

Strategy Appraisal Report

Authority scheme reference	IMSW001380
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Defra/WAG LDW number	
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Promoting authority	Environment Agency, South West Region
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Strategy name	Exe Estuary Flood and Coastal Erosion Risk Management Strategy
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Storm event at Exmouth, March 2008

Date	June 2013
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Version	Final
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StAR for Exe Estuary Flood & Coastal Erosion Risk Management Strategy

Version	Status	Signed off by:	Date signed	Date issued
StAR development stage – draft status				
1	Working draft Exec. Summary submission to project team	R Corney	12 March 2013	12 March 2013
2	Full draft submission to project team	R Corney	9 April 2013	9 April 2013
StAR development stage – final status				
3	Final submission to project team	R Corney	8 May 2013	8 May 2013
4	Final submission for assurance review	R Corney	28 May 2013	30 May 2013
5	Final submission for sign-off	R Corney	10 June 2013	10 June 2013
6	Final submission to LPRG	R Corney	21 June 2013	21 June 2013
7	Amended for LPRG comments	R Corney	6 August 2013	6 August 2013

Template version – April 2011

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Glossary and Acronyms

Benefit Cost Ratio (BCR): BCRs are used to identify the relative worth of one approach over another. It is the ratio of the PV benefits to the PV costs for each option.

Breach: Failure of existing linear flood defences allowing flood water inundation of the land behind.

Do Minimum: An option where the Operating Authority takes the minimum amount of action necessary to maintain an asset. For many places, this means patch and repair works of existing defences with no replacement should the defences fail.

Do Nothing: An option used in appraisal to act as a baseline against which all other options are tested. It assumes that no action whatsoever is taken. In the case of existing works, it assumes for the purposes of appraisal that Risk Management Authorities cease all maintenance, repairs and other activities immediately. In the case of new works, it assumes that there is no intervention, and natural and other external processes are allowed to take their course.

Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM-AG): Defra guidance to Risk Management Authorities on the process for appraising flood and coastal defence projects to ensure best use of public money.

Flood Defence Asset: Any structure with the prime purpose to provide flood defence, e.g. groynes, beach and sea walls.

Flood & Coastal Risk Management Grant in Aid (FCRM GiA): Government money allocated to Risk Management Authorities (Environment Agency, Local Authorities, Internal Drainage Boards) for capital works which manage and reduce flood and coastal erosion risk.

Fluvial: Relating to the flow in the river that originates from the upstream catchment and not the sea.

Incremental Benefit Cost Ratio (IBCR): The ratio of the additional benefit to the additional cost, when two options are compared.

Habitats Regulations Assessment (HRA): Formal assessment process that all European Union Member States are required to adhere to, where a project or plan may affect a site that has been protected under the Habitats Directive or the Birds Directive. Sites protected ('designated') under the Habitats Directive are called Special Areas of Conservation (SACs) and those designated under the Birds Directive are called Special Protection Areas (SPAs). HRA also applies to sites protected under the Ramsar Convention, although this is not always specified in law. These sites are designated because of their high value in terms of nature conservation, meaning that they contain rare and highly valued habitats or species, and often both.

Joint Probability: The probability of two separate events occurring at the same time.

Lead Local Flood Authority: After flooding in 2007 the government commissioned a review, which recommended that "Local authorities should lead on the management of local flood risk, with the support of the relevant organisations" (The Pitt Review, 2008). This led to the Flood and Water Management Act (2010) and the set up of Lead Local Flood Authorities (LLFA) who have new powers and duties for managing flooding from local sources, namely Ordinary Watercourses, surface water (overland runoff) and groundwater.

Maintain: Active intervention to keep defences at their current crest level.

Managed Realignment: The placement of a new Managed Realignment flood defence landward of the existing flood defences or realignment to higher ground. This policy would be achieved through the partial or complete removal of the existing flood defences or through regulated tidal exchange. This policy would be gradually implemented and regularly monitored in order to study any potential effects on the overall estuary shape

Multi-coloured Manual (MCM): The MCM provides techniques and data that can be used in benefit assessments for flood and coastal erosion risk management appraisals.

Natura 2000 Network (N2K): European network of protected sites which represent areas of the highest value for natural habitats and species of plants and animals which are rare, endangered or vulnerable in the European Community. The Natura 2000 network includes Special Areas of Conservation (SAC) or Sites of Community Importance (SCI) where they support rare, endangered or vulnerable natural habitats and species of plants or animals (other than birds). Where areas support significant numbers of wild birds and their habitats, they may become Special Protection Areas (SPA). SACs and SCIs are designated under the Habitats Directive and SPAs are classified under the Birds Directive.

Net Present Value (NPV): Stream of all benefits net of all costs for each year of the projects life discounted back to the present date.

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Present Value (PV): Monetary value of ongoing or future costs, discounted to provide equivalent present day costs.

PV Benefits (PVb): Those positive quantifiable changes that a project will produce over its lifetime.

PV Costs (PVC): The cost for implementation of a particular scheme over its lifetime.

PV Damage Avoided: The economic damages avoided once an option has been implemented.

Ramsar: Ramsar is the town in Iran that hosted a meeting in 1971 that adopted the Convention on Wetlands of International Importance, subsequently known as the Ramsar Convention. Ramsar designated wetland sites have the same level of effective protection in UK law as Natura 2000 sites (see Habitats Regulations Assessment in this glossary). At the centre of the Ramsar philosophy is the “wise use” concept. The wise use of wetlands is defined as “the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development”.

Scheduled Monument (SM): To protect archaeological sites for future generations, the most valuable sites may be “scheduled”. Scheduling means nationally important sites and monuments are protected by law by being placed on a list, or ‘schedule’. Further information can be found on the English Heritage (www.english-heritage.org.uk) website.

Site of Special Scientific Interest (SSSI): Sites notified under the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way (CROW) Act 2000) for their flora, fauna, geological or physiographical features. Notification of a SSSI includes a list of activities that may be harmful to the special interest of the site. Section 28 of the Wildlife and Countryside Act 1981 (provisions relating to SSSIs) has been replaced by a new Section 28 in Schedule 9 of the CROW Act.

Special Area of Conservation (SAC): An internationally important site for habitats and/or species, designated as required under the European Community ‘Habitats Directive’ (92/43/EEC). SACs are protected for their internationally important habitat and non-bird species. SACs also receive SSSI designation under The Countryside and Rights of Way (CROW) Act (2000) and The Wildlife and Countryside Act (1981) (as amended).

Special Protection Area (SPA): A site of international importance for birds, designated as required by the EC Birds Directive. The Government has to consider the conservation of SPAs in all its planning decisions. SPAs receive SSSI designation under The Countryside and Rights of Way (CROW) Act 2000 and The Wildlife and Countryside Act 1981 (as amended).

Standard of Protection (SoP): The design event standard, measured by Annual Event Probability (AEP), that an existing asset or proposed scheme provides.

Strategic Environmental Assessment (SEA): A process set out in European and domestic legislation that must be followed to ensure that significant environmental effects arising from policies, plans and programmes are identified, assessed, mitigated, communicated to decision-makers, monitored and that opportunities for public involvement are provided.

Strategy Appraisal Report (StAR): A business case including a programme of works that supports a recommendation to implement a management plan. The plan is approved by the Environment Agency under the Non-Financial Scheme of Delegation from Defra and does not confer any financial authorisation. The plan is supported by technical appendices.

Sustain: Active intervention to raise defence levels to keep pace with sea level rise, thereby retaining the pre-existing Standard of Protection.

Water Framework Directive (WFD): A European Directive to help to protect and enhance the quality of surface freshwater (including lakes, streams and rivers), groundwaters, groundwater dependant ecosystems, estuaries and coastal waters out to one mile from low-water. European Community Directive (2000/60/EC) on integrated river basin management. The WFD sets out environmental objectives for water status based on: ecological and chemical measures; common monitoring and assessment strategies; arrangements for river basin administration and planning; and a programme of measures to meet the objectives.

World Heritage Sites: World Heritage Sites receive designation from the United Nations Educational, Scientific and Cultural Organisation (UNESCO). These sites must be protected or safeguarded but receive no additional statutory protection from such designation, although there is an assumption that they will already be of such importance to receive protection from their status alone, if not from existing statutory arrangements and laws (such as Heritage, Conservation, Environmental, Planning, etc. at national and local level).

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For technical approval of the business case

Environment Agency Region: South West

Project name: Exe Estuary Flood & Coastal Erosion
Risk Management Strategy

Approval Value: £145 million (100 yr whole life cost)
£12.5 million (15 yr cost)

Sponsoring Director: David Jordan Director of Operations

Non-financial scheme of delegation

Part 11 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 Regional Director or Director, Wales and 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:	Exe Estuary Flood & Coastal Erosion Risk Management Strategy		Project Code: IMSW001380
Project Manager:	Fiona Geddes		Date of Submission: 21 June 2013
Lead Authority:	Environment Agency		Version No: 7
Consultant Project Manager: Russell Corney		Consultants: Atkins/Halcrow Alliance	
<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	J Taberham		
	Job Title:	Regional Operations 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	Exe Estuary Flood & Coastal Erosion Risk Management Strategy		Start date	January 2010
				End date	June 2013
	Business unit	South West	Programme	FCRM GiA	
	Project ref.	IMSW001380	Regional SoD ref.	Head Office SoD ref.	-

2.	Role	Name	Post Title
	Project Sponsor	Gordon Trapmore	FCRM Manager
	Project Executive	John Taberham	Regional Operations Manager
	Project Manager	Fiona Geddes	ncpms Project Manager

3.	Risk Potential Assessment (RPA) Category	Low	<input type="checkbox"/>	Medium	<input checked="" type="checkbox"/>	High	<input type="checkbox"/>
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4.	NFSoD value	£k
	Whole Life Costs (WLC) of Complex Change Project / Strategic Plan	145,000

5.	Required level of Environmental Impact Assessment (EIA)	N/A	Low	Medium	High
		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

6.	NFSoD approver name	Post title	Signature	Date
	Richard Cresswell	Regional Director		
	David Jordan	Director of Operations		
	NFSoD consultee name	Post title	Signature	Date
	Gordon Trapmore	AFCRM		
	Dermot Smith	NEAS Operations Manager		
Miles Jordan	Head of AOS			

