residential and commercial properties were assessed, alongside impacts on agricultural land, key infrastructure, and wider social and environmental criteria. The results of this for each frontage is included in the ASTs (Technical Appendix E). Generally, it was shown that there could be a significant economic and environmental impact of a Do Nothing scenario.

3.3 Strategic issues

3.3.1 A strategic approach has been adopted for MEASS for the following reasons:

- Complex interdependencies between the natural systems and coastal processes of both the Medway and Swale Estuaries;
- The need to assess the environmental impacts and potentially address the legal requirements of the Habitats Directives;
- To develop partnerships with risk management authorities, key infrastructure providers and other beneficiaries and identify potential opportunities, funding and efficiencies in strategy implementation. A joint approach is required to promote any works from MEASS, so it has been developed through involvement of all the authorities, and consultation with the landowners and wider communities to identify the preferred options and any additional benefits; and
- There are many opportunities for recreation and cultural benefits through the development of MEASS, and a Strategic approach has been undertaken to review the Local Plans to ensure that MEASS delivers wider benefits in addition to coastal flood and erosion protection.

3.3.2 MEASS promotes and encourages long-term sustainable and strategic management of coastal flood and erosion risk. It will help the Environment Agency and local authorities prioritise future investment and ensure the best use of public funds by providing a plan to implement capital projects, routine maintenance, further studies, surveys and investigations. Without these investments, it will become unsustainable to maintain the current defences due to their condition particularly with the increasing risks due to sea level rise. MEASS has considered, whether in particular areas, if it is more cost-effective to invest in the defences in the first epoch, to reduce the maintenance costs in the future.

3.3.3 MEASS does not include a detailed risk assessment of combination surface water and tidal flooding, and fluvial and tidal flooding. This will need to be reviewed and assessed, where necessary, by the respective Lead Local Flood Authority. The higher risk areas where this could impact local plans are considered to be particularly within the Medway area, and ongoing communication and discussions with Medway Council are being undertaken to ensure there are no adverse impacts of this Strategy on other proposed schemes.

3.3.4 A Water Framework Directive (WFD) assessment was undertaken as an integral component of MEASS, being used to influence decision making throughout the SEA and to guide the identification and development of environmentally acceptable solutions.

3.3.5 MEASS identifies how to manage the loss of various habitat types within sites designated under European Bird and Habitats Directive through either coastal squeeze, due to defences being maintained, or through the inundation or risk of overtopping to areas of freshwater SPA habitat.

3.4 Key constraints

3.4.1 There were a number of constraints that were outlined at the start through workshops involving the project team and key stakeholders. These were fed into the strategy objectives to help refine the delivery of MEASS (Section 3.5).

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3.4.2 The key constraints have generally been identified as:

- Risk of flooding and erosion to properties, industries and infrastructure due to the poor condition and aging defences in the area (Section 2.2.25).
- Requirement to protect and maintain integrity of the Natura 2000 sites within the MEASS area (Section 2.2.20).
- The MEASS area is characterised by large rural areas with expansive flood defences and as such funding availability will be low. Therefore there is a requirement to identify cost effective solutions.
- MEASS shares a boundary with the TE2100 strategy and the overall strategic approach to developing MEASS should be in line with the development of the Thames Estuary Strategy due to the functional environmental and coastal process links (it should be noted that this has not directly influenced policy decision in MEASS however).
- There are several development and regeneration opportunities being assessed by the Local Authorities and the strategy should look to support these where possible.

3.4.3 An SEA and HRA have been developed due to the high environmental sensitivity of the natural and built environment within the MEASS area. These reports are included in Technical Appendices J and K, and the assessments have been integral to the development of the preferred options.

3.5 Objectives

3.5.1 MEASS has assessed and considered a variety of economic, environmental, and technical approaches to manage the coastal flood and erosion risk, to balance the wide range of features and interests within the area.

3.5.2 The vision statement of MEASS is to “work with the community to plan how we will sustainably reduce flood risk to 17,226 homes in the Medway Estuary, Swale and Sheppey over the next 100 years (under a 0.1%AEP event), whilst also protecting and enhancing the local environment.”

3.5.3 Building on from this vision statement a series of primary and secondary objectives for MEASS have been developed (Table 3.2) to drive the delivery of an effective FCRM strategy which supports as many local plans and aspirations as possible.

Table 3.2 MEASS Objectives

MEASS objectives	
Primary Objectives	Secondary Objectives
1) Reduce flood and erosion risk to properties and infrastructure at significant or very significant risk in light of coastal change over the next 100 years.	3) Favour options that reduce the whole life costs of current defences.
2) Maintain the integrity of Natura 2000 sites (protected under the Habitats and Birds Directives) assuming the loss due to coastal squeeze of 113ha of saltmarsh habitat between years 0-20 and a further 140ha of saltmarsh habitat between years 20-50.	4) Favour options that support delivery of the Thames River Basin Management Plan.
	5) Help enable local plan objectives to be realised where possible.

4 Options for managing flood risk

4.1 Potential FCRM measures

- 4.1.1 Based on the FCRM-AG (EA, 2010) there are four generic management policies for flood and erosion risk, which have formed the basis of the options that have been developed in MEASS. The initial long list of options was produced during an internal Project Team workshops using information from the SMPs, and knowledge from the KSL Area Team of the existing structures and areas (Table 4.1).

Table 4.1 FCRM measures that have been considered as the long list for MEASS

Policy	Measure appropriate to MEASS	MEASS long list of options	Description of option
No Active Intervention (NAI)	Monitoring and assessments for health and safety Flood Warning System Land Use Planning Development Control Emergency Response Plans	No Active Intervention (NAI)	This option is usually proposed where there is little risk to assets and there are no economically viable solutions.
Hold the Line (HTL)	Embankments Seawalls Rock Revetments Rock Groynes Timber Structures Demountable Defences Temporary Defences Beach Recharge (sand or shingle) Tidal Barrier	Ongoing maintenance (patch and repair)	This option considers ongoing maintenance of the existing structures. Capital works are not considered within this option and therefore the condition of the structure will deteriorate over time.
		HTL Maintenance	This option considers ongoing maintenance of the existing structures until they reach the end of their residual lives. At this point the structure will be replaced with the same structure at the same crest height. Due to sea level rise, with this option the SoP will reduce over time.
		HTL Sustain	This option considers immediate capital works to increase the SoP of the structure to a defined level by increasing the crest level of the structure. In year 50 further capital works are required to maintain this SoP with sea level rise. Maintenance of the structure is required throughout the appraisal period.
		HTL Upgrade	This option is similar to the sustain option, however all capital works occur immediately, i.e. the structure is increased to the largest SoP immediately. Dependent on the design life, future capital works may also be required.
Managed Realignment (MR)	Set-back Embankments Breach High Ground Adaptation	MR with HTL Maintain	Maintain/Sustain/Upgrade defines the capital and maintenance works along the frontage as described above with the exception of the defences within the Managed Realignment (MR) site. For the MR site, capital works include a setback embankment providing a defined SoP, and a breach. The setback embankment is maintained throughout the appraisal period. The existing defences within the MR site are no longer maintained.
		MR with HTL Sustain	
		MR with HTL Upgrade	
Advance the Line (ATL)	Not included in MEASS as not considered a sustainable option for management of the estuary.		

4.2 Long list of options

- 4.2.1 Based on the potential FCRM options outlined in Table 4.1 a high-level review of the assets at risk under a Do Nothing scenario, and the condition of the existing defence structures, was used to determine the long list of options. These are listed in the ASTs (Technical Appendix E).
- 4.2.2 Following the review of the risks to assets, and the existing defences and their condition, the appropriateness of the general long list (Table 4.1) was reviewed for each frontage, and an assessment of the most suitable long list options was undertaken. The results were presented in the ASTs (Technical Appendix E), with a justification for why options were/ were not selected for the long list.

4.3 Options short-listed for appraisal

- 4.3.1 To refine the long list of options to the short list each long listed option was tested against a variety of criteria:
- **How well the option met the strategy objectives** – if the option did not meet the first objective, to reduce flood risk to properties in a significant event, the option was not taken forward. This assessment was based on the SoP and residual life of the current defences, which provided an indication of how the crest level of the defences would change under the different options.
 - **The assets at risk under a Do Nothing scenario** – the options were then compared with the high-level assessment of the assets at risk under the Do Nothing scenario. It was assumed that in some cases if there were limited assets at risk, a 'HTL Upgrade' option would not be taken through to short list as it is very unlikely to be economically viable.
 - **Comments from stakeholders** – information from stakeholders provided at workshops and in stakeholder meetings provided the project team with information which helped refine the long list.
 - **Review of potential environmental risks** – as a key requirement of MEASS is the promotion of environmentally acceptable solutions. A high level review of potential risks was undertaken to provide an understanding of the potential adverse or positive impacts on the designated sites. Additionally environmental enhancements were included wherever possible.
- 4.3.2 For all assessments, a 'Do Nothing' option has been included in the short list which provides an economic baseline which all options are tested against.
- 4.3.3 A 'Do Minimum' option has also been included. In each case, the Do Minimum option is presented as 'Option b' for each Benefit Area section.
- 4.3.4 Due to the size of MEASS the results of this assessment are recorded in the ASTs (Technical Appendix E). A summary of the type of options that were short listed for more detailed appraisal is outlined in Table 4.2.

Table 4.2 Summary of the types of options which formed the short list for each Benefit Area.

Frontage	Benefit Area	Type of Short listed option						
		NAI	HTL Maintain	HTL Sustain	HTL Upgrade	Managed Realign	Adaptation	Monitoring
BA1 – Hoo Peninsula	BA 1.2	✓	✓	✓	✓			
	BA 1.3	✓	✓	✓	✓	✓		
	BA 1.4	✓						✓
BA2 – Medway Towns	BA 2.1	✓	✓	✓	✓			
	BA 2.2	✓	✓	✓	✓			
	BA 2.3	✓	✓	✓	✓			
BA3 – Upper Medway	BA3.1	✓	✓	✓				
	BA 3.2	✓	✓	✓	✓	✓		
	BA 3.3	✓	✓	✓				
	BA 3.4	✓	✓	✓	✓	✓		
	BA 3.5	✓	✓			✓		
BA4- Medway Marshes	BA 4.1	✓	✓	✓		✓		
	BA 4.2A	✓	✓	✓	✓			
	BA 4.2B	✓	✓	✓		✓		
	BA 4.3	✓						✓
	BA 4.4	✓	✓	✓				
	BA 4.5	✓	✓		✓	✓	✓	
	BA 4.6	✓					✓	✓
	BA 4.7	✓	✓	✓	✓	✓		
BA5- Sittingbourne	BA 5.1	✓	✓	✓	✓			
	BA 5.2	✓	✓	✓	✓	✓		
BA6 – Swale Mainland	BA 6.1	✓	✓	✓		✓		
	BA 6.2	✓	✓	✓		✓		
BA7 – Faversham Creek	BA 7.1	✓	✓	✓	✓			
	BA 7.2A	✓	✓	✓	✓			
	BA 7.2B	✓	✓	✓				
BA8 – South of Sheppey	BA 8.2	✓	✓	✓	✓	✓		
	BA 8.3	✓	✓	✓		✓		
	BA 8.4	✓	✓			✓		
	BA 8.5	✓	✓	✓				
BA9 – Leysdown	BA 9.1	✓	✓				✓	
	BA 9.2	✓	✓	✓				
BA10 – Sheppey Cliffs	BA 10.1	✓					✓	
BA11 - Sheerness	BA 11.1	✓	✓					
	BA 11.2	✓	✓	✓	✓			

5 Options appraisal and comparison

5.1 Technical issues

- 5.1.1 A numerical model has been used to allow an assessment of the interactions of the proposed short listed options with the coastal processes, flood and erosion risks, and impacts on currents and scour within the estuaries. The model was set-up using a MIKE21 flexible mesh model.
- 5.1.2 Hydrodynamic modelling of the MEASS area has been undertaken using the MIKE21 HD model. Technical Appendix I provides the information on the modelling, results and analysis.
- 5.1.3 A baseline scenario, based on the current defences, was developed for the Medway and Swale Estuaries. This scenario indicates that several rural areas are low lying and have defences with low crest levels which means they are at risk of flooding from a 50%AEP event. An undefended scenario shows that the land topography means that majority of frontages would experience large flooding under a 50%AEP if the defences were removed.
- 5.1.4 Modelling the baseline scenario with climate change highlighted that the current defences are not adequate to protect from flooding when considering sea level rise, with widespread flooding predicted in the future.
- 5.1.5 Following the development of the baseline, models were run for the Sustain and Upgrade options. The modelling results indicate that the HTL Upgrade options will provide at least a 0.5% AEP SoP to the estuary in 100 years (considering 100 years of sea level rise).
- 5.1.6 The short listed managed realignment sites were also modelled to test the technical feasibility of the different sites. It was concluded that if all of the managed realignment sites that were identified at SMP level were implemented, there would be an increase in the amount of water being drawn into the estuaries and therefore increases in peak water levels.
- 5.1.7 Sediment modelling was undertaken using the MIKE21 Mud Transport module. A baseline model was developed to allow subsequent first-order assessment of the potential environmental impacts on estuarine sediments that may arise as a result of implementing one or more managed realignment schemes within the short list of options.