1 Executive summary

1.1 Introduction and background

- 1.1.1 This Strategy Appraisal Report (StAR) presents the business case and implementation plan for the Exe Estuary Flood and Coastal Erosion Risk Management (FCERM) Strategy (referred to as 'the Strategy').
- 1.1.2 The Strategy has been developed in partnership with Devon County Council (DCC), East Devon District Council (EDDC), Teignbridge District Council (TDC) and Exeter City Council (ECC), who are all risk management operating authorities under the Coast Protection Act within the study area. Along with Network Rail (NR) and Natural England (NE) these local authorities formed a Steering Group, involved in decision making at key stages of the Strategy and ensuring appropriate engagement within each organisation.
- 1.1.3 The Strategy area, situated on the south coast of Devon, extends from Sandy Bay to Holcombe, including the communities of Exmouth, Lypstone, Exton, Clyst St George, Clyst St Mary, Topsham, Countess Wear, Exminster, Starcross, Cockwood and Dawlish – total frontage of 62 km (Key Plan 1). The city of Exeter sits at the head of the estuary.
- 1.1.4 The Exe Estuary is of international importance for nature conservation and is designated as a Special Protection Area (SPA) and Ramsar site (refer to Key Plan 2). Dawlish Warren sand spit is a Special Area of Conservation (SAC). These designations form part of the European Natura 2000 (N2K) network of sites. There are three Sites of Specific Scientific Interest (SSSI) and one National Nature Reserve (NNR) within the strategy area: Exe Estuary SSSI, Dawlish Warren SSSI/NNR and Dawlish Cliffs SSSI.
- 1.1.5 Existing defences along 46 km of frontage (of the total 62 km), including seawalls, revetments, embankments and gated structures, are generally in good condition, though at some locations they require refurbishment and there are low spots in these defences. The remaining 16 km comprises either natural frontage or privately owned defences.
- 1.1.6 The Strategy has been divided into 11 reaches for appraisal purposes. The Strategy identifies for each reach an expenditure profile for the recommended management options over the next 15 years, within the context of a 100-year overall plan. The Strategy has drawn on the policy making process within the South Devon and Dorset Shoreline Management Plan (SMP2, 2011) that covers the Strategy frontage.
- 1.1.7 The Strategy considers the longer term implications of coastal change, climate change and sea level rise, and therefore enables the Environment Agency and local authorities to understand the various technical, environmental and financial constraints when making local choices to best protect local communities.
- 1.1.8 Key strategic issues for the Strategy area include the future evolution of Dawlish Warren sand spit that provides an important sheltering function to the inner estuary, legislative requirements to maintain Natura 2000 (N2K) sites under the EU Habitats and Birds Directives and the deterioration of flood defences around the estuary.
- 1.1.9 The objectives of the Strategy are:
- Promote with our partners jointly funded sustainable flood and coastal erosion risk management solutions to protect local communities, including priority projects in the short term, that are resilient to climate change.
 - Manage tidal flood and erosion risks around the estuary and identify opportunities to improve the unfavourable condition of Dawlish Warren SAC, restore estuarine processes in support of the Water Framework Directive (WFD) and support the objectives of international, national and local conservation designations.
 - Identify preferred locations for new inter-tidal habitat to compensate for losses of habitat caused by rising sea levels where attributable to anthropogenic influences (e.g. coastal and tidal defences) and uncertain changes, with specific requirements to compensate for losses of habitats resulting from the Strategy.
 - Seek ways to enhance the environmental, amenity and recreational value.

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1.2 Problem

- 1.2.1 The Strategy area contains assets at risk of flooding with Present Value damages (PVd) of £657,369k over the next 100 years for the Do Nothing option. There are 2,795 properties (2,215 residential and 580 commercial) currently at risk with a 0.5% (1 in 200) chance of flooding in any year, increasing to 5,016 properties by 2110 – see Table 1.1. The majority of these properties are in Exmouth, Starcross and Dawlish Warren.

Table 1.1 Summary of properties at 0.5% risk for Do Nothing option (no Strategy in place)

	The Maer	Exmouth	Courtlands, Lymptstone, Exton	East bank, Clyst St George	Clyst St Mary	West bank, Lower Clyst	Topsham, Countess Wear	Exminster, Powderham, Kenn Valley	Starcross, Cockwood	Dawlish Warren	Dawlish to Holcombe	Total
Properties at risk, now	0	1,823	125	32	22	1	103	0	627	62	0	2,795
Properties at risk, 2110	6	2,667	173	54	62	14	257	271	752	726	34	5,016
Standard of protection* 2010	0.1%	4%	0.1%	20%	0.1%	20%	10%	2%	4%	2%	0.1%	
Do Nothing PV damages, £m	<0.1	355	44.1	4.9	4.2	0.7	17.5	47.7	145	13.1	25.5	657

Note: no property currently at risk for two reaches – Sandy Bay (small caravan park at risk) and Sowton
 *gives the SoP against the chance of tidal flooding to property in any year.

- 1.2.2 Flood risks are of general concern for both the exposed coastal and sheltered estuary reaches. Erosion risks are only significant for the exposed coastal frontage (Sandy Bay, The Maer, Dawlish Warren and Dawlish to Holcombe).
- 1.2.3 Critical infrastructure at risk includes parts of the Penzance to London main and Exmouth branch railways, sections of the A379 (Starcross) and A376 (Clyst), industry, four care homes (Exmouth, Dawlish), two schools (Exmouth, Starcross), sewage treatment works (Exeter, Exton), power and fuel transmission lines and 25 electricity sub-stations (Starcross, Exmouth and Dawlish).
- 1.2.4 For Dawlish Warren sand spit there are conflicts between Hold the Line for FCERM purposes and supporting the conservation objectives of Dawlish Warren SAC, which is currently in unfavourable condition due to the effects of hard defences (gabions) on coastal processes. Foreshore erosion is damaging these defences added to the front face of the sand dunes in the 1960-70s, and continuing maintenance of these defences is considered by Natural England to be damaging to the Dawlish Warren SAC.
- 1.2.5 The spit has breached eight times in 200 years, naturally resealing each time. In 1949 evidence points to a breach leading to overtopping of Powderham Banks and damage to the main railway. The hard defences control this risk. Other estuarine features have historically been mainly static (low water channel), and either accreting or broadly stable (the ebb and flood deltas of Pole Sands and Bull Hill Bank).
- 1.2.6 Without ongoing intervention, the progressive erosion of the sand spit, sea level rise and increased storminess would accelerate the loss of its sheltering function and ability to naturally reseal, increasing flood risk in the inner estuary. Under this scenario, PVd damages then increase by £91,665k to £190,036k, depending on future changes including sea level rise and assuming continued maintenance of other defences.
- 1.2.7 In Exmouth, Starcross and Dawlish there is risk to life due to the flood hazards. The greatest risk is at Exmouth, as an overtopping event would significantly flood the town centre due to its 'dish-shaped' topography behind the defences.
- 1.2.8 Main and branch railways managed by Network Rail run either side of the Exe Estuary and their embankments form part of the flood defence line over 13.1 km (28% of total). Under their licensing agreement, Network Rail has a legal obligation to maintain the existing routes. Network Rail also has internal design standards to provide a Standard of Protection (SoP) above 2% (1 in 50) chance of flooding in any year for main railways.
- 1.2.9 The FCERM assets (defences) located at the estuary mouth, west bank of the River Clyst and River Exe are identified as causing coastal squeeze of inter-tidal habitat within the N2K sites. By continuing to Hold the Line there would be a legal duty to secure

compensatory habitat to replace up to 54 ha of inter-tidal and terrestrial habitat in the short term.

1.3 Options considered

- 1.3.1 A three staged process was adopted to appraise options; a) review of SMP2 outcome and identification of preferred High Level Options (HLO); b) develop a long-list of technically viable options defining their type and alignment then refine to a short-list and; c) select the preferred option on the outcome of the economic analysis and Strategic Environmental Appraisal (SEA).
- 1.3.2 The FCERM options considered are covered by Do Nothing, Do Minimum, Maintain defences at current crest height, Sustain SoP, Improve SoP, and Managed Realignment (MR). The options for Dawlish Warren sand spit are wide ranging, including combinations of Do Nothing, Maintain, Sustain and MR, with measures such as beach recycling and erosion protection. A tidal barrage option across the estuary mouth was rejected as high cost and environmentally unacceptable.
- 1.3.3 Non structural measures include influencing the planning system to focus on long term re-development out of the floodplain and Flood Incident Management (FIM) initiatives to improve flood resilience of properties and the community response to flooding.
- 1.3.4 Compensatory habitat opportunities were primarily considered within and adjacent to the N2K site, and also at a regional level. Eleven potential sites were investigated at a high level.

1.4 Recommended Strategy

- 1.4.1 The recommended Strategy combines the preferred options for each flood reach to provide a strategic solution with optimal SoP, agreed by all key partners. Options recommended in the Strategy are:
- 1.4.2 **Dawlish Warren sand spit:** The preferred option is to improve the SAC condition by removing gabions to reactivate the sand dunes, to recharge the beach in the short term (up to 2030) to prevent loss of sheltering function to the inner estuary and Improve SoP for Dawlish Village. Longer term (after 2030) the sand spit will be allowed to evolve more naturally, requiring up-grade of the inner estuary defences as this is lower cost than future maintenance of the sand spit.
- 1.4.3 **Priority FCERM schemes** (within five years): The preferred option is to Improve SoP for Exmouth, Starcross, and Dawlish Warren by upgrading their flood defences to 0.1% SoP (currently 2% to 4% SoP) to protect 2,766 residential and 607 non-residential properties in total (Table 1.1 gives the total numbers at risk) and reduce risk to life.
- 1.4.4 **Priority compensatory habitat schemes** (within five years): The preferred option is Managed Realignment on the West Bank of the Lower Clyst and a regulated tidal exchange scheme at Kenn Valley. These are the most feasible sites within the Exe Estuary SPA / Ramsar site to offset inter-tidal habitat losses, providing up to 56 ha of replacement habitat (of which 51 ha inter-tidal). The Exe Estuary Habitat Delivery project is being progressed to capitalise on the willingness of landowners to proceed.
- 1.4.5 **Short to medium term FCERM schemes** (by 2030): The preferred option is to Improve SoP by upgrading flood defences in Topsham to 0.5% SoP, Powderham Banks to 0.1% SoP and The Maer to 0.1% SoP to protect a total of 227 residential and 99 non-residential properties (Table 1.1 gives the total numbers at risk). These schemes deliver FCERM, railway, tourism and environmental benefits and require Partnership Funding.
- 1.4.6 **Longer term** (after 2030): The preferred option is to Sustain SoP in Exmouth, Lypstone, Exminster and Starcross (0.1% SoP), Kenn Valley (1% SoP) and Clyst St George (2% SoP), and Maintain at Clyst St Mary and Countess Wear (2% SoP). The preferred options are property protection (1% SoP) for Dawlish to Holcombe and no active intervention for Sandy Bay and Sowton as no properties are at flood or erosion risk.
- 1.4.7 **Non structural measures:** Flood warning improvements, planning and development control changes are recommended to continue.

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- 1.4.8 The preferred Strategy options are generally in accordance with SMP2 policy, except for the following specific reaches; The Maer, Exminster and Powderham Banks, Kenn Valley, Dawlish Warren.

1.5 Economic case

- 1.5.1 Table 1.2 summarises the 100 year economic case for the preferred Strategy options and the cash costs for the next 15 years. The preferred option SoP is quoted as the lowest standard over the 100 year appraisal period taking account of climate change (refer to Table 1.1 for current SoP).

Table 1.2 Benefit-cost assessment

Flood reaches	Preferred Option, Standard of Protection	PV Costs (£k)	PV Benefits (£k)	Av. Benefit /Cost Ratio	Total Cash Costs (£k)	Cash costs, 15 years (£k)
The Maer	Maintain: 0.1% SoP (1 in 1000)	9,796	19,166	2	36,810	5,742
Exmouth	Improve: 0.1% SoP (1 in 1000)	5,278	353,461	67	14,504	3,076
Courtland, Lymptone, Exton	Sustain: 2% SoP (1 in 50)	5,510	43,846	8	21,745	1,890
East bank, Clyst St George	Maintain: 20% to 100% SoP (1 in 5 to 1 in 1)	169	-28	0	563	113
Clyst St Mary	Maintain: 2% SoP (1 in 50)	804	3,595	4	1,133	757
West bank, Lower Clyst	MR, locally improve: 0.1% SoP	1,674	3,412	2	3,584	1,317
Topsham, Countess Wear	Improve: 2% SoP (1 in 50)	2,203	16,468	7	7,540	1,273
Exminster Powderham	Improve: 0.1% SoP (1 in 1000)	16,987	49,010	3	33,250	10,878
Kenn Valley	MR, sustain: 1% SoP (1 in 100)					
Starcross, Cockwood	Improve: 0.1% SoP (1 in 1000)	4,254	144,968	34	9,209	2,250
Dawlish Warren	Sustainable mgt, locally improve: 0.1% SoP (1 in 1000)	9,316	54,670	6	14,908	11,103
Dawlish to Holcombe	Sustain: 1% SoP (1 in 100)	196	3,544	18	979	0
Strategy area	As above, 100% to 0.1%	56,251	692,280	12	144,540	38,399

Notes: costs include 60% Optimism Bias; excludes inflation

1.6 Environmental considerations

- 1.6.1 The preferred Strategy options will improve the status of Dawlish Warren SAC and provide replacement habitat to offset the adverse impact of losses entirely within the Strategy area. The SEA, which includes WFD assessment and Habitat Regulations Assessment (HRA), informed the selection of the preferred options.
- 1.6.2 The HRA concludes that the Hold the Line options are likely to adversely affect the integrity of the Exe Estuary SPA and Ramsar site at some locations. No alternative solutions are identified that avoid adverse effects while protecting people and public safety. Consequently, the preferred Strategy options will be progressed through an Appendix 20 (statement of case), which considers the Imperative Reasons of Overriding Public Interest and compensatory habitat requirements. This has been drafted, accepted by Natural England and will be submitted to Defra.
- 1.6.3 Assessment of compatibility with the WFD has concluded that the preferred options will not cause deterioration in any water body nor prevent any from reaching future good status or potential. The Strategy's No Active Intervention and Managed Realignment policies will make significant contributions to WFD objectives.
- 1.6.4 Feedback from consultation undertaken throughout the preparation of this Strategy, including three public exhibitions at Dawlish, Exmouth and Topsham, has been positive with support for the improve options presented.
- 1.6.5 Natural England supports the Strategy as an environmentally acceptable solution. A strategic environmental monitoring plan has been drafted addressing uncertainties

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surrounding the future effects of coastal squeeze and the need for and success of compensatory habitat creation. This will be finalised in discussion with Natural England as part of the SEA Statement of Environmental Particulars once the Strategy has been recommended for approval.

1.7 Implementation and Outcome Measures

1.7.1 The recommended Strategy, subject to funding, will reduce flood and erosion risk to the most vulnerable communities and meet the legal obligation of the Exe Estuary SPA for replacement habitat by 2030. Table 1.3 shows the spend profile for the next five years, costs for the next 15 and 100 years, and FCRM-GiA Partnership Funding (PF) score.

1.7.2 Procurement for capital works will be through the Environment Agency frameworks.

Table 1.3 Annualised Cash Spend Profile for 15 years

	2013-14	2014-15	2015-16	2017-18	2018-19	Future 10 years	Total 15 years	Total 100 years
Dawlish Warren, sustainable management , PF score 120% – flood embankment, groyne works, etc.								
Operating authorities: TDC, Environment Agency, DCC								
Cost, £k	555	555	1,110	4,441	555	3,886	11,103	14,908
Priority compensatory habitat schemes (within 5 years) – tidal exchange, realign embankments, IPP*								
Two projects: Kenn Valley (PF score 120%); Lower Clyst (PF score 130%)								
Operating authorities: TDC, EDDC, Environment Agency, DCC								
Cost, £k	180	180	285	285	285	1,747	2,962	15,915
Priority FCERM schemes (within 5 years) – revetments, flood walls, raise harbour/sea wall, IPP*								
Two projects: Exmouth (PF score >200%); Starcross / Cockwood (PF score >200%)								
Operating authorities: EDDC, TDC, Environment Agency, DCC								
Cost, £k	215	378	1,527	1,175	824	1,208	5,326	23,713
Short to medium term FCERM schemes (by 2030) – beach recharge, raise ground / embankments								
Three projects: Topsham/Countess Wear (PF score 40%); Powderham Banks (PF 10%); The Maer (PF 5%)								
Operating authorities: ECC, EDDC, TDC, Environment Agency, DCC								
Cost, £k	680	1,180	1,180	3,180	2,180	7,923	16,323	65,179
Remaining strategy area: ongoing maintenance, refurbishment								
Operating authorities: All relevant authorities								
Cost, £k	179	179	179	179	179	1,790	2,684	24,825
Total Strategy area (sum of the above)								
Cost, £k	1,809	2,472	4,281	9,261	4,023	16,553	38,399	144,540

Notes: costs include capital and non-capital costs; 60% Optimism Bias; excludes inflation; PF score for 15 year duration of benefit

*IPP - Individual Property Protection

1.8 Contributions and funding

1.8.1 The priority FCERM schemes for Exmouth and Starcross qualify for full FCRM Grant in Aid funding of £3,445k. The proposed Managed Realignment schemes on the west bank of the Clyst and at Kenn Valley also qualify for central funding of £2,427k given the need to provide this strategic approach.

1.8.2 The Dawlish Warren scheme justifies full FCRM Grant in Aid funding of £8,334k less funding allocated under the 'Growth Through Flood Alleviation' to accelerate flood defence schemes in this spending review period and £250k contribution agreed by Teignbridge District Council.

1.8.3 The three FCERM projects recommended between 2018 and 2030 require a total of £1,206k FCRM GIA funding and Partnership Funding of approximately £159k for Topsham, £8,288k for Powderham and £4,011k for The Maer.

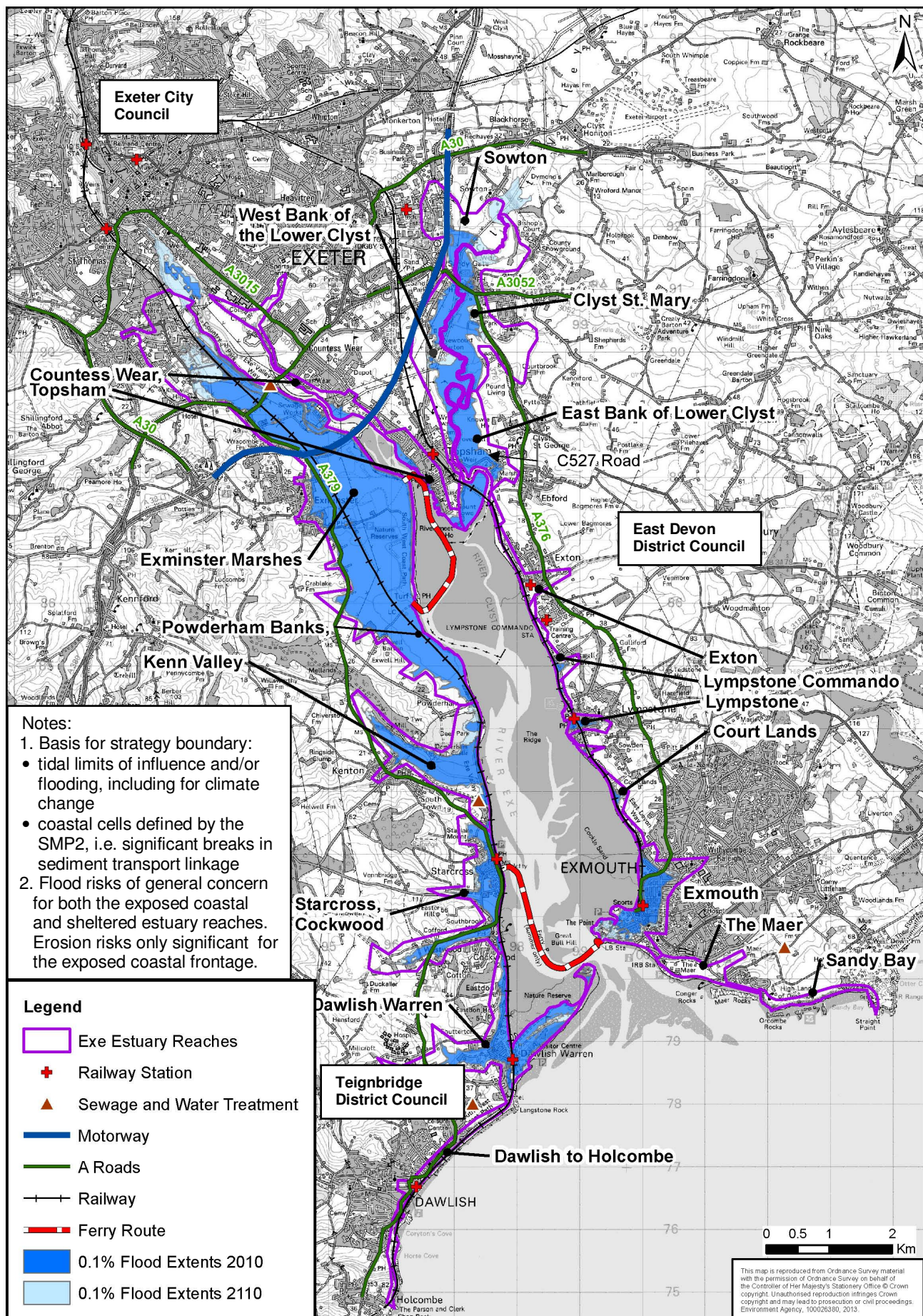
1.8.4 Contributions will be sought from partners for all FCERM schemes.

1.9 Recommendations: Exe Estuary FCERM Strategy

1.9.1 We recommend that the Exe Estuary FCERM Strategy is approved at a Whole Life Cost of £144,540k (excluding inflation) for managing the risk of flooding and coastal erosion to 4,993 properties over 100 years. Contribution plans should be developed to secure funding ahead of implementing the schemes recommended in this Strategy.