5.2 Environmental assessment

- 5.2.1 The assessment of the environmental impacts has been integral to the optioneering process. An assessment of the environmental impacts of the short listed options was included in the optioneering assessment. A high level HRA, SEA and WFD was undertaken to assess a number of criteria (Table 5.1) and the results were recorded in the ASTs (Technical Appendix E). The opportunities/ impacts associated with each option were scored to provide a ranking of the short listed options. These total scores were used to rank the

environmental impacts of each option, and were used when assessing the leading option.

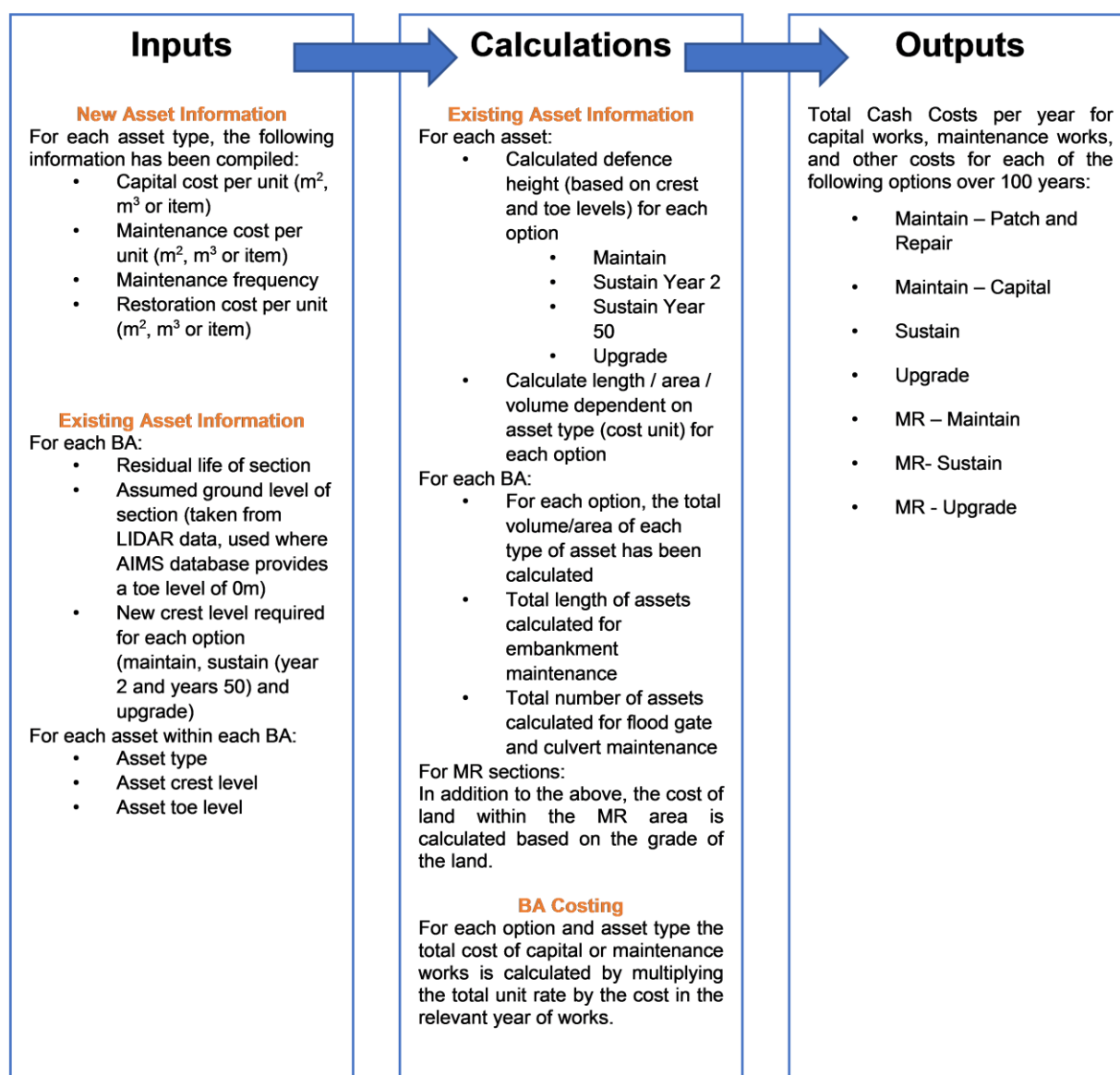
Table 5.1 The environment assessment criteria used to assess the short listed options

Environmental Assessment	Criteria	Explanation
Water Framework Directive	Compliance assessment outcome	Presents the preliminary results of the Water Framework Directive (WFD) assessment. At this stage assessment is based on the heavily modified water bodies and the diffuse pollution (e.g. impacts from agricultural run-off).
Habitats Regulation Assessment	Impact on SPA/ Ramsar qualifying features	Assesses the potential impacts of the option on the HRA and Ramsar qualifying features and assemblages. Negative impacts are scored with a low score, and positive impacts receive a high score. This assessment is based on the results of the HR01 assessment.
	Impacts on freshwater habitats	Assesses the potential impacts of the option on the qualifying features which might be affected by changes to the freshwater SPA/ Ramsar sites e.g. if the species in the site cannot tolerate saline intrusion this would be a negative impact.
	Impacts on intertidal habitats	Assesses the potential impacts of the option on the qualifying features which could be affected by changes to the intertidal habitats e.g. if the species at the site require intertidal habitat, and this is lost through coastal squeeze this is a negative impact.
	Habitat Connectivity	Assesses the potential impact of the option on the function of the site within the wider estuary e.g. will the species be able to use other areas of the estuary, or will their habitat be lost, leading to a reduction in habitat connectivity. An adverse impact on the ecological functioning of the site would be given a negative score.
Strategic Environmental Assessment	Historic Environment	Outlines if there are any observable historical assets, listed buildings, scheduled monuments, conservation areas, locally listed buildings, registered parks and gardens and undesignated historical assets at risk. Also highlights the risk to potential unknown heritage assets, scoring also reflects type and number of historic assets and historic setting in towns.
	Effects on population	Assesses the potential risks to community, amenities and livelihoods. This does not include the cost of the asset (included in the economic benefits) but refers to the intangible effects e.g. human health/ social impacts.
	Impact on plans/ programmes	This criterion focusses on the Local Plans and Development Plans within the area and draws out the key issues associated with these. It should be noted that there are a lot more plans that have been reviewed as part of the SEA and these are included in the main SEA document. Where the option differs from the CFMP it will be noted.
	Freshwater Biodiversity	Assesses the potential risks to freshwater habitats and species within the scope of a strategy. Include species protected under SSSIs and local conservation designations and other non-aquatic species to the level of a strategy.
	Saline Biodiversity	Assesses the potential risks to saline habitats and species within the scope of a strategy. Include species protected under SSSIs and local conservation designations to the level of a strategy.
	Soil	Assesses the potential risks to agricultural land and woodland soils.
	Groundwater	Focusses on the risk to Source Protection Zones (SPZ) and aquifers, and the risk of the release of contaminants from landfill sites.
	Landscape (visual impact)	Assesses the balance of change to the landscape character area. It is important to note that this criterion focuses on the timescale and amount of change rather than what people perceive as good/ bad landscape to remove the subjectivity. This also reflects changes to landscape character as the landscape is comprised of both natural and manufactured landscapes.
	Carbon Storage	Assesses the impact of the options on the carbon cost e.g. the loss of carbon storage due to habitat change, but also carbon used in the construction/ maintenance of the defences. It should be noted that the MR sites sometime have a lower score as a conservative assumption has been made that it might be mudflat that is developed and this stores less carbon than freshwater/ saltmarsh.

5.3 Option costs

- 5.3.1 To enable the economic assessment, and help select the preferred options, each short listed option was costed over the 100-year appraisal period. This cost includes costs for capital works, costs for maintaining the structure, and 'other' costs including costs to create the Outline Business Case (OBC), post-OBC to construction costs and costs incurred during the construction phase. The costs have been estimated and optimised using contractor information and recent costs of construction of similar works.
- 5.3.2 Costs have been estimated as realistically as possible considering the high level designs within the strategy, with an Optimism Bias of 60% added to reflect the assumptions and risks at this stage. As designs are subsequently refined and specific contractor methods, materials and working practices are gained through early contractor involvement during the project level business case development, the optimism bias can be reduced.
- 5.3.3 There were a number of assumptions that were made when developing the costs for each of the options. More technical detail on this is included in the Options Technical Report (Technical Appendix D). Figure 4 presents an overview of the inputs, calculations, and outputs within the option costing process.
- 5.3.4 The final costs for all the short listed options can be found in the ASTs (Technical Appendix E).

Figure 4 Flow chart outlining the process used to cost the short listed options



5.4 Options benefits (Damages avoided)

- 5.4.1 Option benefits have been calculated using the Multi-Coloured Manual (Middlesex University, 2016), and the FCERM-AG (Environment Agency, 2010) over a 100-year period; with benefits discounted in line with the HM Treasury Green Book. The price date for the benefits is the same as the costs.
- 5.4.2 The extents of the damages were determined based on the flood extent and depths from the flood modelling for a series of extreme events (50%, 5%, 2%, 1% 0.5% and 0.1% AEP), for both present day and future water levels. The erosion damages were based on a projection of the future rates of retreat based on the historic rate of retreat and the impacts of sea level rise.
- 5.4.3 A variety of potential damage sources from flooding were assessed in MEASS including: Annual Average Damages (AAD's) from property damages (both residential and commercial) and the associated health and vehicle impacts;

agricultural land; recreation; roads and railways. For the erosion frontages the damages were associated with the loss of property (residential and commercial), loss of roads and railways and recreation.

- 5.4.4 A detailed description of the method used to undertake the damage assessment is included in Technical Appendix C, and the results for each of the damage sources, for each of the short listed options is presented in the ASTs (Technical Appendix E).
- 5.4.5 Based on the assessment of the strategy wide Do Nothing damages (presented in Table 5.2) it can be seen that there is a high economic impact of not maintaining the defences. It was also noted that a large proportion of damages comes from properties that are written off. Properties are 'written off' when they are at risk of flooding in a greater than 33%AEP event. This highlights the number of properties that are at risk of flooding under frequent return period events, and the importance of MEASS to review the potential options to manage this risk.

Table 5.2 Summary of the strategy wide present value (PV) damages under the Do Nothing scenario

Assets assessed	Total Damage (PVd) (£k)
Residential Properties	£120,000k
Commercial Properties	£184,000k
Vehicle and Health Damages	£12,000k
Emergency services	£13,000k
Written off properties	£917,000k
Agricultural Land	£17,000k
Roads and Railways	£10,000k
Recreation	£11,000k
Erosion	£41,000k
TOTAL	£1,324,000k

- 5.4.6 Some benefits are easier to place a monetary value on than others. The benefit analysis cannot fully account for the significance of internationally designated habitat, and cultural and historical assets in relation to other monetised benefits. MEASS has tried to account for these impacts by including the results of a high-level socio-environmental assessment (WFD, HRA and SEA) and an ecosystem services assessment in the ASTs (Technical Appendix E). These impacts were scored, and the total value for each option was ranked to determine not only the most economically viable option, but also the best socio-environmental option. The value of these less tangible benefits could be reappraised in more detail at scheme appraisal stage.

6 Selection and details of the preferred option

6.1 Selecting the preferred option

- 6.1.1 This section details the identification of the preferred option for each frontage, and the subsequent results of the strategy wide assessment.

- 6.1.2 Table **6.3** outlines the preferred option and the justification and resulting economics. Table 7.3 presents the expenditure profile and the whole life costs of the strategy wide assessment.
- 6.1.3 Selection of the preferred options has been an ongoing and iterative process taking into account the potential socio-environmental impacts and the technical feasibility of the options. The short listed options for each frontage were compared against the strategic objectives, environmental issues and the economic results to determine the preferred option. Further details on the method used to assess the preferred option, and the results are explained in MEASS Technical Appendix G: Economic Assessment Report.

6.2 Sensitivity testing

- 6.2.1 To further refine the short list of options to the preferred options, a series of sensitivity assessments were undertaken, and an iterative approach used to define the optimum preferred option. This process is summarised in Figure 5.
- 6.2.2 A leading option was outlined at the end of each assessment (blue boxes in Figure 5), and there was a justification for why this option was chosen. Section 3 in the Economic Report (Technical Appendix G) provides the results of each of the assessments.
- 6.2.3 Through undertaking sensitivities and looking at the frontages in more detail, economically viable schemes could be identified that maximise the benefits for the costs as well as minimising and mitigating impacts on the environment.
- 6.2.4 The following sensitivity assessments were undertaken:

Review economic sensitivities - a sensitivity assessment was undertaken to determine if there was a more economically viable option which could be proposed, particularly those displaying low BCRs. Three sensitivities were assessed:

- Delay sustain – delaying the first phase of works in the HTL sustain option until the residual life of the defences;
- HTL in localised areas – where it is not economically viable to defend the whole frontage, this sensitivity assessed whether there are key lengths of frontage that can be maintained to protect the areas which are more densely populated/ key assets are at risk; and
- Short term maintenance - Undertake short term ongoing maintenance to extend the residual life of the current assets.

Review strategy wide coastal squeeze requirements – a review of the coastal processes, sea level rise and implications on intertidal habitat to help determine the potential loss of intertidal habitat due to coastal squeeze and the resultant compensatory habitat requirements. This assessment of habitat at risk provided the requirement for the hectares of saltmarsh habitat that needs to be created to mitigate against the coastal squeeze losses.

Identify managed realignment sites - Following an assessment of the compensatory saltmarsh habitat requirements, a strategy wide assessment of the proposed MR sites was undertaken to determine the most appropriate MR sites to be taken forwards.

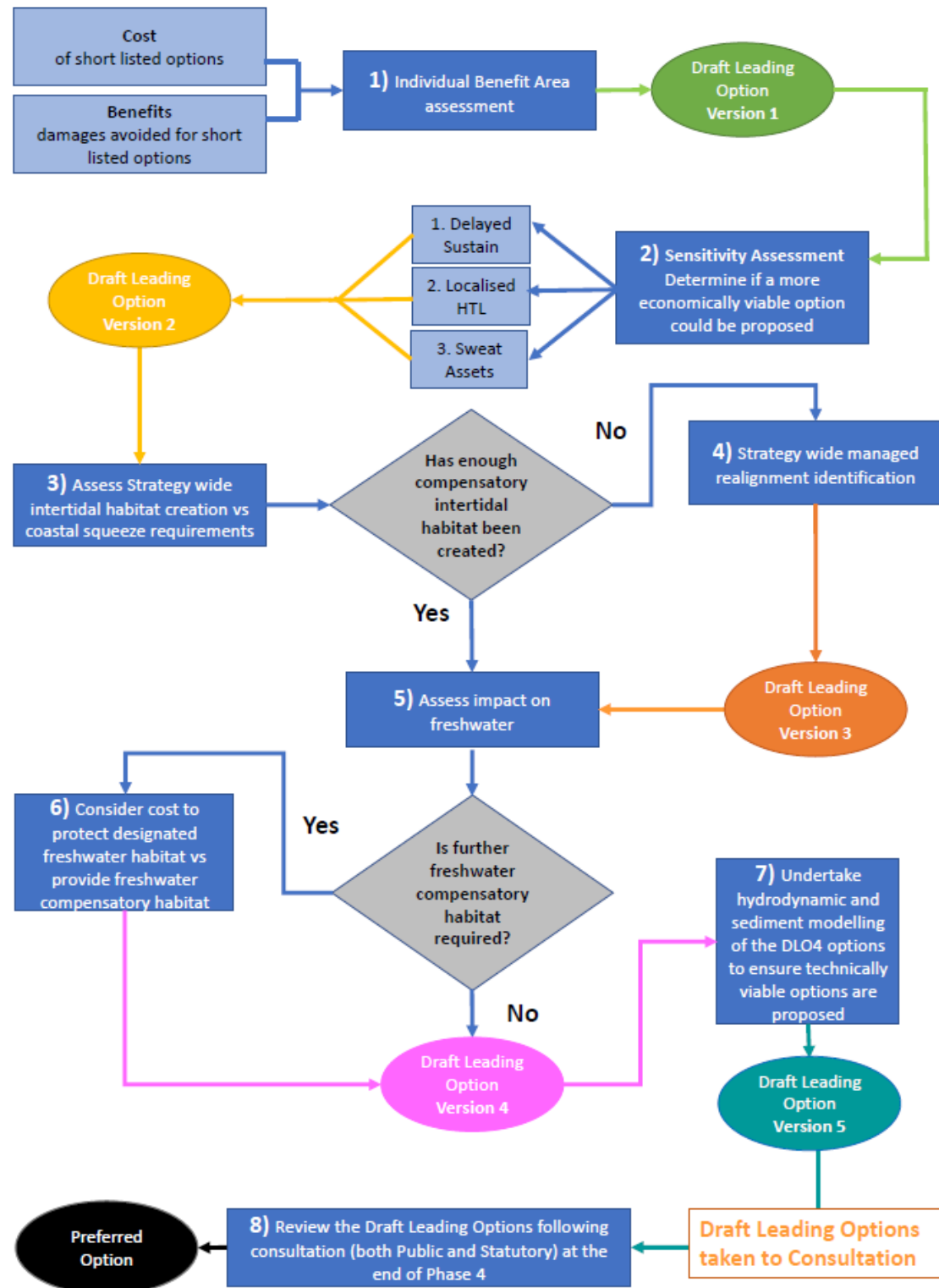
Review the impacts on freshwater habitat and consider if a moderation case could be appropriate in some areas - A strategy wide assessment was undertaken to determine the extent of freshwater compensation that might be required due to impacts on designated freshwater habitat. These compensation costs were compared with the costs of maintaining the defences over the 100 years, and raising them in line with sea level rise so there is no increased risk from overtopping over time. Where it is considered more cost effective to maintain the defences and raise in line with sea level rise, a HTL option was proposed in these areas as the leading option.

Modelling of the preferred option – the preferred options were modelled to determine that there is not an increase in flood risk in areas, that the defences have the effect assumed within the optioneering and to check that there is not significant increased scour or flows in areas. This assessment ensured that the preferred options are technically viable.

Consultation – the preferred options were consulted upon with statutory consultees, land/ asset owners, the MEASS Stakeholder Engagement Group and the wider public to gain support for the strategy and identify if there were any key constraints.

- 6.2.5 Following these sensitivity assessments, the final preferred options were defined. The results of the sensitivity assessments and the justifications for the preferred options are outlined in the economic assessment, Technical Appendix G.

Figure 5 Flow chart outlining the sensitivity assessment undertaken to refine the preferred option.



6.3 Details of the preferred option

- 6.3.1 A summary of the preferred options and justification for each frontage is included in Section 5 of the Economic Assessment Report (Technical Appendix G).
- 6.3.2 In the Economic Report a summary table has been developed for each BA to present the business case for that specific area. A review has been undertaken in frontages where there could be an impact on SPA designated habitat, to assess the most cost-effective way to mitigate these impacts.

- 6.3.3 Table **6.3** below summarises the results of the economic assessment and the justification of the preferred option.
- 6.3.4 Monitoring during the strategy implementation will be important with a focus on monitoring reaction of saltmarsh and mudflat to sea level rise, and impacts from No Active Intervention policies on freshwater habitat. This includes monitoring the development of habitat that provides compensation for the loss in functionality and maintains the integrity of the Natura 2000 sites (both intertidal and freshwater habitat). More details on the monitoring requirements is presented in the Implementation Plan (Technical Appendix H).

Technical aspects

- 6.3.5 To ensure the technical viability of the preferred options the final options were assessed in a hydrodynamic model and sediment model. The aims of this modelling assessment were to determine that there is not an increase in flood risk within the MEASS area, compared to the baseline (current defences in place with current water levels); and to check that there is not an increased risk of scour or increased flows which could have negative impacts.
- 6.3.6 The results from the hydrodynamic model demonstrate that for a present day 0.5% AEP event, under the proposed preferred strategy option:
- There is a marginal increase in spring high water levels in the Swale and Medway Estuaries which have been taken into consideration in the optioneering;
 - Current speeds in the Swale Estuary Entrance and the Upper Medway Estuary increase slightly, however the increases are fairly small and focussed on existing channels rather than areas of mudflat and saltmarsh;
 - Current speeds in the Swale Estuary decrease around Elmley Reach; and
 - At most locations, there is a significant decrease in the flood risk for the 1:200-year event.
- 6.3.7 As outlined above, it was identified that the Managed Realignment sites, as well as reduced overtopping, causes slight increases to water levels and current speeds in a lot of the estuary area. However the crest level determination for the different options has taken this into account and therefore there are no increased flood risks as a result of this.
- 6.3.8 The results of the sediment model show that the hydrodynamic changes associated with the preferred options increase the amount of suspended sediment in the estuaries, both for present day and future scenarios. Consequently, across the Medway and the Swale, a general increase in accretion is observed, including within the proposed managed realignment sites. In broad terms, the results show that there is net importation of sediment into the estuaries and an increase in accretion. This will further support the development of intertidal habitat within the proposed MR sites.
- 6.3.9 A detailed assessment of the results is outlined in the Modelling Report (Technical Appendix I).

Environmental aspects

- 6.3.10 Due to the large amount of environmentally designated freshwater and intertidal habitat in the MEASS area, the environmental impacts have been key in assessing the preferred options. The preferred options have been assessed to

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try and reduce the impacts on the designated sites, or where this is not possible mitigation has been proposed.

6.3.11 An SEA, HRA and WFD have been completed on the preferred options, and the results are presented in Technical Appendices J and K. Key impacts have been identified on the Natura 2000 sites as impacts on intertidal habitat from coastal squeeze, and impact on freshwater habitat from flooding under Managed Realignment of No Active Intervention.

6.3.12 The managed realignment sites being proposed as compensation for coastal squeeze are outlined in Table 6.1. Saltmarsh habitat is the only required intertidal habitat for compensation as mudflat habitat is predicted to increase in the estuaries over the 100 years.

Table 6.1 Managed realignment sites proposed as the preferred strategy option.

Epochs	Designated?	MR Site	Area of saltmarsh habitat (ha)	Total Ha provided	Total for Epoch
1	Internationally Designated	Kemsley	4.8	115.4	125.6ha
		Danes Hill	1.9		
		Spitend	7.3		
		Elmley	66.2		
		Tailness Marsh	5.6		
		Abbotts Court	29.6		
	Non – Designated	Halling Marshes	10.2	10.2	
2	Internationally Designated	Cleve Hill	202.7	202.7	202.7ha
	Non – Designated	N/A – ha is covered in epoch 1		-	
3	Internationally Designated	Chetney Marsh	175	175	175ha + 72.96ha (extra from epoch 2) = 247.96ha
	Non – Designated	To be confirmed in the future		-	

6.3.13 The HRA has identified potential impacts to Natura 2000 freshwater designated sites over the lifetime of the strategy. A total of 823ha of freshwater habitat will need to be compensated. In the short term, the compensation will be provided by Great Bells Farm. Over the first ten years of the strategy, additional sites will be identified and procured by the KSL Regional Habitat Programme.

6.3.14 Alongside the assessment regarding the compensation required as part of the HRA, an assessment has been undertaken for sites where No Active Intervention will cause adverse impacts on the integrity of the freshwater Natura 2000 sites. This assessment has compared the costs for providing compensatory habitat compared to the costs for continuing to maintain defences and effectively protect the habitat from increased flood risk compared to current risk levels.

6.3.15 This moderation case showed that in BAs 6.1, 8.2 and 8.3 it will be more effective in the long term to HTL and increase the crest levels overtime with sea level rise to ensure overtopping rates do not increase. Elsewhere, it is considered more sustainable to provide compensatory habitat. Not only is there an economic driver for this but if HTL was not undertaken on BA6.1, 8.2 and 8.3, an additional 2,364ha of compensatory habitat would be required which would be very difficult to identify. Furthermore, allowing increased flooding of these

large, low lying areas draws in additional water into the Swale Estuary which increases peak flood flows and would require additional increased heights of defences in the Swale Estuary.

- 6.3.16 A summary of the potential residual impacts of the preferred options on the designated sites for the frontages, and the mitigation required for this is outlined in the Implementation Plan (Technical Appendix H) and the Strategic Environmental Assessment (Technical Appendix J). Costs for freshwater compensation are presented in

6.3.17 Table 6.3.

Costs of the preferred option

6.3.18 The whole life present value costs for the preferred options can be found in

6.3.19 Table 6.3.

- 6.3.20 In order to present the economics for FDGiA funding and tie in with partnership funding calculations etc, the costs associated with the managed realignment sites has been proportionately distributed across HTL schemes, based on the proportionate OM1 benefit values. For each HTL scheme proposed, there will therefore be a cost associated with the MR sites which will provide the intertidal habitat required as a result of coastal squeeze caused by a combination of sea level rise and HTL policies.
- 6.3.21 The strategy wide expenditure profile is outlined in Table 7.3. The full expenditure profile for all the frontages can be found in Technical Appendix F. The strategy wide costs are the greatest in year 5-20. This accounts for the capital works that will be required to maintain and upgrade a significant amount of defences in the first epoch.