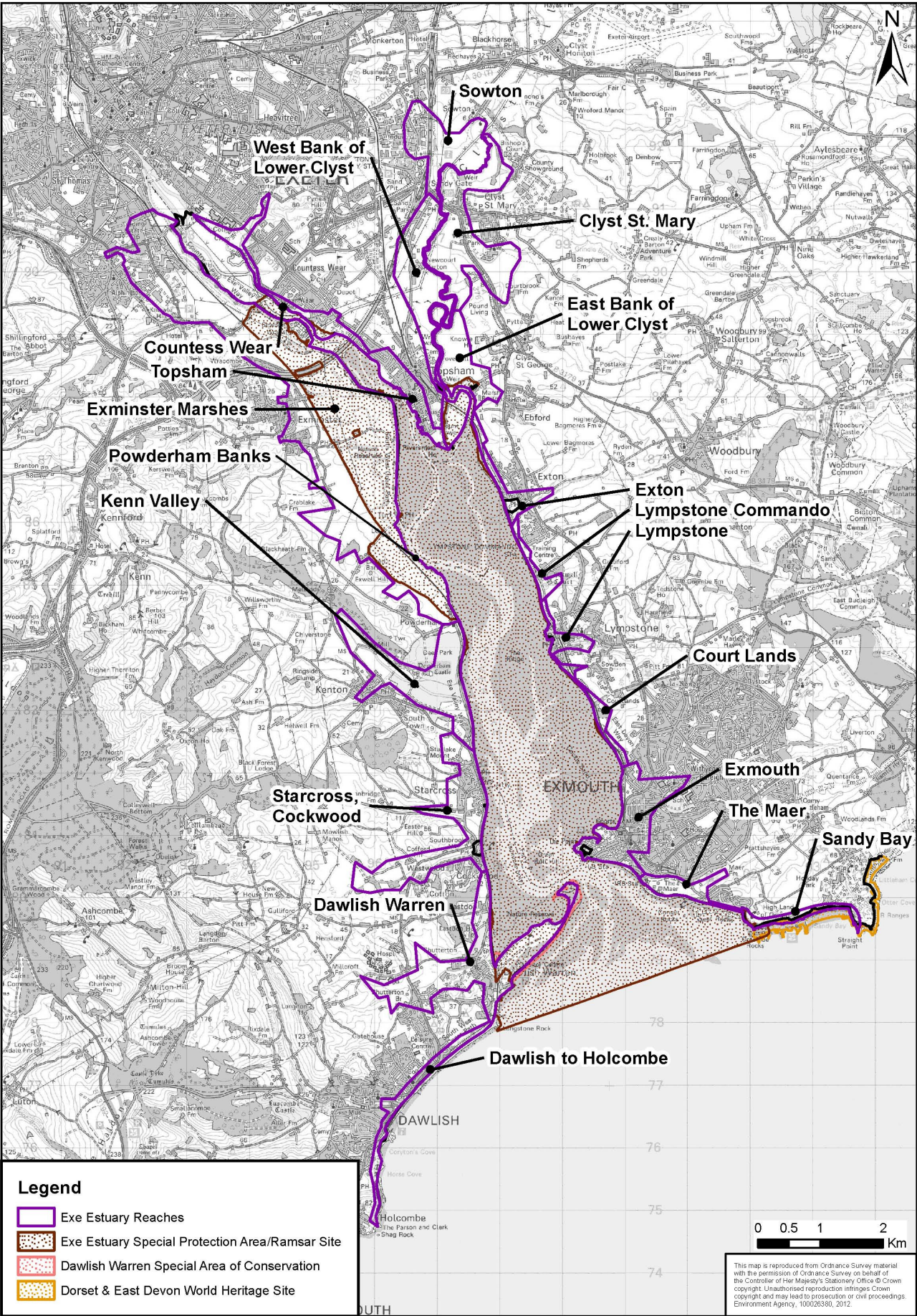
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Key Plan 1 Strategy area, reaches and key assets



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Key Plan 2 Environmental designations



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2 Introduction and background

2.1 Purpose of this report

- 2.1.1 The Exe Estuary Flood and Coastal Erosion Risk Management (FCERM) Strategy has been developed to identify the preferred strategic tidal flood and erosion risk management approach for an area of the south coast of Devon, from Sandy Bay to Holcombe, including the communities of Exmouth, Lypstone, Exton, Clyst St George, Clyst St Mary, Sowton, Topsham, Countess Wear, Exminster, Starcross, Cockwood and Dawlish.
- 2.1.2 The Strategy identifies the recommended management options for the short term 15-year programme within the context of a 100-year overall plan. A strategic approach is required as the problems are long-term and large-scale, include linked coastal processes and multiple benefit areas and require a consistent approach to the management of internationally designated habitats within the Exe Estuary.
- 2.1.3 The preferred Strategy has been developed in accordance with Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM-AG) and associated Environment Agency policies and procedures. The appraisal considers the longer-term implications of coastal change, climate change and sea level rise, and therefore enables the Environment Agency, local authorities and interested parties to understand the various technical, environmental and financial constraints when making local choices.
- 2.1.4 This Strategy has been developed in partnership with Devon County Council (DCC), East Devon District Council (EDDC), Teignbridge District Council (TDC) and Exeter City Council (ECC), who are all risk management operating authorities under the Coast Protection Act within the study area. Network Rail is another key partner. This Strategy Appraisal Report (StAR) will be adopted by the local authorities in accordance with their respective procedures. Following Strategy approval, scheme Project Appraisal Reports (PARs) will be developed in line with the recommended short term programme.

2.2 Background

Strategic and legislative framework

- 2.2.1 The Strategy identifies the most appropriate FCERM activities needed over the next 100 years, adding greater local detail to, being informed by and/or supporting the following most significant plans.
- 2.2.2 The **South Devon and Dorset Shoreline Management Plan** (SMP2, 2011) recommends selectively holding the existing defence line by maintaining or improving existing defences and MR at Powderham Banks, the Lower Clyst and The Maer, Exmouth.
- 2.2.3 The **Exe Estuary Coastal Management Study** (EECMS, 2008) recommends active intervention to maintain Dawlish Warren, possibly on a set-back line, and to generally Hold the Line except for potential MR at Powderham Banks, Lower Clyst Valley and The Maer, and NAI at Straight Point to Orcombe Rocks.
- 2.2.4 The **Exe Catchment Flood Management Plan** (2012) covers the strategy area and recommends further action to sustain the current level of flood risk.
- 2.2.5 The **South West River Basin Management Plan** (2009), together with further investigations to support its update in 2015, has been used to guide the implications of the Strategy on the WFD water bodies that might be affected by it.
- 2.2.6 The other plans considered include the Lyme Bay and South Devon SMP1 (1998), the Devon Preliminary Flood Risk Assessment (2011), and the Devon Local Flood Risk Management Strategy currently being developed.

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- 2.2.7 Works identified by this Strategy will be implemented using powers under Section 165 of the Water Resources Act 1991 and the Coast Protection Act 1949. Schemes will be subject to the Town and Country Planning Regulations, Marine and Coastal Access Act 2009 and Land Drainage regulations where required.
- 2.2.8 Continuing to maintain some flood defences in the Strategy area will cause coastal squeeze of intertidal habitat within the Exe Estuary and Dawlish Warren SPAs and Dawlish Warren SAC. We have a legal duty under the Habitats/Birds Directives to take measures to maintain the integrity of the N2K sites. Where there are no alternative solutions that avoid adversely impacting the N2K sites in some locations, Imperative Reasons of Overriding Public Interest would be required and compensatory habitat would need to be secured.

Previous studies

- 2.2.9 The Strategy takes into account the various FCERM and environmental studies listed below. These provide a comprehensive source of information in terms of the range of options considered (local to large scale) for the Strategy and adjacent areas.
- Dawlish Warren/ Exmouth beach recharge study (TDC, ongoing).
 - Exeter Flood Defence Scheme (Environment Agency in partnership with ECC and DCC, ongoing).
 - Exmouth Vision: A Vision for Exmouth and the Town Centre and Seafront Masterplan (EDDC).
 - Long-term development plans for the Maer in Exmouth (EDDC).
 - Lower Clyst Inter-tidal Habitat Creation (Environment Agency, 2009).
 - Proposed improvements to Teignmouth – Dawlish seawall (Network Rail).
- 2.2.10 The area is extensively designated for its international, national and local conservation importance. Studies within the Strategy provided an overview of potential habitat change, the likely cause of that change, and identified habitat creation opportunities within and adjacent to the Exe Estuary (refer to the Options Assessment Report in Appendix D).

Social and political background

- 2.2.11 The Strategy area (see Key Plans in the Executive Summary) extends across four local authorities; DCC, EDDC, TDC and ECC. These local authorities and the Environment Agency maintain 33.2 km of assets and Network Rail 13.1 km of railway embankment in the study area, all perform FCERM functions. These organisations are members of the Steering Group for the Strategy, providing oversight and engagement through its development.
- 2.2.12 The Strategy area includes the population centres of Exmouth, Lympstone, Exton, Clyst St George, Clyst St Mary, Sowton, Topsham, Countess Wear, Exminster, Starcross, Cockwood and Dawlish (see Key Plan 1).
- 2.2.13 EDDC are developing a major regeneration programme for Exmouth. This includes proposals in the Exmouth and The Maer reaches.
- 2.2.14 Consultation with farmers about changing land management practice in the Lower Clyst valley dates back to 1999. Reduced river maintenance budgets, together with the availability of better funded Environmental Stewardship schemes, provided further impetus for change. With growing understanding of climate change and sea level rise, a partnership project was formed and a study considered the feasibility of managed realignment. This was funded by Natural England and all landowners agreed to it being done. The study concluded that large scale habitat creation is feasible, but landowner support is patchy at best and significant opposition has developed.
- 2.2.15 The Strategy area is important for recreation and tourism, with an estimated 500,000 visitors a year to Dawlish Warren alone.
- 2.2.16 ECC as the Harbour Authority for the Exe Estuary is responsible for navigation.

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Location and designations

- 2.2.17 There are several sites of international nature conservation importance in the Strategy area including SACs, designated under the Habitats Directive (92/43/EEC), SPAs designated under the Birds Directive (79/409/EC) and Ramsar sites designated under the Convention on Wetlands (Ramsar, 1971). These sites shown in Key Plan 2 (Executive Summary) are:
- Exe Estuary SPA and Ramsar site
 - Dawlish Warren SAC
- 2.2.18 The coastline between Orcombe Point and Straight Point forms part of the Dorset and East Devon World Heritage Site (WHS), administered by the UNESCO World Heritage Committee. This WHS is recognised for its important geological formations, fossils, geomorphology and aesthetic beauty.
- 2.2.19 The following three nationally designated sites are present within the Strategy area:
- Exe Estuary SSSI
 - Dawlish Warren SSSI and NNR
 - Dawlish Cliffs SSSI
- 2.2.20 The Strategy area includes four Local Nature Reserves (LNR), one RSPB Reserve and 36 County Wildlife Sites (CWS). The RSPB also manage additional areas of land for nature conservation.
- 2.2.21 The Strategy area includes many sites of known and non-designated features of archaeological and historical importance, and historic settlements at Exeter, Topsham and later Exmouth and Dawlish. In the inter-tidal area are many known archaeological sites and locations where items of archaeological interest have been found.
- 2.2.22 The following designated built heritage assets are present in the Strategy area:
- 22 Scheduled Monuments - two are at risk of flooding.
 - Approximately 1,300 Listed Buildings - 169 are at risk of flooding.
 - 15 Conservation Areas (of importance for historic heritage) – all at risk of flooding.
 - Three Registered Parks and Gardens – one (Powderham) is at risk of flooding.
- 2.2.23 The Strategy area also falls within part of the national designation of the East Devon Area of Outstanding Natural Beauty (AONB), occupying the same footprint as the WHS within the Strategy area.