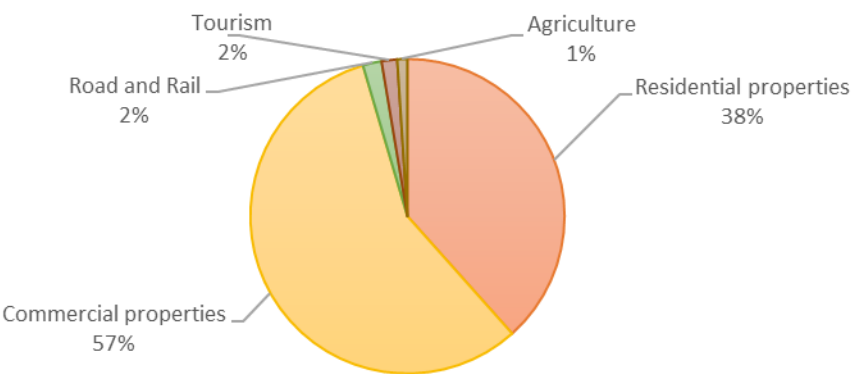
Contributions and funding

- 6.3.22 The potential Partnership Funding (PF) available for each of the short listed and preferred options was calculated using the EA GiA Calculator. This tool identified the maximum amount of funding available based on the economics, properties better protected from the risk of flooding and erosion and the hectares of intertidal habitat created over the next 100 years. The results of the assessment are included in the ASTs (Technical Appendix E), and the Economic Report (Technical Appendix G) as well as Table 7.2.
- 6.3.23 Any gap between the GiA funding available and the cost of the works would need to be filled by external contributions before the scheme would be approved and the funding released. A partnership funding plan is presented in Technical Appendix R.
- 6.3.24 Based on the strategy wide economic assessment (Table 6.2) MEASS has a BCR of 6.75. It should be noted that 92% of the frontages require third party funding to allow implementation of the schemes. 70% of frontages have a Partnership Funding score below 50%. A total of £93,827k in external contributions is required across the strategy to fully fund all the schemes.
- 6.3.25 Whilst this is a high figure, it should be noted that 65% of this is focused on four BAs: 1.2 Kingsnorth, 2.1 Strood, 2.3 St Mary's Island and 3.4 Aylesford to Wouldham. Many of these areas are already areas where third parties and industries contribute to, or undertake the maintenance of defences.
- 6.3.26 Reviewing, pursuing and confirming third party funding is a fundamental task to be undertaken within the implementation of the strategy. The consultation undertaken as part of the development of the strategy has introduced to key stakeholders what Partnership Funding is and the requirements and reliance of schemes across different frontages on third party funding. Discussions and feedback from this has highlighted the concern across many parties about the future of funding, but has importantly started stakeholders considering the requirements around this.
- 6.3.27 The funding gap for the different frontages has also been presented specifically to the Local Authorities and the KSL Area Team will continue to regularly meet

and discuss key issues with the Local Authorities. Section 7.3 of this StAR further discusses the required actions and risks around third party funding.

6.3.28 Figure 6 presents the percentage of benefits associated to different categories over the strategy area. This demonstrates the range of potential funders for the different schemes proposed within the strategy and the involvement and coordination there will need to be with commercial industry as many of the benefits are associated with commercial properties. Technical Appendix R details the breakdown for different schemes and looks in more detail regarding the potential funders for different frontages in the strategy. Section 7.3 of this StAR further discusses the required actions and risks around third party funding.

Figure 6 Pie chart demonstrating percentage of benefits according to different categories from across the Strategy



6.4 Summary of preferred strategy

6.4.1 A strategy wide assessment has been undertaken to determine the economic viability of MEASS. The results are presented in Table 6.2. The breakdown of the benefit cost ratios is presented in

6.4.2 Table 6.3.

6.4.3 The strategy wide results demonstrate that MEASS has a BCR significantly above one. This is a positive outcome and highlights the viability of MEASS to undertake coastal management works to deliver the objectives of MEASS, including improving the SoP provided to residential and commercial property, and compensating for the potential adverse impacts on intertidal and freshwater compensation.

6.4.4 It should also be noted that as this is a strategy level study, the optioneering and associated costing have been calculated at a high level. As such a conservative approach has been undertaken and a 60% risk allowance has been included on all the costs. The viability of the scheme could potentially increase in the future as the risk budget is reduced as more detailed information becomes available.

Table 6.2 Summary of MEASS economics

MEASS economic summary	
Present value whole life costs ¹	£178,175k
Present value benefits	£1,203,220k
Benefit Cost Ratio	6.75
Present value whole life costs for freshwater moderation cases	£43,244k
Present value whole life costs for freshwater compensation ²	£18,364k

¹It is to be noted that this includes the cost for the Managed Realignment sites.

²It is to be noted that this number includes costs for compensation for all areas, and does not allow for Great Bells Farm, which is a scheme that was completed in 2013 by the Environment Agency and will likely provide compensatory habitat for three sections. This will reduce this cost by around £7,000k.

Table 6.3 Summary of the economic assessment and preferred option decision, split by Benefit Areas. Benefit Area 1.

Option	Economics (preferred economic option highlighted in purple, hashed purple demonstrates an option which was initially identified as economically preferred option, but final preferred option was updated following either consideration of wider benefits, local choices or was superseded through consideration of legal requirements)									SPA freshwater habitat considerations (preferred freshwater option in blue)		Managed Realignment Sites to provide coastal squeeze compensation		Final Strategy Preferred Option	
	PVc (£k)	PVb (£k)	NPV (£k)	BCR	IBCR	Min SOP (when assets first flooded) to residential and commercial properties (%AEP, 100yr flood risk)	Number of residential properties at risk from 0.1% AEP (100yr flood risk).	Number of commercial properties at risk from 0.1% AEP (100yr flood risk).	Does consideration of potential contributions, uncertainty or wider objectives/ outcomes affect leading option?	Cost to Hold the Defence Line (£k)	Compensate for Freshwater Habitat loss (£k)	MR site identified for section?	MR proportional costs added to Hold the Line options (PV costs £k)	Total PV Whole Life Cost of Strategy Preferred Option (£k)	Description of Strategy Preferred Option
Benefit Area 1.2															
Do Nothing	-	-	-	-		>50%	6	71	Maintain (capital) option has highest NPV and highest BCR following the Do Minimum and an incremental BCR greater than 1. However, the Maintain option is not desirable due to the potential impacts on nationally important infrastructure due to sea level rise and therefore it does not meet the Strategy objectives. Under local choices, the Sustain Option will be preferred and would require and additional £1.5m funding over 100 years.	N/A	N/A	1,218	22,054		<u>Delayed Sustain:</u> Maintain until year 5. Then sustain.
Do Minimum	307	13,044	12,738	42.5		>50%	6	71							
Maintain	19,293	38,248	18,955	2.0	1.5	50%	5	62							
Sustain	23,067	41,151	18,084	1.8	-	0.1%	0	0							
Upgrade	29,642	41,151	11,509	1.4	-	0.1%	0	0							
Delayed Sustain	20,836	41,148	20,312	2.0	1.6	0.1%	0	0							

Option	Economics (preferred economic option highlighted in purple, hashed purple demonstrates an option which was initially identified as economically preferred option, but final preferred option was updated following either consideration of wider benefits, local choices or was superseded through consideration of legal requirements)									SPA freshwater habitat considerations (preferred freshwater option in blue)		Managed Realignment Sites to provide coastal squeeze compensation		Final Strategy Preferred Option	
	PVc (£k)	PVb (£k)	NPV (£k)	BCR	IBCR	Min SOP (when assets first flooded) to residential and commercial properties (%AEP, 100yr flood risk)	Number of residential properties at risk from 0.1% AEP (100yr flood risk).	Number of commercial properties at risk from 0.1% AEP (100yr flood risk).	Does consideration of potential contributions, uncertainty or wider objectives/ outcomes affect leading option?	Cost to Hold the Defence Line (£k)	Compensate for Freshwater Habitat loss (£k)	MR site identified for section?	MR proportional costs added to Hold the Line options (PV costs £k)	Total PV Whole Life Cost of Strategy Preferred Option (£k)	Description of Strategy Preferred Option
Benefit Area 1.3															
Do Nothing	-	-	-	0.0	N/A - only one with BCR above 1	>50%	8	127	N/A	MR site therefore compensation required.	1,772	MR site proposed for Abbots Court in Year 11. Freshwater habitat compensation required as part of this.	10	1,919	Do minimum: Maintain until year 25. Then NAI. <u>Freshwater habitat:</u> Freshwater habitat compensation <u>MR site:</u> MR site in year 11.
Do Minimum	137	331	195	2.4		>50%	8	127							
Maintain	4,032	2,048	- 1,985	0.5		50%	8	121							
Sustain	6,268	4,298	- 1,969	0.7		1%	0	0							
Upgrade	10,974	4,497	- 6,476	0.4		1%	0	0							
Setback Embankment and Maintain	4,972	2,223	- 2,749	0.4		50% in some areas, 1% for MR site	8	121							
Setback Embankment and Sustain	8,285	4,349	- 3,936	0.5		1%	0	0							
Setback Embankment and Upgrade	10,345	4,543	- 5,803	0.4		1%	0	0							
Benefit Area 1.4															
Do Nothing	-	-	-	0.0	N/A	N/A	N/A - Erosion	N/A - Erosion	N/A	N/A	N/A	N/A	-	<u>Do Nothing:</u> NAI.	
Monitoring Only	-	-	-	0.0		N/A	N/A - Erosion	N/A - Erosion							

Benefit Area 2

Option	Economics (preferred economic option highlighted in purple, hashed purple demonstrates an option which was initially identified as economically preferred option, but final preferred option was updated following either consideration of wider benefits, local choices or was superseded through consideration of legal requirements)									SPA freshwater habitat considerations (preferred freshwater option in blue)		Managed Realignment Sites to provide coastal squeeze compensation		Final Strategy Preferred Option	
	PVc (£k)	PVb (£k)	NPV (£k)	BCR	IBCR	Min SOP (when assets first flooded) to residential and commercial properties (%AEP, 100yr flood risk)	Number of residential properties at risk from 0.1% AEP (100yr flood risk).	Number of commercial properties at risk from 0.1% AEP (100yr flood risk).	Does consideration of potential contributions, uncertainty or wider objectives/ outcomes affect leading option?	Cost to Hold the Defence Line (£k)	Compensate for Freshwater Habitat loss (£k)	MR site identified for section?	MR proportional costs added to Hold the Line options (PV costs £k)	Total PV Whole Life Cost of Strategy Preferred Option (£k)	Description of Strategy Preferred Option
Benefit Area 2.1															
Do Nothing	-	-	-	0.0		>50%	487	917	N/A	N/A	N/A	1,149	20,534	<u>Sustain:</u> Sustain defences.	
Do Minimum	864	276	-588	0.3		>50%	487	917							
Maintain	13,931	10,472	-3,459	0.8		50%	475	908							
Sustain	19,385	38,820	19,435	2.0	5.2	1%	0	0							
Upgrade	32,830	40,747	7,918	1.2	0.1	1%	0	6							
Benefit Area 2.2															
Do Nothing	-	-	-	0.0	N/A - only one BCR above 1	>50%	260	335	N/A	N/A	N/A	179	5,417	<u>Localised sustain:</u> Sustain defences in localised areas.	
Do Minimum	855	64	-791	0.1		>50%	260	335							
Maintain	14,963	1,273	-13,690	0.1		50%	231	313							
Sustain	17,628	11,307	-6,321	0.6		0.1%	0	0							
Upgrade	35,608	11,307	-24,301	0.3		0.1%	0	0							
Localised Sustain	5,238	6,037	799	1.2		0.1%	0	0							
Benefit Area 2.3															
Do Nothing	-	-	-	0.0		>50%	1374	290	N/A	N/A	N/A	1,868	16,124	<u>Sustain:</u> Sustain defences.	
Do Minimum	447	1,317	870	2.9		>50%	1374	290							
Maintain	6,541	21,360	14,820	3.3	3.3	50%	1329	283							
Sustain	14,256	63,084	48,828	4.4	5.4	0.5%	6	0							
Upgrade	20,226	63,193	42,966	3.1	0.0	0.5%	6	0							

Benefit Area 3

Option	Economics (preferred economic option highlighted in purple, hashed purple demonstrates an option which was initially identified as economically preferred option, but final preferred option was updated following either consideration of wider benefits, local choices or was superseded through consideration of legal requirements)									SPA freshwater habitat considerations (preferred freshwater option in blue)		Managed Realignment Sites to provide coastal squeeze compensation		Final Strategy Preferred Option	
	PVc (£k)	PVb (£k)	NPV (£k)	BCR	IBCR	Min SOP (when assets first flooded) to residential and commercial properties (%AEP, 100yr flood risk)	Number of residential properties at risk from 0.1% AEP (100yr flood risk).	Number of commercial properties at risk from 0.1% AEP (100yr flood risk).	Does consideration of potential contributions, uncertainty or wider objectives/ outcomes affect leading option?	Cost to Hold the Defence Line (£k)	Compensate for Freshwater Habitat loss (£k)	MR site identified for section?	MR proportional costs added to Hold the Line options (PV costs £k)	Total PV Whole Life Cost of Strategy Preferred Option (£k)	Description of Strategy Preferred Option
Benefit Area 3.1															
Do Nothing	-	-	-	0.0	N/A	>50%	1	12	N/A	N/A	N/A	N/A	-	Do Nothing: NAI.	
Do Minimum	220	1	-	0.0		>50%	1	12							
Maintain	2,905	3	-	0.0		50%	1	12							
Sustain	5,858	673	-	0.1		0.5%	1	1							
Benefit Area 3.2															
Do Nothing	-	-	-	0.0	N/A - only one BCR above 1	>50%	50	11	N/A	N/A	MR site Halling Marshes	83	1,725	Localised sustain: Sustain defences in localised areas. MR site: MR site at Halling.	
Do Minimum	372	102	-	0.3		>50%	50	11							
Maintain	4,082	102	-	0.0		50%	50	10							
Sustain	11,408	3,031	-	0.3		5%	1	0							
Upgrade	14,671	3,090	-	0.2		5%	1	0							
Setback Embankment and Sustain	13,771	3,074	-	0.2		5%	1	0							
Setback Embankment and Upgrade	16,182	3,133	-	0.2		5%	1	0							
Localised Sustain	1,642	2,789	-	1.7		5%	1	0							

Option	Economics (preferred economic option highlighted in purple, hashed purple demonstrates an option which was initially identified as economically preferred option, but final preferred option was updated following either consideration of wider benefits, local choices or was superseded through consideration of legal requirements)									SPA freshwater habitat considerations (preferred freshwater option in blue)		Managed Realignment Sites to provide coastal squeeze compensation		Final Strategy Preferred Option	
	PVc (£k)	PVb (£k)	NPV (£k)	BCR	IBCR	Min SOP (when assets first flooded) to residential and commercial properties (%AEP, 100yr flood risk)	Number of residential properties at risk from 0.1% AEP (100yr flood risk).	Number of commercial properties at risk from 0.1% AEP (100yr flood risk).	Does consideration of potential contributions, uncertainty or wider objectives/ outcomes affect leading option?	Cost to Hold the Defence Line (£k)	Compensate for Freshwater Habitat loss (£k)	MR site identified for section?	MR proportional costs added to Hold the Line options (PV costs £k)	Total PV Whole Life Cost of Strategy Preferred Option (£k)	Description of Strategy Preferred Option
Benefit Area 3.3															
Do Nothing	-	-	-	0.0		>50%	1020	251	Maintain (capital) option has the highest benefits following the Do Minimum and an incremental BCR greater than 1. However, the Sustain option protects over 160 additional properties and therefore much better meets the Strategy objectives. Under local choices, the Sustain Option will be preferred and would require and additional £2.1m funding over 100 years.	N/A	N/A	6,325	17,628		<u>Delayed sustain:</u> Maintain until year 20. Then sustain.
Do Minimum	592	17,398	16,806	29.4		>50%	1020	251							
Maintain	8,898	205,958	197,061	23.1	22.7	50%	339	104							
Sustain	17,957	215,079	197,123	12.0	0.2	0.1%	0	0							
Upgrade	25,472	215,079	189,608	8.4	0.1	0.1%	0	0							
Delayed Sustain	11,303	213,624	202,321	18.9	3.2	0.1%	0	0							

Options	Economics (preferred economic option highlighted in purple, hashed purple demonstrates an option which was initially identified as economically preferred option, but final preferred option was updated following either consideration of wider benefits, local choices or was superseded through consideration of legal requirements)									SPA freshwater habitat considerations (preferred freshwater option in blue)		Managed Realignment Sites to provide coastal squeeze compensation		Final Strategy Preferred Option	
	PVc (£k)	PVb (£k)	NPV (£k)	BCR	IBCR	Min SOP (when assets first flooded) to residential and commercial properties (%AEP, 100yr flood risk)	Number of residential properties at risk from 0.1% AEP (100yr flood risk).	Number of commercial properties at risk from 0.1% AEP (100yr flood risk).	Does consideration of potential contributions, uncertainty or wider objectives/ outcomes affect leading option?	Cost to Hold the Defence Line (£k)	Compensate for Freshwater Habitat loss (£k)	MR site identified for section?	MR proportional costs added to Hold the Line options (PV costs £k)	Total PV Whole Life Cost of Strategy Preferred Option (£k)	Description of Strategy Preferred Option
Benefit Area 3.4															
Do Nothing	-	-	-	0.0	N/A - only one BCR above 1	>50%	315	93	N/A	N/A	N/A	629	10,708	Localised sustain: Sustain defences in localised areas.	
Do Minimum	701	317	- 384	0.5		>50%	315	93							
Maintain	7,375	3,645	- 3,730	0.5		50%	302	81							
Sustain	29,548	22,281	- 7,267	0.8		0.1%	59	5							
Upgrade	45,393	22,320	- 23,073	0.5		0.1%	59	5							
Setback Embankment and Sustain	29,949	22,431	- 7,518	0.7		2%	59	5							
Setback Embankment and Upgrade	44,777	22,431	- 22,346	0.5		2%	59	5							
Localised Sustain	10,079	21,243	11,164	2.1		0.1%	59	5							
Benefit Area 3.5															
Do Nothing	-	-	-	0.0	N/A - only one BCR above 1	>50%	6	2	Do Minimum only provides maintenance of defences for 5 years, overall policy for epoch 1 would be NAI.	N/A	N/A	N/A	-	Do Nothing: NAI.	
Do Minimum	34	71	37	2.1		>50%	6	2							
Maintain	3,389	160	- 3,230	0.0		50%	2	2							
Sustain	11,385	398	- 10,987	0.3		5%	2	2							

Benefit Area 4

Option	Economics (preferred economic option highlighted in purple, hashed purple demonstrates an option which was initially identified as economically preferred option, but final preferred option was updated following either consideration of wider benefits, local choices or was superseded through consideration of legal requirements)									SPA freshwater habitat considerations (preferred freshwater option in blue)		Managed Realignment Sites to provide coastal squeeze compensation		Final Strategy Preferred Option	
	PVc (£k)	PVb (£k)	NPV (£k)	BCR	IBCR	Min SOP (when assets first flooded) to residential and commercial properties (%AEP, 100yr flood risk)	Number of residential properties at risk from 0.1% AEP (100yr flood risk).	Number of commercial properties at risk from 0.1% AEP (100yr flood risk).	Does consideration of potential contributions, uncertainty or wider objectives/ outcomes affect leading option?	Cost to Hold the Defence Line (£k)	Compensate for Freshwater Habitat loss (£k)	MR site identified for section?	MR proportional costs added to Hold the Line options (PV costs £k)	Total PV Whole Life Cost of Strategy Preferred Option (£k)	Description of Strategy Preferred Option
Benefit Area 4.1															
Do Nothing	-	-	-	0.0		>50%	19	7	N/A	N/A	MR site at Danes Hill	274	4,846	Sustain: Sustain defences. MR site: MR site at Danes Hill.	
Do Minimum	86	596	510	6.9		>50%	19	7							
Maintain	4,494	1,467	- 3,027	0.3		50	15	7							
Sustain	4,572	9,252	4,680	2.0	1.9	2%	0	0							
Setback Embankment and Maintain	4,649	1,896	- 2,753	0.4		2%	15	7							
Setback Embankment and Sustain	6,365	9,252	2,886	1.5	1.4	2%	0	0							
Benefit Area 4.2a															
Do Nothing	-	-	-	0.0	N/A	>50%	15	38	N/A	7,512	2,000	N/A	N/A	2,000	Do Nothing: NAI. Freshwater: Freshwater compensation.
Do Minimum	236	24	- 211	0.1		>50%	15	38							
Maintain	7,512	162	- 7,350	0.0		50%	9	35							
Sustain	8,363	536	- 7,826	0.1		2%	0	0							
Upgrade	12,422	575	- 11,847	0.0		2%	0	0							
Benefit Area 4.2b															
Do Nothing	-	-	-	0.0	N/A - only one BCR above 1	>50%	10	2	N/A	4,781	3,243	N/A	9	3,286	Do minimum: Maintain until year 15. Then NAI. Freshwater: Freshwater Compensation required.
Do Minimum	33	312	279	9.4		>50%	10	2							
Maintain	4,781	261	- 4,521	0.1		50%	10	2							
Sustain	7,016	1,673	- 5,343	0.2		5%	1	0							
Setback Embankment and Maintain	5,691	1,044	- 4,647	0.2		5%	10	2							
Setback Embankment and Sustain	6,369	1,785	- 4,584	0.3		5%	1	0							
Benefit Area 4.3															
Do Nothing	-	-	-	0.0	N/A	0%	5	1	N/A	N/A	N/A	N/A	-	Do Nothing: NAI.	
Monitoring Only	-	-	-	0.0		0%	5	1							

Option	Economics (preferred economic option highlighted in purple, hashed purple demonstrates an option which was initially identified as economically preferred option, but final preferred option was updated following either consideration of wider benefits, local choices or was superseded through consideration of legal requirements)									SPA freshwater habitat considerations (preferred freshwater option in blue)		Managed Realignment Sites to provide coastal squeeze compensation		Final Strategy Preferred Option	
	PVc (£k)	PVb (£k)	NPV (£k)	BCR	IBCR	Min SOP (when assets first flooded) to residential and commercial properties (%AEP, 100yr flood risk)	Number of residential properties at risk from 0.1% AEP (100yr flood risk).	Number of commercial properties at risk from 0.1% AEP (100yr flood risk).	Does consideration of potential contributions, uncertainty or wider objectives/ outcomes affect leading option?	Cost to Hold the Defence Line (£k)	Compensate for Freshwater Habitat loss (£k)	MR site identified for section?	MR proportional costs added to Hold the Line options (PV costs £k)	Total PV Whole Life Cost of Strategy Preferred Option (£k)	Description of Strategy Preferred Option
Benefit Area 4.4															
Do Nothing	-	-	-	0.0	N/A - option with highest SOP also has highest BCR	>50%	26	11	N/A	N/A	N/A	26	814	Localised sustain: Sustain defences in localised areas.	
Do Minimum	33	33	-	1.0		>50%	26	11							
Maintain	1,499	384	- 1,114	0.3		5%	21	10							
Sustain	3,191	1,089	- 2,101	0.3		1%	7	5							
Localised Sustain	788	865	76	1.1		1%	7	5							
Benefit Area 4.5															
Do Nothing	-	-	-	0.0	N/A	>50%	0	1	N/A	2,572	2,381	N/A	N/A	2,381	Do Nothing: NAI. Freshwater: Freshwater compensation.
Do Minimum	214	6	- 208	0.0		>50%	0	1							
Adaptation	-	151	151	0.0		N/A	0	1							
Maintain	2,282	151	- 2,131	0.1		50%	0	1							
Upgrade	6,842	192	- 6,650	0.0		2%	0	0							
Setback Embankment	1,741	355	- 1,386	0.2		2%	0	0							
Benefit Area 4.6															
Do Nothing	-	-	-	0.0	N/A	N/A	0	0	N/A	N/A	N/A	N/A	-	Do Nothing: NAI.	
Adaptation	8,768	808	- 7,960	0.1		N/A	0	0							
Monitoring Only	95	-	- 95	0.0		N/A	0	0							
Benefit Area 4.7															
Do Nothing	-	-	-	0.0	N/A - only one BCR above 1	>50%	2	9	N/A	N/A - Compensation requirements addressed under MR option	MR site at Tailness. MR - Habitat Adaptation from year 15	N/A	599	Do minimum: Maintain until year 15. MR site: Habitat adaptation (MR) from year 15.	
Do Minimum	599	750	151	1.3		>50%	2	9							
Maintain	20,893	761	- 20,132	0.0		50	2	9							
Sustain	25,651	1,349	- 24,303	0.1		5	0	5							
Upgrade	32,284	1,370	- 30,913	0.0		5	0	5							
Setback Embankment and Maintain	29,434	1,029	- 28,406	0.0		50% (5% at MR site)	2	9							
Setback Embankment and Sustain	34,684	1,497	- 33,187	0.0		5%	0	5							
Setback Embankment and Upgrade	40,964	1,517	- 39,448	0.0		5%	0	5							

Benefit Area 5

Option	Economics (preferred economic option highlighted in purple, hashed purple demonstrates an option which was initially identified as economically preferred option, but final preferred option was updated following either consideration of wider benefits, local choices or was superseded through consideration of legal requirements)									SPA freshwater habitat considerations (preferred freshwater option in blue)		Managed Realignment Sites to provide coastal squeeze compensation		Final Strategy Preferred Option	
	PVc (£k)	PVb (£k)	NPV (£k)	BCR	IBCR	Min SOP (when assets first flooded) to residential and commercial properties (%AEP, 100 year flood risk)	Number of residential properties at risk from 0.1% AEP (100 year flood risk).	Number of commercial properties at risk from 0.1% AEP (100 year flood risk).	Does consideration of potential contributions, uncertainty or wider objectives/ outcomes affect leading option?	Cost to Hold the Defence Line (£k)	Compensate for Freshwater Habitat loss (£k)	MR site identified for section?	MR proportional costs added to Hold the Line options (PV costs £k)	Total PV Whole Life Cost of Strategy Preferred Option (£k)	Description of Strategy Preferred Option
Benefit Area 5.1															
Do nothing	-	-	-	0.0		>50%	84	86	Maintain option is the economically preferred. However, Sustain protects 160 additional properties and therefore much better meets the Strategy objectives. Under local choices, the Sustain Option is preferred and will require additional £2.1m funding over 100 years.	N/A	N/A	1,996	8,920	<u>Delayed sustain:</u> Maintain until year 20. Then sustain.	
Do minimum	298	11,023	10,725	37.0		>50%	84	86							
Maintain	4,828	63,476	58,648	13.1	11.58	50%	82	85							
Sustain	11,284	67,585	56,301	6.0	0.04	0.1%	0	1							
Upgrade	14,705	67,585	52,880	4.6	0.02	0.1%	0	1							
Delayed sustain	6,924	67,408	60,484	9.7	1.88	0.1%	0	1							
Benefit Area 5.2															
Do nothing	-	-	-	0.0		>50%	1,235	274	N/A	N/A	MR site at Kemsley	1,996	8,751	<u>Sustain:</u> Sustain defences. <u>MR site:</u> New MR site at Kemsley.	
Do minimum	358	4,390	4,032	12.2		>50%	1,235	274							
Maintain	3,372	55,254	51,882	16.4		50%	105	204							
Sustain	6,754	67,428	60,674	10.0	3.60	0.5%	0	0							
Upgrade	12,535	67,491	54,955	5.4	0.01	0.5%	0	0							
Setback embankments and sustain	8,783	67,428	58,645	7.7	0.00	0.5%	0	0							
Setback embankments and upgrade	12,285	67,491	55,206	5.4	0.01	0.5%	0	0							