History of flooding and coastal erosion

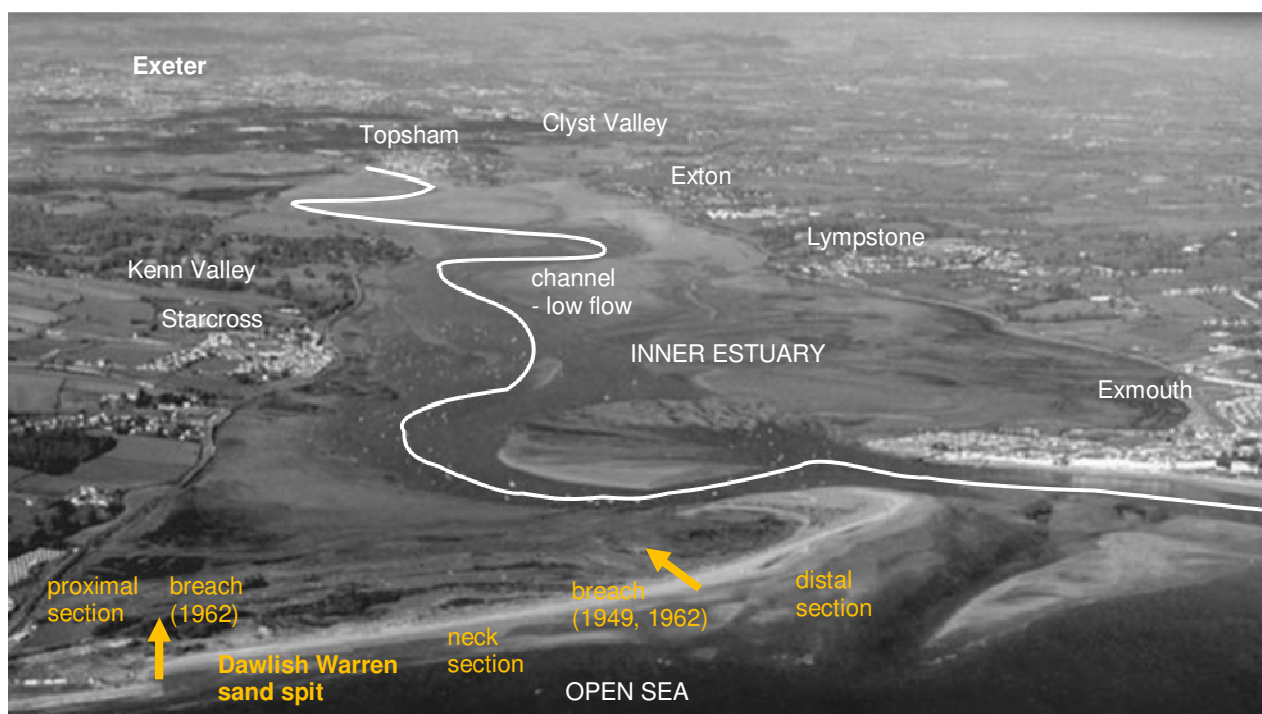
- 2.2.24 The existing defences limit flooding within the Strategy frontage and additionally, there have been no significant tidal surge events in recent years. However, the reducing residual life of existing flood defence assets and predicted sea level rise expose an increasing number of properties and infrastructure to flood risk. Fluvial flood risk is mainly associated with tide-locking in defended areas, notably Exmouth, Lympstone and Dawlish (considered a local, non-strategic, issue).
- 2.2.25 Records of flooding in the Strategy area are limited, with flood levels no higher than a 4% (1 in 25) chance in any year recorded in the last 35 years (in 2004). Exeter is at fluvial flood risk and a flood defence scheme is being promoted outside the Strategy, and there is no conflict with the Strategy recommendations.
- 2.2.26 Fluvial and surface water flooding in 2012 affected roads in the Clyst Valley area and Starcross. Some of the tidal river embankments on the Lower Clyst overtop regularly (spring tides), causing local saline influence to the low-grade grazing land. Temporary flooding of the locally important C527 road linking Topsham to Exmouth has occurred during fluvial events, and could also occur during tidal events.
- 2.2.27 Historic rates of coastal erosion along the Strategy frontage have been low due to the low wave energy within the estuary and the existing defence structures. Records of storm events over the last 200 years indicate that Dawlish Warren sand spit has been

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damaged on nearly 20 occasions over this period, most recently in 2000, and breached on eight occasions. The railway and defences from Dawlish to Holcombe (open sea facing) were significantly damaged in 2000.

- 2.2.28 A well documented series of storms in the 1940s significantly damaged Dawlish Warren sand spit, resulting in breach of the neck (central) section, and consequent separation and flattening of the distal (far end) section. This resulted in the permanent loss of properties on the distal section. In the same period, anecdotal records noted increased storm damage at Starcross in the lee of the sand spit. By 1950 the distal section reconnected to the main sand spit form, regaining its previous form. Further, less well documented over-washing events also occurred in the 1960s.
- 2.2.29 The Penzance to London main line railway runs for 5 km along the west side Strategy frontage and has been regularly disrupted due to high tide and wave combinations. Continuation of this disruption is of significant concern to the South West economy. The sea wall defence was seriously damaged in 1986, 1990 and 1994. As a comparator, the cost of recent (2012) disruption due to fluvial flooding of the main railway near Exeter is estimated at £1 million per event (Flood Hazard Research Centre, 2013).

Figure A: Strategy area, with Dawlish Warren sand spit detail



2.3 Current approach to flood and erosion risk management

Measures to manage the probability of flood and erosion risk

- 2.3.1 Formal and de facto defences are owned and maintained by a range of organisations including the Environment Agency, Devon County Council, East Devon District Council, Teignbridge District Council, Exeter City Council, Network Rail, South West Water and private owners. As a result of the range of owners, the defence system has been built to various levels and SoP, and the level of maintenance is also variable.
- 2.3.2 In order to structure the analysis of flood and coastal erosion risk management options for the Strategy, the 62.4 km total frontage length has been divided into 18 FCERM units. The appraisal process used these units, but they have been combined and presented in this report as 11 strategy appraisal reaches – separated by either natural contours or tidal / coastal erosion process linkages for clarity (there is no double counting of benefits).

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- 2.3.3 The reaches are listed below and shown on Key Plan 1 in the Executive Summary:
- FCERM unit 2: The Maer
 - FCERM unit 3: Exmouth
 - FCERM unit 4-7: Courtlands, Lymptone, Lymptone Commando, Exton
 - FCERM unit 8: East Bank of the Lower Clyst, Clyst St George
 - FCERM unit 9: Clyst St Mary
 - FCERM unit 11: West Bank of the Lower Clyst
 - FCERM unit 12-13: Topsham, Countess Wear
 - FCERM unit 14-15: Exminster Marshes and Powderham Banks, Kenn Valley
 - FCERM unit 16: Starcross, Cockwood
 - FCERM unit 17: Dawlish Warren
 - FCERM unit 18: Dawlish to Holcombe
- 2.3.4 Sandy Bay (FCERM unit 1) and Sowton (FCERM unit 10) are not listed due to no properties being at risk of flooding or erosion.
- 2.3.5 Table 3.1 gives details of the existing defences protecting each analysis reach. Further information is included in the Baseline Report (Appendix C, see Section 3 and Annex C).
- 2.3.6 Teignbridge District Council and the Environment Agency are responsible for maintenance of Dawlish Warren sand spit at the mouth of the estuary, which provides significant protection to the inner estuary and its defences.
- 2.3.7 Network Rail is responsible for maintenance of the main and branch railways including the embankments/revetments that effectively act as flood and erosion defences. Network Rail has a maintenance programme in place. These structures will be maintained throughout the Strategy period to protect this element of critical transport infrastructure.

Measures to manage the consequences of flood and erosion risk

- 2.3.8 The Environment Agency's Flood Warning system covers the Strategy area. The adoption of this service was promoted through the exhibitions held during the public consultation along with information on flood resilience. The exhibitions were also used to promote the Environment Agency's Flood Line service and offer guidance on measures homeowners can take to increase the flood resilience of their properties.
- 2.3.9 Management of flood risk through Development Control will continue to regulate development in the floodplain to avoid putting new assets at risk in accordance with the National Planning Policy Framework (NPPF).
- 2.3.10 Emergency planning is a vital part of managing the risks to coastal communities and the relevant authorities continually review and update their procedures to account for changing circumstances. It will be necessary to ensure the Strategy outcomes and identified risks are fed into the local emergency planning system.
- 2.3.11 A Community Engagement Officer works with the local authorities and communities to develop emergency plans and increase preparedness for flooding. This has been effective in improving the Environment Agency relationship with Emergency Planning Officers and getting the local community involved in flood exercises, such as the Exercise Watermark in March 2011.
- 2.3.12 The Environment Agency continues to further encourage flood resilience measures with property owners at risk in the Strategy area.

3 Problem definition and objectives

3.1 Outline of the problem

- 3.1.1 The Strategy frontage on the east and west side of the Exe Estuary forms almost a continuous flood and erosion defence line, with the annual chance of flooding varying from 20% to less than 0.5% for current conditions. Dawlish Warren sand spit currently offers a sheltering function to the inner estuary and therefore acts as a *de facto* defence reducing flood and erosion risks.
- 3.1.2 A large number of assets are currently at a significant level of flood and erosion risk, including significant areas of residential, commercial and industrial development, critical infrastructure, high grade agricultural land and landfill sites.
- 3.1.3 The Do Nothing PVd is £657,396k over the next 100 years. Under current conditions, there are 2,215 residential and 580 commercial properties (2,795 in total) with a 0.5% (1 in 200) or greater chance of flooding in any year across the Strategy area. For the Do Nothing option this will increase to 3,936 residential and 1,080 commercial properties (5,016 in total, see Table 3.1), taking account of the predicted sea level rise over the next 100 years.
- 3.1.4 The existing defences protect the towns and villages to a varying SoP are listed from lowest to highest, and to illustrate the current flood risk the number of properties flooded if these defences are just overtopped is given in brackets: Clyst St George 20% SoP (17 properties), Topsham 10% SoP (37 properties), Exmouth 4% SoP (1,560 properties), Starcross 4% SoP (572 properties), Dawlish Warren 2% SoP (51 properties) and Exminster 2% SoP (150 properties).
- 3.1.5 Other towns and villages are protected to higher SoP (at least 0.1%) either due to defences or their position on higher ground, including Lymptstone, Exton, Clyst St Mary, Countess Wear, Sowton and Dawlish.
- 3.1.6 Fluvial and surface water flooding is localised within the study area, with particular areas of concern including Exmouth, Clyst St. Mary, Kenn Valley, Starcross and Dawlish.
- 3.1.7 Other assets at risk include:
- Flood and erosion risk to the main railway (and to a lesser extent the branch railway), A376, A379, and C527.
 - Flood risk to the Exeter Canal.
 - Flood risk to Exton and Exeter sewage treatment works, 25 electricity sub-stations, two schools and four care homes.
 - Flood and erosion risk to terrestrial and freshwater nature conservation features and gradual narrowing of inter-tidal habitat due to coastal squeeze.
 - Flood and erosion risk to important local recreation and tourist features including amenity and designated bathing beaches, public footpaths and cycleways.
 - Flood and erosion risk to approximately 14 km² of farmland (57% of agricultural land in the Strategy area is very good to moderate quality – Grades 1 to 3a).
 - Flood risk to historic landfill sites, which may constrain achieving good Ecological Status/Potential (under the WFD) for the Exe Estuary transitional water body.
 - Flood risk to archaeological and architectural assets in historic centres and throughout the Strategy area.
- 3.1.8 The Exe Estuary is a heavily modified water body (HMWB) and a review of its classification indicates that flood defence assets are contributing to less than good overall potential. Therefore, in order to meet the environmental objectives of the Water Framework Directive there is a requirement to deliver some identified mitigation measures related to the presence of existing flood defence assets.

3.1.9 Dawlish Warren Special Area of Conservation (SAC) is currently in unfavourable condition due to the effects of hard defences (gabions) on coastal processes. Continuing maintenance of these defences is considered by Natural England to be damaging to the Dawlish Warren SAC.

3.1.10 Extreme water levels now and in 2110 are presented in Table 3.1.

Table 3.1 Extreme water levels (mAOD) in years 2010 and 2110

	100% AEP	20% AEP	10% AEP	4% AEP	2% AEP	1% AEP	0.5% AEP	0.1% AEP
Year 2010	2.74	2.90	2.97	3.06	3.13	3.20	3.27	3.46
Year 2110	3.49	3.65	3.72	3.81	3.88	3.95	4.02	4.21

3.2 Consequences of doing nothing

3.2.1 Table 3.2 summarises the FCERM units defined for the Strategy area in terms of property numbers, key assets, flood risk and standard of protection without defences. The lowest probability or shortest residual life for any defence asset within the reach has been used to define flood risk. The probability of flooding or overtopping increases to 2110 due to the predicted effects of climate change including sea level rise. The Baseline Report provides further assessment detail (Appendix C – Section 3 and Annex D).