Benefit Area 6

Option	Economics (preferred economic option highlighted in purple, hashed purple demonstrates an option which was initially identified as economically preferred option, but final preferred option was updated following either consideration of wider benefits, local choices or was superseded through consideration of legal requirements)									SPA freshwater habitat considerations (preferred freshwater option in blue)		Managed Realignment Sites to provide coastal squeeze compensation		Final Strategy Preferred Option	
	PVc (£k)	PVb (£k)	NPV (£k)	BCR	IBCR	Min SOP (when assets first flooded) to residential and commercial properties (%AEP, 100 year flood risk)	Number of residential properties at risk from 0.1% AEP (present day flood risk).	Number of commercial properties at risk from 0.1% AEP (present day flood risk).	Does consideration of potential contributions, uncertainty or wider objectives/ outcomes affect leading option?	Cost to Hold the Defence Line (£k)	Compensate for Freshwater Habitat loss (£k)	MR site identified for section?	MR proportional costs added to Hold the Line options (PV costs £k)	Total PV Whole Life Cost of Strategy Preferred Option (£k)	Description of Strategy Preferred Option
Benefit Area 6.1															
Do nothing	-	-	-	0.0	N/A - only one BCR above 1	>50%	92	73	Do minimum only protects in the short term, therefore a cost effectiveness analysis was undertaken to assess impacts on internationally designated freshwater.	14,283	20,228	N/A	N/A	14,283	Freshwater: Maintain defences and raise with sea level rise – a moderation case to protect freshwater habitat.
Do minimum	261	532	271	2.0		>50%	92	73							
Maintain	12,935	2,113	- 10,822	0.2		50%	73	50							
Sustain	27,821	6,025	- 21,796	0.2		1%	0	0							
Setback embankments from year 20 and maintain	12,518	2,776	- 9,743	0.2		50%	73	50							
Setback embankments from year 20 and sustain	16,272	4,828	- 11,444	0.3		1%	0	0							
Benefit Area 6.2															
Do nothing	-	-	-	0.0	N/A - only one BCR above 1	>50%	7	40	N/A	913	1,444	MR site at Cleve Hill from Year 20	100	1,694	Do minimum: Maintain for 20 years. Freshwater: Where not MR, HTL and raise with SLR to protect freshwater habitat from year 20. MR site: Managed Realignment from year 20.
Do minimum	681	3,115	2,434	4.6		1%	5	38							
Sustain	12,786	3,131	- 9,654	0.2		0.5%	0	37							
Setback embankments and maintain	14,295	3,439	- 10,856	0.2		0.5%	5	38							
Setback embankments and sustain	22,418	3,450	- 18,968	0.2		2%	0	37							
Setback embankments from year 20 and maintain	12,250	3,390	- 8,860	0.3		2%	5	38							
Setback embankments from year 20 and sustain	12,217	3,400	- 8,817	0.3		2%	0	37							

Benefit Area 7

Option	Economics (preferred economic option highlighted in purple, hashed purple demonstrates an option which was initially identified as economically preferred option, but final preferred option was updated following either consideration of wider benefits, local choices or was superseded through consideration of legal requirements)									SPA freshwater habitat considerations (preferred freshwater option in blue)		Managed Realignment Sites to provide coastal squeeze compensation		Final Strategy Preferred Option	
	PVc (£k)	PVb (£k)	NPV (£k)	BCR	IBCR	Min SOP (when assets first flooded) to residential and commercial properties (%AEP, 100 year flood risk)	Number of residential properties at risk from 0.1% AEP (present day flood risk).	Number of commercial properties at risk from 0.1% AEP (present day flood risk).	Does consideration of potential contributions, uncertainty or wider objectives/ outcomes affect leading option?	Cost to Hold the Defence Line (£k)	Compensate for Freshwater Habitat loss (£k)	MR site identified for section?	MR proportional costs added to Hold the Line options (PV costs £k)	Total PV Whole Life Cost of Strategy Preferred Option (£k)	Description of Strategy Preferred Option
Benefit Area 7.1															
Do nothing	-	-	-	0.0	N/A - only one BCR above 1	>50%	8	72	N/A	4,159	2,335	N/A	44	2,500	Do minimum: Maintain until year 30. Then NAI. Freshwater: Freshwater compensation.
Do minimum	121	1,502	1,382	12.5		>50%	8	72							
Maintain	4,159	401	3,758	0.1		50%	8	72							
Sustain	10,667	5,218	5,449	0.5		5%	5	60							
Upgrade	13,973	5,478	8,495	0.4		5%	5	60							
Benefit Area 7.2a															
Do nothing	-	-	-	0.0		>50%	366	73	N/A	N/A	N/A	362	5,877	Sustain: Sustain defences.	
Do minimum	153	152	- 1	1.0		>50%	366	73							
Maintain	1,381	- 490	- 1,871	0.0		50%	339	66							
Sustain	5,515	12,235	6,721	2.2		0.5%	0	0							
Upgrade	9,257	12,559	3,302	1.4	0.09	0.5%	0	0							
Benefit Area 7.2b															
Do nothing	-	-	-	0.0		>50%	14	5	Maintain (capital) option has the highest benefits following the Do Minimum and an incremental BCR greater than 1. However, the land will still be flooded under a 50% AEP. An additional £330k would enable protection to a 0.1% AEP. Under local choices, the Sustain Option will be preferred and would require and additional £330k funding over 100 years.	N/A	N/A	42	1,236	Delayed sustain: Maintain until year 20. Then sustain.	
Do minimum	61	181	120	3.0		>50%	14	5							
Maintain	866	1,421	555	1.6	1.54	50%	0	0							
Sustain	1,947	1,421	- 526	0.7		0.1%	0	0							
Delayed sustain	1,194	1,421	227	1.2	N/A - same SOP	0.1%	0	0							

Benefit Area 8

Option	Economics (preferred economic option highlighted in purple, hashed purple demonstrates an option which was initially identified as economically preferred option, but final preferred option was updated following either consideration of wider benefits, local choices or was superseded through consideration of legal requirements)									SPA freshwater habitat considerations (preferred freshwater option in blue)		Managed Realignment Sites to provide coastal squeeze compensation		Final Strategy Preferred Option	
	PVc (£k)	PVb (£k)	NPV (£k)	BCR	IBCR	Min SOP (when assets first flooded) to residential and commercial properties (%AEP, 100 year flood risk)	Number of residential properties at risk from 0.1% AEP (present day flood risk).	Number of commercial properties at risk from 0.1% AEP (present day flood risk).	Does consideration of potential contributions, uncertainty or wider objectives/ outcomes affect leading option?	Cost to Hold the Defence Line (£k)	Compensate for Freshwater Habitat loss (£k)	MR site identified for section?	MR proportional costs added to Hold the Line options (PV costs £k)	Total PV Whole Life Cost of Strategy Preferred Option (£k)	Description of Strategy Preferred Option
Benefit Area 8.2															
Do nothing	-	-	-	0.0	N/A - only one BCR above 1	>50%	97	33	Do minimum only protects in the short term, therefore a cost effectiveness analysis was undertaken to assess impacts on internationally designated freshwater.	28,048 (BA 8.2 and 8.3 assessed together due to same area impacted)	52,210 (BA 8.2 and 8.3 assessed together due to same area impacted)	N/A	N/A	7,155	Freshwater: Maintain defences and raise with sea level rise – a moderation case to protect freshwater habitat.
Do minimum	455	1,681	1,225	3.7		4%	97	33							
Sustain	10,310	1,966	- 8,344	0.2		1%	78	1							
Upgrade	13,852	1,967	-11,885	0.1		1%	78	1							
Setback embankment in year 50 and sustain	12,275	1,863	-10,411	0.2		1%	78	1							
Benefit Area 8.3															
Do nothing	-	-	-	0.0	N/A - only one BCR above 1	>50%	4	13	Do minimum only protects in the short term, therefore a cost effectiveness analysis was undertaken to assess impacts on internationally designated freshwater.	28,048 (BA 8.2 and 8.3 assessed together due to same area impacted)	52,210 (BA 8.2 and 8.3 assessed together due to same area impacted)	N/A	N/A	20,893	Freshwater: Maintain defences and raise with sea level rise – a moderation case to protect freshwater habitat.
Do minimum	304	4,359	4,055	14.3		>50%	4	13							
Maintain	20,893	6,248	-14,645	0.3		6%	3	11							
Sustain	25,651	6,654	-18,997	0.3		2%	0	0							
Upgrade	29,434	6,342	-23,093	0.2		2%	3	11							
Setback embankment and maintain	34,684	6,710	-27,974	0.2		6%	0	0							
Benefit Area 8.4															
Do nothing	-	-	-	0.0	N/A	>50%	0	1	N/A	MR site therefore compensation required	4,022	Construct MR site at Elmley Round Field with freshwater habitat compensation	N/A	4,022	Freshwater: Freshwater Compensation. MR site: MR site at Elmley.
Do minimum	55	-	- 55	0.0		>50%	0	1							
Maintain	3,770	76	- 3,694	0.0		9%	0	0							
Setback embankments	2,233	134	- 2,099	0.1		5%	0	0							
Benefit Area 8.5															
Do nothing	-	-	-	0.0	N/A - only one BCR above 1	>50%	26	14	Subsequently assessed as part of BA11.2.	N/A	N/A	N/A	0	HTL as part of 11.2 option. Assessed under 11.2.	
Do minimum	217	331	114	1.5		>50%	26	14							
Maintain	3,202	2,410	- 791	0.8		5%	17	14							
Sustain	6,236	2,495	- 3,740	0.4		0.10%	0	0							

Benefit Area 9

Option	Economics (preferred economic option highlighted in purple, hashed purple demonstrates an option which was initially identified as economically preferred option, but final preferred option was updated following either consideration of wider benefits, local choices or was superseded through consideration of legal requirements)									SPA freshwater habitat considerations (preferred freshwater option in blue)		Managed Realignment Sites to provide coastal squeeze compensation		Final Strategy Preferred Option	
	PVc (£k)	PVb (£k)	NPV (£k)	BCR	IBCR	Min SOP (when assets first flooded) to residential and commercial properties (%AEP, 100 year flood risk)	Number of residential properties at risk from 0.1% AEP (present day flood risk).	Number of commercial properties at risk from 0.1% AEP (present day flood risk).	Does consideration of potential contributions, uncertainty or wider objectives/ outcomes affect leading option?	Cost to Hold the Defence Line (£k)	Compensate for Freshwater Habitat loss (£k)	MR site identified for section?	MR proportional costs added to Hold the Line options (PV costs £k)	Total PV Whole Life Cost of Strategy Preferred Option (£k)	Description of Strategy Preferred Option
Benefit Area 9.1															
Do nothing	-	-	-	0.0		N/A -erosion	N/A -erosion	N/A -erosion	N/A	N/A	N/A	404	5,612	<u>Maintain:</u> Maintain (capital) defences.	
Do minimum	161	2,134	1,973	13.3		N/A -erosion	N/A -erosion	N/A -erosion							
Maintain	5,207	13,660	8,453	2.1	2.28	N/A -erosion	N/A -erosion	N/A -erosion							
Maintain and property rollback	6,463	11,712	5,249	1.7	N/A	N/A -erosion	N/A -erosion	N/A -erosion							
Benefit Area 9.2															
Do nothing	-	-	-	0.0		>50%	221	335	N/A	N/A	N/A	268	2,771	<u>Maintain:</u> Maintain (capital) defences.	
Do minimum	150	2,162	2,012	14.4		>50%	221	335							
Maintain	2,503	9,063	6,560	3.6	2.90	4%	63	226							
Sustain	5,400	9,545	4,145	1.8	0.17	0.50%	3	0							