3.2.2 Progressive loss of Dawlish Warren sand spit that shelters the inner estuary would lead to major costs to re-build the inner estuary defences as coastal defences. Foreshore erosion is damaging the defences built in the 1960s/70s, which are not sustainable long term. In a climate change scenario if the defences breach the spit would be unlikely to reseal, increasing flood and erosion risk to the inner estuary.

3.2.3 Without ongoing intervention, it is estimated that the neck section of the sand spit would permanently breach towards 2030, resulting in separation and flattening of the distal section (refer to Figure A, page 11). This would particularly impact the built and natural environment in the lee of the sand spit (Starcross and Powderham), and to a lesser degree throughout the estuary. Under this scenario, PVd damages then increase by £91,665k to £190,036k, depending on sea level rise and the timing and form of changes to the sand spit, and assuming continued maintenance of other defences.

3.2.4 The Do Nothing option at Dawlish Warren sand spit (internationally designated for nature conservation), would contribute towards the spit functioning naturally, but unless the existing groynes and gabions that form the hard defences are removed, this option is likely to maintain its current unfavourable condition, impeding coastal processes.

3.2.5 Property assets will continue to be at flood risk as identified in 3.1.3 and 3.1.4. Following any event which caused a breach, the defence would not be repaired under the Do Nothing option and regular tidal flooding would rapidly establish. Approximately 4,084 properties by Year 20 would be flooded or damaged too frequently to be habitable, so would be written off. This increases to 5,016 properties by Year 100 (see Table 1.1).












3.2.6 The residual life of the railway embankment revetments is estimated to be 50 years. Once the integrity of the revetment is lost the main and branch railways would not be operable, causing disruption at regional to national level.













3.2.7 The C527 road that provides an access route from Topsham to Exmouth and the east side of the estuary is currently at risk in a 20% (1 in 5 year) flood event, and would be regularly (more than annually) flooded by tidal and fluvial events by Year 20.

3.2.8 Parts of Exton and Exeter sewage treatment works ground levels are currently at risk in a 2% (1 in 50 year) flood event. Sea level rise will increase this risk to regular flooding by Year 50. Without flood risk investment it is estimated the site will cease to operate viably by 2060.

- 3.2.9 The historic landfill site at the Imperial Recreation Ground at Exmouth is protected by revetments, currently being refurbished by EDDC. Exposure of the landfill to the internationally and nationally designated estuary would cause significant pollution and breach of environmental legislation.
- 3.2.10 Defences protecting the international designations at Exminster Marshes would breach in a 2% (1 in 50 year) flood event, causing changes in the designated habitat. By Year 50, the defences would regularly overtop and breach.

Table 3.2 Summary of existing defences, standard and assets at risk

Reach	SMP2 policy	Length (km)	Problem and Standard of Protection (SoP)	Existing defences	Photographs	Properties at risk: 0.5% (1 in 200) probability of flooding in any year - without defences		Key assets at risk
						Residential	Commercial	
FCERM unit 1 - Sandy Bay	Do Nothing (No Active Intervention)	2.6	Very low erosion risk to cliffs, with caravan park at risk from 2060.	natural cliffs (2.5 km)	 	0 (2010) 0 (2110) Future coastal erosion risk to small caravan park	0 (2010) 0 (2110) if defence assets maintained over next 100 years	<ul style="list-style-type: none"> future risk to 58 caravans based on current park location
FCERM unit 2 - The Maer	Hold the Line	2.8	Low flood risk, 0.1% SoP min (1 in 1000) Cost of dealing with public health & safety issues if assets npt maintained Risk to developable land	sea wall (1.9 km) groynes sand dunes protection		0 (2010) 0 (2110)	0 (2010) 6 (2110)	<ul style="list-style-type: none"> local access road
FCERM unit 3 - Exmouth	Hold the Line	4.2	Tidal flood risk to Exmouth, 4% SoP (1 in 25) Parts of town also at risk from surface water flooding	defences (4.2 km) - masonry walls - sheet piled walls - revetments - raised ground - embankment		1,417 (2010) 2,040 (2110)	406 (2010) 627 (2110)	<ul style="list-style-type: none"> branch railway schools electrical sub-stations
FCERM units 4, 6, and 7 - Courtlands, Lympstone Commando and Exton	Hold the Line	5.7	Low flood risk, 0.1% SoP min (1 in 1000) Future tidal flood risk to properties and railway branch line	main railway embankment with revetment in places walls/ revetments (0.74 km)	 	0 (2010) 4 (2110)	0 (2010) 7 (2110)	<ul style="list-style-type: none"> branch railway cycleway
FCERM unit 5 - Lympstone	Hold the Line	1.1	Low flood risk, 0.1% SoP min (1 in 1000)	sea walls (1.1 km) tidal flood gates		105 (2010) 129 (2110)	20 (2010) 33 (2110)	<ul style="list-style-type: none"> branch railway
FCERM units 8 and 10 - East bank of Lower Clyst and Sowton	Hold the Line	3.1	20 properties, only 20% SoP (1 in 5) Agricultural land, 20% SoP (1 in 5) Erosion risk to branch railway and one road bridge	earth embankments short sections of wall	 	11 (2010) 12 (2110)	21 (2010) 42 (2110)	<ul style="list-style-type: none"> C527 access from Topsham to Exmouth
FCERM unit 9 - Clyst St Mary	Hold the Line	4.7	13 properties, only 2% SoP (1 in 50) Flood risk to A376, 0.1% SoP (1 in 1000)	agricultural earth embankments protect agricultural land. earth embankments along Winslade Barton to Frog Lane to protect properties and A376.	 	19 (2010) 40 (2110)	3 (2010) 22 (2110)	<ul style="list-style-type: none"> A376

Reach	SMP2 policy	Length (km)	Problem and Standard of Protection (SoP)	Existing defences	Photographs	Properties at risk: 0.5% (1 in 200) probability of flooding in any year - without defences		Key assets at risk
						Residential	Commercial	
FCERM unit 11 - West bank of Lower Clyst	Hold the Line	5.2	Agricultural land, 20% SoP (1 in 5) Properties with 0.1% SoP (1 in 1000)	earth embankments	 	1 (2010) 6 (2110) if defence assets maintained over next 100 years	0 (2010) 8 (2110) if defence assets maintained over next 100 years	• None
FCERM units 12 and 13 - Topsham and Countess Wear	Hold the Line	8.4	30 properties in Topsham, 10% (1 in 10) SoP near recreation ground and Strand Fluvial and groundwater flood risk to properties at Mill Lane, Countess Wear	private and de facto defences (mostly walls for private properties) protect Topsham and Countess Wear	 	93 (2010) 206 (2110)	10 (2010) 51 (2110)	• sewage treatment works at Countess Wear
FCERM unit 14 - Exminster Marshes and Powderham Banks	Hold the Line	9.2	Powderham Banks, 2% SoP. Main railway, 2% SoP (1 in 50) Exminster with 0.1% SoP Erosion risk to Powderham Banks, also breach risk	earth embankments and Exeter Canal banks protect Exminster, main railway, M5 and Exminster Marshes wall / revetment at Powderham (350m)		0 (2010) 131 (2110)	0 (2010) 100 (2110)	• main railway • cycleway • Exeter Canal
FCERM unit 15 - Kenn Valley	Hold the Line	2.2	Properties with 0.1% SoP (1 in 1000) Breach risk	railway embankment walls protect Kenn Valley		0 (2010) 19 (2110)	0 (2010) 21 (2110)	• main railway • Powderham Registered Park and Garden
FCERM unit 16 - Starcross and Cockwood	Hold the Line	2.2	Starcross with 0.1% SoP (1 in 1000) Cockwood, only 4-10% SoP (1 in 25 to 1 in 10)	defences protect property/infrastructure: - main railway - embankment - masonry walls - other embankments	 	551 (2010) 665 (2110)	76 (2010) 87 (2110)	• main railway
FCERM unit 17 - Dawlish Warren	Hold the Line	6.8	Dawlish, only 4% SoP (1 in 25) Erosion risk to sand spit from open sea.	sand spit / beach protects inner estuary defences protect Dawlish Warren: - sea walls / revetments - gabions - embankments - dunes / natural cliff	 	18 (2010) 652 (2110)	44 (2010) 74 (2110)	• main railway, • area visited by estimated 500,000/year • 611 caravans at risk
FCERM unit 18 - Dawlish to Holcombe	Hold the Line	1.8	Dawlish or Holcombe, 4% SoP (1 in 25)	railway embankment recurved walls	 	0 (2010) 32 (2110)	0 (2010) 2 (2110)	• main railway

3.3 Strategic issues

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

- To identify a solution for Dawlish Warren sand spit that manages the conflicts between maintaining the defences at the spit for flood risk management in the wider estuary, and meeting legislative requirements to support the conservation objectives of Dawlish Warren SAC. The future evolution and management will impact on the wider estuary, the N2K designations, and the defences owned or maintained by the Environment Agency, TDC, ECC, DCC, EDDC and private owners.

Note: The other geomorphological features are either predominantly static (low water channel), or naturally accreting or stable (the ebb and flood deltas of Pole Sands and Bull Hill Banks).

- To investigate potential solutions for effects on internationally designated habitat and to support morphological mitigation proposals under the WFD by considering at an appropriate scale the legal obligations likely to fall to the Environment Agency and partners.
- To investigate flood risk management options for the Strategy frontage, including the existing flood and erosion defences and railway embankments that perform an important flood defence function and link the majority of the frontage.

3.3.2 In addition, the responsibility of managing the existing flood and erosion defence assets are held by different organisations (EA, DCC, EDDC, TDC, ECC and NR). A joint and committed partnership approach by all these stakeholders is required to promote any works from this Strategy.

3.3.3 This Strategy has been developed through involvement of the Steering Group (DCC, TDC, ECC, EDDC, NR, NE, EA) and consultation with other stakeholders to identify the preferred approach to manage flood and erosion risk cost effectively to the benefit of the local community. The Steering Group have been involved in decision making at each key stage and has ensured an appropriate level of engagement within each organisation.

3.3.4 This Strategy will assist local planning teams in their assessment of future development and land use change applications.

3.3.5 This Strategy has been informed by the South Devon and Dorset SMP2 (approved in 2011), signed off by the Secretary of State as it identified adverse effects on the N2K sites, and the Exe CFMP (2012). The SMP2 recognised complex issues and the Strategy recommends changes to SMP policy at four sites:

- The Maer: SMP policy for MR in the medium term. The Strategy recommends maintaining the existing alignment through beach management and groyne maintenance in all epochs.
- Exminster and Powderham banks: SMP policy for MR in the medium term. The Strategy recommends Hold the Line in all epochs.

3.3.6 Kenn Valley: SMP policy for Hold the Line. The Strategy recommends habitat creation by regulated tidal exchange. Dawlish Warren: SMP policy to Hold the Line in the short-term and not determined for medium to long-term policy, recognising the need for a Strategy due to complexities. The Strategy recommends a policy that combines maintenance, managing the natural processes (central section of spit) and beach (including gabion removal) and improving defences locally. The WFD assessment undertaken as an integral component of the Strategy (in accordance Council Directive 2000/60/EC) has been used to influence decision making throughout the SEA and to guide the identification and development of environmentally acceptable solutions.

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3.4 Key constraints

- 3.4.1 The key constraints (and opportunities) include:
- Urban areas with a growing population at flood and/or erosion risk. There is flood risk-related anxiety for local residents, while owners of property at risk may either be unable to obtain insurance or pay particularly high premiums.
 - Presence of internationally, nationally and locally designated conservation sites within and around the Strategy area, which will be affected by climate change, sea level rise and development pressure.
 - Presence of the internationally important Dorset and East Devon WHS (Jurassic Coast), designated for its earth heritage value.
 - Presence of water bodies (WFD) including the Exe Estuary transitional waterbody, a highly modified water body (HMWB) due to flood defences and shellfish exploitation, Lyme Bay West coastal HMWB due to shellfish exploitation, two groundwater bodies, the Clyst and Kenn river waterbodies directly affected by the proposals, 14 upstream river waterbodies and one upstream canal.
 - Whole of the estuary designated as Shellfish Waters and the Strategy area includes numerous designated bathing waters.
 - High archaeological potential of the Strategy area and historic settlements of Exeter, Topsham, Exmouth and Dawlish, and diverse historic landscapes.
 - Landscapes and views that are internationally, nationally, regionally or locally designated for their scenic value within the mapped flood extents. These include the WHS and the nationally designated East Devon AONB.
- 3.4.2 A Strategic Environmental Assessment (SEA) has been undertaken reflecting the high environmental sensitivity of the natural and built environment within the Strategy area. The SEA Environmental Report is included in Appendix E.

3.5 Objectives

- 3.5.1 The Strategy promotes and encourages long term sustainable and strategic management of 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.
- 3.5.2 The Strategy objectives (taken from the Environmental Scoping Report) are to:
- Define and agree a 100 year plan of investment for tidal flood and coastal erosion risk management (including a plan for prioritising projects in the short-term) to allow the Environment Agency and partnering local authorities to protect local communities.
 - Identify and prioritise other flood risk management activities such as providing advice to utility companies to protect important infrastructure, providing advice to planning authorities to control development in inappropriate areas, and investment in flood warning.
 - Support achievement of conservation objectives for the Exe Estuary N2K sites, given rising sea levels, allowing for adaptive management over time and a transition towards natural functioning, and promote a sustainable programme for creating inter-tidal habitats to compensate for losses of internationally designated habitat caused by rising sea levels (where attributable to tidal defences).
 - Manage tidal flood and erosion risks to the social, human and physical environment around the estuary while identifying opportunities to restore estuarine processes in support of the WFD and improving the unfavourable condition of Dawlish Warren SAC.

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4 Options for managing flood & erosion risk

4.1 Potential FCERM measures

- 4.1.1 A High Level Option assessment has been completed, reviewing and expanding the policies identified previously at SMP2 level. These policies were transferred to a FCERM unit scale and a range of High Level Options considered for each Unit.
- 4.1.2 The range of High Level Options are defined as:
- No Active Intervention. No further works would be carried out to manage flood risk, except relating to legal compliance such as public health and safety.
 - Maintain. Maintenance of flood / erosion defence assets, ensuring structural integrity and standard of service, but not accounting for climate change impacts.
 - Sustain. Improvements to assets that would be carried out to ensure the Standard of Protection remains consistent, and keeps pace with climate change.
 - Improve. Improvements to existing or construction of new assets, increasing the Standard of Protection over and above climate change impacts.
 - Managed Realignment. Realigning the location of the existing assets, either through a partial or full set-back to high ground.
- 4.1.3 For each FCERM unit the above High Level Options were considered based on policy context, present day flood and erosion risk, opportunities for habitat creation, environmental issues and socio-economic viability. The outcome of this was the identification of two or three high levels options suitable for further appraisal – see Table 4.1. From these high level options, a long list of potential options for each unit was identified.
- 4.1.4 The FCERM measures considered are all associated with Hold the Line and Managed Realignment. Advance the Existing Line has not been considered as it would not be environmentally acceptable, directly encroaching on the inter-tidal habitat of the international conservation designations. Additionally, the option was not recommended by the SMP2.

Table 4.1 Summary of Preferred High Level Options

FCERMU	Reach	Preferred High Level Options*
1	Sandy Bay	NAI
2	The Maer	Maintain
3	Exmouth	Improve, Sustain
4	Courtlands	Maintain, Sustain
5	Lympstone	Sustain
6	Lympstone Commando	Maintain, Sustain
7	Exton	Maintain, Sustain
8	East bank of Lower Clyst	MR, Sustain
9	Clyst St Mary	Maintain, Sustain
10	Sowton	NAI
11	West bank of Lower Clyst	NAI, MR, Maintain
12	Topsham	Improve, Sustain
13	Countess Wear	Sustain
14	Exminster Marshes, Powderham Banks	Improve, Sustain
15	Kenn Valley	MR, Maintain, Sustain
16	Starcross and Cockwood	Improve, Sustain
17	Dawlish Warren	NAI, MR, Improve
18	Dawlish to Holcombe	Improve, Sustain

*NAI – No Active Intervention MR – Managed Realignment

- 4.1.5 As part of the Sustain and Improve options the potential FCERM measures include:
- Soft or hard foreshore management: beach recharge/recycling, groynes and breakwaters.

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- Improvements to existing defences, and/or new flood defences: embankments, revetments and walls.
 - Secondary defences: set back with less risk exposure than front-line defences.
 - Point structures: refurbish and improve pump stations, outfalls, regulated tidal exchange (RTE) or breaches.
 - Property level protection / resilience.
 - Demountable or temporary defences.
- 4.1.6 Non-structural measures to manage the consequences of risk include monitoring, flood and coastal risk awareness (education, flood forecasting, flood warning) and land management (development control).

4.2 Long list of options

- 4.2.1 A wide range of long list options was developed with flood and erosion risk management technical solutions, in order to assist the short-listing of appropriate options for detailed appraisal. This 'Alignment and Type' stage has been undertaken for each FCERM unit, informed by the High Level Options but not excluding options where potential constraints (legal or funding) may limit implementation of the preferred High Level Option.
- 4.2.2 Options short-listed were determined based on assessment of the suitability of each option to the specific problem(s) for each unit. The Options Assessment Report in Appendix D (see Section 3 and Annexes F and G) details fully the tabulated process applied in the short-list selection.
- 4.2.3 Due to the complexities at Dawlish Warren sand spit, a wider range of measures was considered, summarised as:
- Do Nothing: No Active Intervention
 - Do Minimum: maintain assets until the end of their residual life.
 - Maintain: proactively maintain beach and repair groynes to protect the sand spit.
 - Sustain: proactively increase beach and groyne management, with hardening required by Year 50 including mitigation for sea level rise.
 - Improve: increased intervention to harden the erosion protection measures including mitigation for sea level rise.
 - Managed Realignment: removal of hard engineered assets (gabions) from sand spit fronting dunes.

4.3 Options rejected at preliminary stage

- 4.3.1 No options were rejected at the preliminary stage for Dawlish Warren sand spit as this is a complex location, which required further, more detailed assessment.
- 4.3.2 Estuary-wide options such as a tidal barrier at the estuary mouth (circa £500 million) were not considered viable in the SMP2 and would impact on a considerably wider area than this Strategy area.
- 4.3.3 Managed Realignment options were prioritised according to a range of factors and the following sites were rejected or considered less favourable to progress at this time due to their lower suitability:
- The Maer: uneconomic; unlikely to provide appropriate compensatory habitat.
 - Powderham Banks: designated site requires secondary compensatory habitat.
 - Bowling Green Marsh: present status as a RSPB reserve and important high tide roost limits feasibility.
 - Exminster Marshes: presence of infrastructure, designated site requiring secondary compensatory habitat and RSPB reserve limits feasibility.
 - Cockwood Marsh: environmental constraints and limited habitat creation.
 - East Bank of River Clyst: lack of landowner agreement and significant public opposition (rejected in the short term, following public consultation).

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4.4 Options short-listed for appraisal

- 4.4.1 The technical short-listed options were developed into standard flood and erosion risk management options for detailed appraisal. A description of each option for each reach is detailed in Tables 4.2 to 4.13 below. In these tables, “failed” indicates the existing asset would no longer perform effectively as a defence, based on degradation of the assets over time (predominantly independent of climate change).
- 4.4.2 For the Sandy Bay and Sowton reaches the Maintain and Sustain options were not short-listed since the existing standard is particularly low, there are no specific assets to maintain, and no property or infrastructure at risk. These reaches are not described below.
- 4.4.3 Following public consultation on the draft Strategy, significant objections were received relating to the recommendations applying to the Clyst Valley to create intertidal habitat. Concerns relate to the effect on the C527 road, loss of farmland/ local economy, cost, change to landscape and increased risk of property flooding or erosion. In view of these concerns, Managed Realignment is now recommended only on the West bank of the Lower Clyst.

Table 4.2 The Maer

SMP2 policy: Hold the Line, Managed Realignment Nature of area at risk: urban development

Option	Description / suitability	SoP (% annual prob.)			
		2010	2030	2060	2110
1: Do Nothing	Baseline option	0.1	failed	failed	failed
2: Do Minimum	Maintain defences until end of residual life	0.1	0.1	failed	failed
3: Maintain	Maintain and refurbish existing defences	0.1	0.1	failed	failed
4: Sustain	Maintain and refurbish existing defences, and beach recharge/recycling with groyne maintenance.*	0.1	0.1	0.1	0.1

*this option sustains the beach in a similar form as present day, avoiding loss of seawall function.

Table 4.3 Exmouth

SMP2 policy: Hold the Line Nature of area at risk: urban development

Option	Description / suitability	SoP (% annual prob.)			
		2010	2030	2060	2110
1: Do Nothing	Baseline option	4	100	failed	failed
2: Do Minimum	Maintain defences until end of residual life	4	10	failed	failed
3: Maintain	Maintain and refurbish existing defences	4	10	20	100
4: Sustain	Progressively raise existing defence levels	4	4	4	4
5: Improve (range of SoP)	<u>Short term:</u> Improve defences, raising by 0.5m: - Exmouth docks and sailing club - Camperdown Terrace, slipway and boatyard - property resilience, Camperdown Terrace (20 properties) <u>Longer term:</u> Improve defences, further raising up to 1m: - Exmouth docks (quay walls) - property resilience, Shelly Road/Camperdown Terrace	2, 1, 0.5, 0.1			

Table 4.4 Courtlands to Exton

SMP2 policy: Hold the Line Nature of area at risk: urban development

Option	Description / suitability	SoP (% annual prob.)			
		2010	2030	2060	2110
1: Do Nothing	Baseline option	0.5	2	failed	failed
2: Do Minimum	Maintain defences until end of residual life	0.5	2	failed	failed
3: Maintain	Maintain and refurbish existing defences	0.5	10	20	100
4: Sustain	Progressively raise existing defence levels to sustain SoP	0.5	0.5	0.5	0.5

Table 4.5 East Bank of Lower Clyst

SMP2 policy: Managed Realignment

Nature of area at risk: rural development

Option	Description / suitability	SoP (% annual prob.)			
		2010	2030	2060	2110
1: Do Nothing	Baseline option	20	failed	failed	failed
2: Do Minimum	Maintain defences until end of residual life	20	failed	failed	failed
3: Maintain	Maintain and refurbish existing defences	20	100	100	100
4: Sustain	Progressively raise existing defence levels	20	20	20	20
5: Managed Realignment	<u>Short term:</u> Local breach of embankments; protects C527 Local breach of embankments; raise C527 as a causeway <u>Medium to long term:</u> Raise embankment protecting C527	10, 5, 2, 1, 0.5, 0.1 (tested for each year)			

Table 4.6 Clyst St. Mary

SMP2 policy: Hold the Line

Nature of area at risk: urban development

Option	Description / suitability	SoP (% annual prob.)			
		2010	2030	2060	2110
1: Do Nothing	Baseline option	0.1	failed	failed	failed
2: Do Minimum	Maintain defences until end of residual life	0.1	0.1	failed	failed
3: Maintain	Maintain and refurbish existing defences	0.1	0.1	0.1	2

Note: further investigations are required to confirm fluvial flood risks.