Benefit Area 10

Option	Economics (preferred economic option highlighted in purple, hashed purple demonstrates an option which was initially identified as economically preferred option, but final preferred option was updated following either consideration of wider benefits, local choices or was superseded through consideration of legal requirements)									SPA freshwater habitat considerations (preferred freshwater option in blue)		Managed Realignment Sites to provide coastal squeeze compensation		Final Strategy Preferred Option	
	PVc (£k)	PVb (£k)	NPV (£k)	BCR	IBCR	Min SOP (when assets first flooded) to residential and commercial properties (%AEP, 100 year flood risk)	Number of residential properties at risk from 0.1% AEP (present day flood risk).	Number of commercial properties at risk from 0.1% AEP (present day flood risk).	Does consideration of potential contributions, uncertainty or wider objectives/ outcomes affect leading option?	Cost to Hold the Defence Line (£k)	Compensate for Freshwater Habitat loss (£k)	MR site identified for section?	MR proportional costs added to Hold the Line options (PV costs £k)	Total PV Whole Life Cost of Strategy Preferred Option (£k)	Description of Strategy Preferred Option
Benefit Area 10.1															
Do nothing	-	-	-	0.0	N/A - only one BCR above 1	N/A -erosion	N/A - erosion	N/A - erosion	N/A	N/A	N/A	N/A	N/A	5,996	<u>Property rollback:</u> NAI with roll back of properties.
Monitoring	95	-	- 95	0.0		N/A -erosion	N/A - erosion	N/A - erosion							
Property rollback	5,996	7,729	1,733	1.3		N/A -erosion	N/A - erosion	N/A - erosion							

Benefit Area 11

Option	Economics (preferred economic option highlighted in purple, hashed purple demonstrates an option which was initially identified as economically preferred option, but final preferred option was updated following either consideration of wider benefits, local choices or was superseded through consideration of legal requirements)									SPA freshwater habitat considerations (preferred freshwater option in blue)		Managed Realignment Sites to provide coastal squeeze compensation		Final Strategy Preferred Option	
	PVc (£k)	PVb (£k)	NPV (£k)	BCR	IBCR	Min SOP (when assets first flooded) to residential and commercial properties (%AEP, 100 year flood risk)	Number of residential properties at risk from 0.1% AEP (present day flood risk).	Number of commercial properties at risk from 0.1% AEP (present day flood risk).	Does consideration of potential contributions, uncertainty or wider objectives/ outcomes affect leading option?	Cost to Hold the Defence Line (£k)	Compensate for Freshwater Habitat loss (£k)	MR site identified for section?	MR proportional costs added to Hold the Line options (PV costs £k)	Total PV Whole Life Cost of Strategy Preferred Option (£k)	Description of Strategy Preferred Option
Benefit Area 11.1															
Do nothing	-	-	-	0.0	N/A - Options have the same SoP	>50%	N/A - erosion	N/A - erosion	N/A	N/A	N/A	412	1,409	<u>Maintain:</u> Maintain defences.	
Do minimum	1,019	13,931	12,912	13.7		5%	N/A - erosion	N/A - erosion							
Maintain	997	13,931	12,934	14.0		5%	N/A - erosion	N/A - erosion							
Benefit Area 11.2															
Do nothing	-	-	-	0.0		>50%	7,213	1,089	Maintain is the economically preferred option. However, Sustain protects over 5,000 additional properties and much better meets the Strategy objectives. Furthermore, Sustain has the highest NPV and environmental scoring. Under local choices, the Sustain Option will be preferred and requires additional £6.5m funding over 100 years.	N/A	N/A	17,979	36,060	<u>Sustain:</u> Sustain defences.	
Do minimum	609	90,966	90,357	149.4		>50%	7,213	1,089							
Maintain	11,613	599,084	587,471	51.6	46.18	6%	5,914	1,005							
Sustain	18,081	607,198	589,117	33.6	1.25	0.1%	318	121							
Upgrade	25,506	607,177	581,671	23.8	0.58	0.1%	318	121							

7 Implementation

7.1 Project planning

Phasing and approach

- 7.1.1 The delivery programme for MEASS is complex due to the length of coastline and variety of preferred option. Technical Appendix H presents the Implementation Plan which goes through each BA section in detail listing the activities to be undertaken each year, the key outstanding residual risks and mitigation actions, and core information required to implement the preferred strategy solution.
- 7.1.2 The delivery programme has been categorised and discussed under a number of different themes:
- Strategy wide activities including strategy reviews and strategy wide surveys,
 - managed realignment capital schemes,
 - flood and coastal erosion defence improvement capital schemes,
 - ongoing maintenance,
 - freshwater habitat compensation, and
 - withdrawal of maintenance sites.

Programme and spend profile

- 7.1.3 Technical Appendix F provides the breakdown spend profile over the 100 years for the strategy frontages. Furthermore, Technical Appendix H presents the key activities required. The annualised spend profile as a total for the strategy area is presented in Table 7.3.
- 7.1.4 Over the first ten years of the strategy implementation, the key activities under strategy wide activities and for capital schemes are presented in Table 7.1. These are presented in more detail with the Implementation Plan (Technical Appendix H). The capital schemes for delivery in the first ten years have been prioritised and phased on a number of criteria:
- Condition of defences,
 - Overall strength of economic assessment,
 - Number of OM2s and OM3s which can be realised through the schemes, and
 - Whether there are key risks, in particular third party funding, which may mean the time between strategy approval and OBC undertaking may be longer than usual.
- 7.1.5 In the development of the compensation sites, Great Bells Farm site has been secured and is currently owned by the Environment Agency, for the initial freshwater compensation required. For the Managed Realignment sites, none of these sites have been formally secured, however specific conversations with the landowners has taken place and these will be continued to develop into formal agreements.
- 7.1.6 The overall Strategy is considered affordable, however it is acknowledged that there will need to be a specific focus on third party funding. There are several BAs which will rely on significant input and contributions from third parties, particularly more industrial areas. Table 7.2 presents the BAs where capital

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schemes are planned under FDGiA funding and outlines the partnership funding score, third party funding requirements and discusses potential affordability.

7.1.7 The capital flood defence schemes under the strategy will look to obtain state aid cover from the Service of General Economic Interest. The strategy falls under the following requirements:

- The proposed schemes are designed to protect a number of different properties that consist of private housing and economic undertakings. It has not been designed in such a way, or amended to protect one specific economic undertaking.
- Where property purchase is involved (through the property relocation/adaptation schemes), the property will be bought at commercial rates.
- The schemes will be procured through either Environment Agency or UK Government tendering processes.

Table 7.1 Key dates for implementation of Strategy wide activities and capital schemes. Please note this presents the first ten years of the Strategy and is presented in order of occurrence in the proposed programme.

Activity	Date <i>Dates in OBC/ Detailed Design/ Construction</i>	Whole life costs in first 10 years (including 60% risk) (£k)	OM2s, 3s and 4s released	Key delivery risks (further risks associated with the scheme delivery are provided in Appendix H of the strategy)
Flood and erosion defence capital schemes				
Benefit Area 9.1	2019/ 2020/ 2021	5,005	183 OM3s	Third party funding required. Cliff erosion to be understood in more detail. Project will be led by Swale Borough Council.
Benefit Area 11.2	2019/ 2020/ 2021-2022	14,826	6,161 OM2s	Need to ensure have considered potential impacts with any fluvial flood risk. Large area with many stakeholders and historical assets – scheme will be a large and complex one.
Benefit Area 2.3	2021/ 2022/ 2023-2024	12,640	376 OM2s	Large number of stakeholders and funding opportunities as well as wider opportunities – these will be assessed prior to OBC.
Benefit Area 5.2	2021/ 2022/ 2023-2024	5,587	540 OM2s	Landscape impacts on the light railway heritage assets to be carefully considered.
Benefit Area 1.2	2024/ 2025/ 2026-2027	21,504	2 OM2s	Benefits are related to industry in the area – need to be the key stakeholders who can influence from the beginning of the OBC as well as key funders.
Benefit Area 2.2	2024/ 2025/ 2026	3,571	94 OM2s	Interactions with Medway Council assets needs to be agreed early on and third party funding required.
Benefit Area 3.4	2024/ 2025/ 2026-2027	8,270	97 OM2s	Early condition survey required to confirm areas which need works to be focussed.
Benefit Area 4.1	2024/ 2025/ 2026	3,670	8 OM2s	Third party funding requirements and interactions with the Riverside Country Park – who will be a key stakeholder.
Benefit Area 7.2a	2024/ 2025/ 2026	4,773	52 OM2s	A lot of third party funding required. Solution will be limited regarding space and impact on heritage assets. Value engineering and innovative solutions to be sought.
Benefit Area 2.1	2025/ 2026/ 2027-2028	15,469	92 OM2s	Landscape impacts to be considered within OBC. Third party funding required – need close engagement with Medway Council.

Activity	Date <i>Dates in OBC/ Detailed Design/ Construction</i>	Whole life costs in first 10 years (including 60% risk) (£k)	OM2s, 3s and 4s released	Key delivery risks (further risks associated with the scheme delivery are provided in Appendix H of the strategy)
Benefit Area 3.2	2026/ 2027/ 2028	1,346	21 OM2s	Third party funding required. Potential opportunity to provide efficiencies by tying into the works undertaken as part of the Managed Realignment site.
Benefit Area 4.4	2026/ 2027/ 2028	907	2 OM2s	Third party funding requirements and more detailed modelling of risk to Lower Halstow required.
Managed Realignment sites capital schemes				
Freshwater surveys Stakeholder consultation Business case development Detailed design including ground investigations, EIAs and archaeological investigation Planning and MMO applications Construction	2019 -2020 2019-2023 2021 (except BA1.3 – 2027) 2021-2022 (except BA1.3 – 2027-2028) 2022 (except BA1.3 – 2028) 2023 (except BA1.3 – 2029)	16,662 (note this does not include the construction cost for Abbots Court MR site as construction is planned for after year 10)	29ha OM4s (this only includes habitat not part of a compensatory habitat site)	Discussed further as a key delivery risk in Section 7.3 of this StAR.

Table 7.2 Summary of Partnership Funding scores and comments on affordability for all Capital Schemes proposed as part of MEASS

Benefit Area Section	% Partnership Funding Score	External Contributions Required	Key Potential Funders	Affordability
1.2 - Kingsnorth Power Station	10%	£19,759k	<ul style="list-style-type: none"> • Kingsnorth Power Station • Damhead Creek Power Station • Local businesses in Kingsnorth Industrial Estate • National Rail /BP 	Frontage is affordable with the infrastructure providers leading in the flood defence management. This is currently the case regarding present day defences as the businesses and industry rely heavily on the continued protection here.

2.1 - Lower Upnor to Medway Bridge	14%	£17,618k	<ul style="list-style-type: none"> • Medway Council • Industry along the water front • National Rail • Local Levy/ RFCC • Local Developers • Southern Water 	There are challenges in this area regarding the potential funding availability from local industries. A more in-depth condition survey and assessment of design to make increased use of existing Quay wall structures could reduce costs and increase affordability. Alternatives such as set back defences and flood gates should also be assessed. Benefits are sufficient to at least reduce flooding to key residential areas.
2.2 - Medway Bridge to West St. Mary's Island	18%	£4,440k	<ul style="list-style-type: none"> • Medway Council • Local Levy/ RFCC • Local Businesses • Developers • Network Rail 	There are challenges in this area regarding the potential funding availability from local industries. A more in-depth condition survey and assessment of design to make increased use of existing Quay wall structures could reduce costs and increase affordability. Alternatives such as set back defences and flood gates should also be assessed. Benefits are sufficient to at least reduce flooding to key residential areas.
2.3 - St. Mary's Island to the Strand	33%	£10,783k	<ul style="list-style-type: none"> • Medway Council • Industry along the water front • Historic Dockyard • St Mary's Island - currently maintain some of the defences • Local Levy/ RFCC 	Affordability of area is provided through the joint approach to flood risk management with developers at St Mary's Island (as is currently undertaken), the Local Authority, the Historic Dockyard and the Environment Agency. This is already a frontage which is partly managed by third parties, so it is expected that future % input from FDGiA will be lower than other frontages.
3.2 - North Halling to Snodland	28%	£1,236k	<ul style="list-style-type: none"> • Medway Council • Local Levy and RFCC • Land and property owners • Network Rail 	Although Partnership Funding score is low, scheme is very localised and has a large community interest currently which will help source funding for this. Tie-in to the managed realignment site here to be carefully considered and could help reduce costs through careful alignment of embankments.
3.3 - Snodland to Allington Lock	76%	£4,285k	<ul style="list-style-type: none"> • Network Rail • Land and property owners • Local Businesses • Tonbridge and Malling Council • Southern Water 	High confidence in the affordability for this area, with lots of potential for value engineering to reduce costs, as well as third party funding.
3.4 - Allington Lock to North Wouldham	16%	£8,925k	<ul style="list-style-type: none"> • Local Businesses • Tonbridge and Malling Council • RFCC and Local Levy • Aylesford Priory 	There are challenges here regarding the level of third party funding required to make these schemes work. The alternative if third party funding cannot be found is to focus the localised defence sections more and undertake property level protection where required. Need to work with landowners around risk to agricultural land and landowners likely to take on more of the responsibilities.

4.1 - The strand to west Motney Hill	13%	£4,222k	<ul style="list-style-type: none"> • Local Landowners • Medway Council • Tourism Funds 	Third party funding required to drive this project but aligns with key recreation areas (Riverside Country Park) and the main road. Local landowners likely to be key driving the works and the options.
4.4 - East of Upchurch to east of Lower Halstow	8%	£748k	<ul style="list-style-type: none"> • RFCC and Local Levy • Swale Borough Council • Recreation/habitat creation at Brickfields site 	Challenges with the partnership funding score - majority of scheme needs to be funded from alternative sources. Key focus for flood defence scheme needs to be ensuring flooding from either side of the village (where the policy will be NAI) is protected.
5.1 - Kingsferry Bridge to Milton Creek	42%	£5,175k	<ul style="list-style-type: none"> • Highways Agency • Network Rail • Ridham Docks • Industry around Ridham Docks (including Morrisons) • Southern Water 	Affordability currently relies on third party funding, however majority of beneficiaries in this section are industries and commercial businesses and therefore a funding case should concentrate on coordinating the potential beneficiaries.
5.2 - Milton Creek	106%	£0	<ul style="list-style-type: none"> • Swale Borough Council • Local Industry • Local Levy/ RFCC • Local Developers 	Partnership funding score is above 100%. Further opportunities to increase third party funding contributions should be sought at OBC stage. High confidence in scheme being able to progress.
7.2a - Faversham to Nagden (Front Brents and Town)	18%	4,798k	<ul style="list-style-type: none"> • Swale Borough Council • Local businesses including the Shephard Neame brewery • RFCC and Local Levy • Southern Water 	This area has challenges around affordability but is also an important area to address with regards to flood risk. There are a large number of wider benefits to help drive the funding requirements such as tourism, historic assets and local businesses. Furthermore, the technical solutions here are likely to be innovative due to old structures and limited space - this can also focus on reducing costs significantly.
7.2b - Faversham to Nagden (Abbey Fields)	12%	£1,083k	<ul style="list-style-type: none"> • Swale Borough Council • RFCC and Local Levy • Landowners 	Although has low Partnership Funding score, big potential here to work with the landowners regarding flood defence maintenance and reducing critical flow paths.
9.1 - Leysdown to Shellness	55%	£2,549k	<ul style="list-style-type: none"> • Swale Borough Council • RFCC and Local Levy • Tourism/regeneration funding 	Scheme requires third party funding - likely to come through from regeneration and Local Authority funding. If the total funding cannot be sought, can reduce the beach and groyne maintenance and promenade elements and focus on just reducing cliff erosion and not the overtopping. Benefits are sufficient to drive an erosion protection scheme.

9.2 - Warden Point to Leysdown	23%	£2,146k	<ul style="list-style-type: none"> • Swale Borough Council • RFCC and Local Levy • Tourism/regeneration funding • Caravan Parks 	Liaison with the Local Authority and caravan parks here is key to the affordability of the scheme. There could be potential cost reductions also by combining the scheme with BA9.1 (particularly works on the foreshore). This would improve the affordability of the scheme.
11.1 - Minster Town to Royal Oak	116%	£0	<ul style="list-style-type: none"> • Swale Borough Council • RFCC and Local Levy • Tourism/regeneration funding 	Scheme has a PF score over 100%. Third party funding should still be sought but would be mostly confined to RFCC and Local Authority.
11.2 - Sheerness to Minster	354%	£0	<ul style="list-style-type: none"> • Local Industry • Peel Ports • Swale Borough Council • Local Levy • Heritage and Regeneration Funding 	Scheme has a PF score over 100%. Third party funding should still be sought, in particular from the local industries and Peel Ports.

Table 7.3 Annualised spend profile. Costs are displayed as cash costs (£k)

Cost	2019/20 (£K)	2020/21 (£K)	2021/22 (£K)	2022/23 (£K)	2023/24 (£K)	Future Year (£K)	Total (£K)
Appraisal studies	300	0	200	0	0	3,175	3,675
Detailed design and surveys	0	1,500	0	634	0	8,555	10,689
Construction	0	0	7,301	4,333	5,279	90,567	107,481
Freshwater compensation	0	0	0	0	1,827	31,484	33,311
Managed Realignment scheme	0	0	460	906	8,938	24,342	34,647
Contingency (60% optimism bias)	180	900	4,777	3,524	9,627	94,874	113,882
Inflation (2.5%)	8	38	199	147	401	3,953	4,745
Total Capital Cost	488	2,438	12,937	9,544	26,072	256,951	308,429
Future construction cost	0	0	0	0	0	70,948	70,948
Future maintenance cost	1,299	169	157	169	163	27,696	29,653
Future contingency (60% optimism bias)	779	102	94	102	98	59,186	60,361
Whole life cash cost incl maintenance but without inflation	2,566	2,709	13,188	9,815	26,333	414,781	469,392

Outcome measures contributions

Table 7.4 MEASS Strategy outcome measures and economic summary

MEASS Wide Economics					
Outcome Measure 1 – Economics					
PVb (£)	£1,203,220k	PVc (£)	£178,175k	BCR	6.75
Outcome Measure 2 – Probability of Houses at Risk of Flooding					
Risk Probability Zone		Households Before		Households After	
Very Significant >5%		6,257		8	
Significant		767		66	
Moderate		739		3	
Outcome Measure 3 – Houses better protected from erosion					
		Long term loss		Medium term loss	
Number of households		221		57	
Outcome Measure 4 – Statutory environmental obligations met					
Ha of intertidal habitat created*		29			

*Note that currently this does not include saltmarsh habitat which is being claimed as compensatory habitat.

7.2 Procurement strategy

- 7.2.1 The strategy has been produced using the Water and Environmental Management Framework, using supplier Mott MacDonald who was appointed by the Environment Agency.
- 7.2.2 Following the approval of the StAR, separate approvals will be sought for the proposed schemes. Some early work may fall under the Project Development Unit (PDU), but the majority will fall under the next generation Environment Agency framework.
- 7.2.3 With regards to the schemes planned for implementation over the next couple years, Swale Borough Council will be responsible for procuring the work for improving defences at Leysdown in BA9.1.
- 7.2.4 The scheme in BA11.2 at Sheerness will be procured by the Environment Agency. Suppliers from the current frameworks within the Environment Agency will undertake the OBC and detailed design stages, managed by ncpms.
- 7.2.5 There are a number of opportunities to package work together across the strategy and provide efficiencies through the delivery of the work. These opportunities have been highlighted within Technical Appendix H: Implementation Plan. This includes coordinated management and undertaking of the freshwater surveys required for short term schemes and Managed Realignment sites by the KSL team, which has already been progressed. Furthermore, it has been identified that the business case for the Epoch 1 Managed Realignment sites will be very similar across all sites and therefore one business case for all sites could reduce procurement and approvals costs.

7.3 Delivery risks

High level risk register

- 7.3.1 Key delivery risks for the strategy cover the large amount of third party funding required, and delivery of the intertidal and freshwater compensatory habitat required under the Habitats Regulation Assessment.
- 7.3.2 To manage and reduce risks associated with the amount of third party funding required, the KSL Area Team will be taking forward the strategy Partnership Funding Plan as presented in Appendix R for the strategy.
- 7.3.3 Mitigation requirements to reduce the risk associated with third party funding will follow several streams, which will all be pursued in the event that one of two of them prove difficult to implement for a particular frontage:
- Assessment of potential efficiencies in project delivery – opportunities to reduce implementation costs through reducing risks (and therefore the required risk budget), value engineering and efficiency through packaging work for delivery will be reviewed and assessed through the procurement strategy by the KSL Area Team. Key potentials for this have been highlighted for each Benefit Area Section in the Implementation Plan (Technical Appendix H).

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- Assessment of wider benefits - this will include undertaking an Integrated Landscape and Green Infrastructure Study to inform decision making on wider opportunities and opportunities for funding.
 - Early engagement with stakeholders to develop funding agreements - the KSL Area Team will take forward the information on beneficiaries that has been developed within the strategy to continue conversations with stakeholders as schemes proceed. It is critical that this is undertaken early in the process as without these key parties on board, some of the schemes will not be able to be delivered. The Implementation Plan has, for each Benefit Area section, indicated the timescale by which this is required to have taken place.
 - Assessment of alternative solutions – should specific schemes have difficulties in finding the required funding, condition surveys (which have been outlined as required as part of the strategy implementation) should be used to determine whether works and funding can be focussed on smaller, more critical sections.
- 7.3.4 To identify appropriate Managed Realignment sites, MEASS has considered preliminary desk studies, information from landowner consultation and the Strategic Environmental Assessment. Managed Realignment sites were selected by considering key and secondary constraints.
- 7.3.5 However, it is acknowledged that there are residual risks in taking Managed Realignment sites through detailed design and to construction; due to unknown infrastructure, ground conditions, and specific site concerns. Within MEASS, if one or two of the Managed Realignment sites cannot be taken forward, there are limited alternative options for meeting our obligation to compensate for loss of saltmarsh habitat due to coastal squeeze.
- 7.3.6 The Project Team have therefore identified potential opportunities to provide compensation from outside of the Strategy area, should this risk be realised. If compensation is required from outside of the Strategy area, the Kent & South London Area Habitat Creation Programme will assess alternative sites. This has been detailed within Appendix H: Implementation Plan.
- 7.3.7 A more detailed risk register has been used to undertake a Monte Carlo calculation (provided in Technical Appendix N) and detailed risk and mitigation tables for each frontage is provided in Technical Appendix H (Implementation Plan). The key risks and mitigations for the strategy are presented below in Table 7.5.

Table 7.5 High level risk schedule and mitigation

Key project risk		Adopted mitigation measure	
Achieving required third party funding (without which some frontages will not be affordable).		The KSL Area Team will specifically focus on the requirements for third party funding over the first five years of strategy implementation. An Integrated Landscape and Green Infrastructure Study is proposed for the first 3 years of the strategy to inform the work to identify wider opportunities and partnership funding. Stakeholder engagement and conversations, continuing on from the engagement already undertaken, will be paramount and the Partnership Funding Plan for the strategy outlines the key requirements for this.	
Creating required intertidal compensatory habitat for SPA and Ramsar losses of saltmarsh in the estuary due to coastal squeeze.		Managed realignment sites have been identified to provide compensatory habitat. Precautionary figures have been used from modelling results to estimate saltmarsh creation within the site. There will be ongoing monitoring of the sites. Should there be any issues, additional habitat elsewhere or bringing forward other sites. There is a risk in MEASS that if one or two of the managed realignment sites cannot be taken forward, that there is limited alternative space and options for other managed realignment sites. The Project Team have identified that there are potential opportunities to provide compensation from outside of the Strategy area, should this risk arise.	

Providing required compensatory habitat due to adverse impacts on freshwater designated habitat from increased flooding or overtopping.	Freshwater habitat compensation has been identified (most of it likely to be Great Bells Farm for the first 10 years), however costs to provide freshwater compensation elsewhere has been included in the case that Great Bells Farm is not suitable.
A high spend and resources are required to undertake the schemes proposed initially in the strategy.	An exercise has been undertaken with the KSL Area Team to prioritise schemes initially identified to be undertaken over the first three years of the strategy. These have now been phased over the first 10 years of the strategy. Appendix H Implementation Plan details the priority of schemes so if they need to be moved forwards or backwards key requirements are clear to inform these decisions.
The proposals for the Solar Farm at Cleve Hill are progressed.	Chetney marshes adaptation policy could be accelerated with additional management/ breaches to create intertidal habitat earlier.
Impacts on BAP habitat at Wouldham marshes due to NAI policy.	Assessment of the alternatives at Wouldham Marshes show that there is no funding available to continue to maintain the defences. Future opportunities to mitigate damage from flooding will be reviewed as part of the KSL Habitat Creation Programme.
Uncertainty regarding landowner management plans in NAI areas – impacts on coastal squeeze and freshwater compensation requirements.	A precautionary approach has been adopted here and requirements for both coastal squeeze compensation as well as freshwater habitat compensation has still been calculated in areas of NAI.
Tailness Marsh modelling - impact on surrounding saltmarsh is greater than the expected gains.	If Tailness Marshes not taken forward, the compensation would only be short by under 1ha. This could be provided within existing sites through additional landscaping.
Achieving funding for the moderation cases.	The moderation cases require funding to maintain defences, despite the low value of benefits in the area. Early discussions with NPAS and LPRG should be undertaken to ensure the development of the business cases are presented in a clear and concise way to allow a quick programme for approval and development of the schemes.

Safety plan

- 7.3.8 A Principal Designer will be appointed at scheme stage for the OBCs, and Detailed Design. A Principal Contractor will be appointed for the construction works.
- 7.3.9 Construction of the majority of schemes will involve some key health and safety risks which will be reduced through Appraisal and Design, as well as during the construction planning. The Project Teams will work closely with key stakeholders and the public to reduce these risks. These risks include:
- Unexploded Ordnance – particularly relating to World War 1 and World War 2 activities;
 - Working in tidal environments; and
 - Working in close proximity to the public.
- 7.3.10 Early Contractor Involvement will also be employed at Appraisal stages to reduce safety risks associated with construction activities, including logistics, transport and placement of materials, as well as operational and maintenance risks.