Table 4.7 West Bank of Lower Clyst

SMP2 policy: Managed Realignment

Nature of area at risk: rural development

Option	Description / suitability	SoP (% annual prob.)			
		2010	2030	2060	2110
1: Do Nothing	Baseline option	20	failed	failed	failed
2: Do Minimum	Maintain defences until end of residual life	20	failed	failed	failed
3: Maintain	Maintain and refurbish existing defences	20	100	100	100
4: Sustain	Progressively raise existing defence levels to sustain SoP	20	20	20	20
5: Managed Realignment / Improve	<u>Short term:</u> Local breach of embankments; properties IPP <u>Medium to Long term:</u> Continued IPP	10, 5, 2, 1, 0.5, 0.1 (tested for each year)			

Table 4.8 Topsham and Countess Wear

SMP2 policy: Hold the Line

Nature of area at risk: urban development

Option	Description / suitability	SoP (% annual prob.)			
		2010	2030	2060	2110
Option 1: Do Nothing	Baseline option	10	failed	failed	failed
Option 2: Do Minimum	Maintain defences until end of residual life	10	20	failed	failed
Option 3: Maintain	Maintain and refurbish existing defences	10	20	100	100
Option 4: Sustain	Progressively raise existing defence levels	10	10	10	10
Option 5: Improve (range of SoP)	<u>Short term:</u> New walls and embankments IPP and road/pavement raising IPP only <u>Medium to Long term:</u> Wider raising of all defences Community level IPP	5, 2, 1, 0.5, 0.1 (tested for each year)			

Table 4.9 Exminster Marshes and Powderham Banks

SMP2 policy: Hold the Line, Managed Realignment Nature of area at risk: infrastructure/rural development

Option	Description / suitability	SoP (% annual prob.)			
		2010	2030	2060	2110
1: Do Nothing	Baseline option	0.1	failed	failed	failed
2: Do Minimum	Maintain defences until end of residual life	0.1	2	failed	failed
3: Maintain	Maintain and refurbish existing defences	0.1	2	20	100
4: Sustain	<u>Short term:</u> Hard foreshore management (sheet piling, rock armouring) Raising of defence (revetment, vertical or wave recurve) Combination of the above <u>Medium to long term:</u> Wider raising of embankments, revetments / canal banks	0.1		2, 1, 0.5, 0.1	

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Table 4.10 Kenn Valley

SMP2 policy: Hold the Line

Nature of area at risk: infrastructure/rural development

Option	Description / suitability	SoP (% annual prob.)			
		2010	2030	2060	2110
1: Do Nothing	Baseline option	0.1	failed	failed	failed
2: Do Minimum	Maintain defences until end of residual life	0.1	2	failed	failed
Option 3: Managed Realignment/ Improve	<u>Short term:</u> Regulated Tidal Exchange (RTE) under main railway Open culvert under main railway with secondary banks <u>Medium to Long term:</u> Railway revetment raising (vertical or wave recurve wall) Railay revetment raising (rock armouring or revetment)	10, 4, 2, 1, 0.5, 0.1 (tested for each year)			

Table 4.11 Starcross

SMP2 policy: Hold the Line

Nature of area at risk: urban development

Option	Description / suitability	SoP (% annual prob.)			
		2010	2030	2060	2110
1: Do Nothing	Baseline option	4	failed	failed	failed
2: Do Minimum	Maintain defences until end of residual life	4	10	failed	failed
3: Sustain	Progressively raise existing defence levels	4	4	4	4
4: Improve (range of SoP)	<u>Short term:</u> Cockwood harbour general wall raising Cockwood harbour local wall/road raising <u>Medium to Long term:</u> Wider defence raising (vertical or wave recurve wall) Wider defence raising (rock armouring or revetment)	2, 1, 0.5, 0.1 (tested for each year)			

Table 4.12 Dawlish Warren – complex

SMP2 policy: Hold The Line, NAI in short term

Nature of area at risk: urban development

Option	Description/Suitability	SoP (% annual prob.)			
		2010	2030	2060	2110
1: Do Nothing	Baseline option	4	failed	failed	failed
2: Do Minimum	Maintain defences until end of residual life	4	10	failed	failed
3: Mixed	<u>Short term:</u> Maintain proximal section; central evolving, distal natural Maintain proximal and distal section; central section evolving Maintain proximal; central/distal sections Maintain maintained; sustain central/distal sections Maintain proximal section; improve central/ distal sections <u>Medium to Long term:</u> Maintain proximal section, central/distal natural Maintain proximal section, central evolving, sustain neck Maintain proximal section, sustain central , neck natural Maintain proximal section, improve central/distal sections	4, 2, 1, 0.5, 0.1 (tested for each year)			

*refer to Figure A, page 13

Table 4.13 Dawlish to Holcombe

SMP2 policy: Hold the Line

Nature of area at risk: urban development

Option	Description / suitability	SoP (% annual prob.)			
		2010	2030	2060	2110
1: Do Nothing	Baseline option	4	failed	failed	failed
2: Do Minimum	Maintain defences until end of residual life	4	10	failed	failed
3: Sustain	Progressively raise existing defence levels to sustain SoP	4	4	4	4
4: Improve (range of SoP)	<u>Short term:</u> Raising of defences (vertical or wave recurve) Raising of defences (rock armouring or revetment) <u>Medium to Long term:</u> Wider defence raising (vertical or wave recurve wall) with IPP Wider defence raising (rock armouring or revetment) with IPP	2, 1, 0.5, 0.1 (tested for each year)			

5 Options appraisal and comparison

5.1 Technical issues

- 5.1.1 The staged approach of identifying preferred High Level Options (HLO) and technical assessment of long and short-lists of options with Steering Group input and check at each stage has provided confidence in identifying options which fulfil the technical objectives for each part of the Strategy area.
- 5.1.2 A wide range of modelling and engineering design guidance was used, described in the Options Assessment report (Appendix D – refer to Section 2).
- 5.1.3 **Hold the line:** through the options to Maintain, Sustain or Improve the existing defences will achieve the strategic objectives, subject to appropriate SoP. There are no specific engineering issues with implementing these options. Analysis of localised, non-strategic fluvial flood risk and surface water drainage requires further study. **Sediment balance and erosion:** Expert geomorphological assessment, based on several techniques giving corroborating results, identified the estuary mouth to be dynamic with significant sediment transfers and only a very limited transfer of sediment into the inner estuary of 4,000 m³/yr in total from coastal and fluvial sources. This is significantly less than the amount of estuary-wide sedimentation required to avoid losses of inter-tidal habitat due to predicted sea level rise and to attenuate wave heights in the estuary.
- 5.1.4 Due to existing defences, there is a general absence of historical erosion records for the Strategy frontage. Where appropriate, erosion rates were based on the National Coastal Erosion Risk Management (NCERM) dataset. This erosion rate is applied from the year of failure of any fronting hard defence, which has been assumed to occur when the residual life has been reached.
- 5.1.5 **Climate change:** The impact of climate change has been assessed based on Environment Agency guidance (Adapting to Climate Change, 2010). This sets out a range of scenarios indicating sea level rise of 0.07-0.11m by 2030 and between 0.41-1.7m by 2110.
- 5.1.6 **Option appraisal:** The appraisal over 100 years (to 2110) reflects the latest guidance on climate change. In the short term the option designs can include for the effects of climate change with relative certainty. In the longer term, the options designs will need to be flexible as the magnitude of climate change is relatively uncertain. This is reflected in the sea level rise indicated above.
- 5.1.7 **Dawlish Warren sand spit:** The sand spit provides a storm sheltering function to the wider estuary. Expert geomorphological assessment (Appendix C – refer to Annex A) identified that even with existing management practices, it is likely that the distal (far end) section would separate and flatten permanently towards 2060. As sea levels rise, increasing breach and overwashing frequency would outpace the natural ability of the sand spit to heal itself (with historic evidence that the healing process takes 5-10 years). We have modelled the impact of flattening of the distal section of the sand spit. This includes for wave climate, tidal hydrodynamics and wind setup. Flattening of the distal section would result in an increase in water level of up to 0.1m (in addition to sea level rise) and increase in wave heights of up to 0.3m in the estuary.
- 5.1.8 Continued works to Hold the Line at the sand spit will continue to adversely impact on Dawlish Warren SAC (in unfavourable condition due to existing hard defences) and Exe Estuary SPA and Ramsar sites. As there are alternative FCERM solutions that avoid adversely impacting on the N2K sites at this location, a Hold the Line option would be:
- difficult to legally implement
 - difficult to secure compensatory dune habitat
 - likely to be financially prohibitive.

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- 5.1.9 However, ceasing all intervention works on the sand spit is likely to result in unacceptable flood risk to the inner estuary (communities) and is also unlikely to support achievement of the conservation objectives of the SAC. Thus options have been explored to maintain the spit's sheltering function whilst also supporting favourable condition of the SAC.

5.2 Environmental assessment

- 5.2.1 The Environmental Assessment of Plans and Programmes Regulations 2004 (SEA Regulations) do not formally require a SEA of flood risk management strategies. However, in view of the environmental sensitivity of the Strategy area and in line with Environment Agency and Defra policy, an SEA Environmental Report was prepared and consulted on (Appendix E).
- 5.2.2 The key environmental constraints including environmental baseline features are discussed in Section 3.2 and presented in figures in the SEA Environmental Report and Strategic Landscape Appraisal Plan (Appendix E).

Habitat Regulations

- 5.2.3 A HRA (including Appropriate Assessment) has been prepared to fulfil the requirements of The Conservation of Habitats and Species Regulations 2010 (as amended in 2012), which identified the potential for the Strategy to have significant impacts on the Exe Estuary SPA and Ramsar site. No alternative solutions are identified that avoid adverse effects while protecting people and public safety. Consequently, the preferred Strategy options will be progressed through an Appendix 20 (statement of case), which considers the Imperative Reasons of Overriding Public Interest and compensatory habitat requirements.
- 5.2.4 Natural England has signed-off the HRA and provided a letter of support for the Strategy. They have also reviewed and accepted a draft statement of case which will now be submitted to Defra.
- 5.2.5 The areas of designated habitat gains and losses calculated for the European sites are shown in Table 5.1. Where change is determined as man-made (e.g. due to the presence of flood defences) or uncertain (too complex to clearly identify as otherwise), the Environment Agency has a responsibility to address this. There would also be up to 3.8 ha of direct designated inter-tidal habitat losses in the footprint of new, extended or raised defences in the long-term.

Table 5.1 Predicted habitat changes from FCERM and uncertain causes in the European sites

Habitat Type	Habitat change relative to 2010 ¹ (ha) without mitigation		
	Short-term (2010 - 2030)	Medium-term (2030 - 2060)	Long-term (2060 - 2110)
Sub-tidal	+32 to +36 ha uncertain causes +4 to +5 ha man-made	+6 to +9 ha man-made	+12 to +50 ha man-made
Inter-tidal – rocks, boulders, mudflats and sandflats	-34 to -35 ha uncertain -3 ha man-made	-2 ha man-made	-4 to -29 ha man-made
Saltmarsh and transitional saltmarsh	+1 to +2 ha uncertain +13 to +15 ha man-made	+9 to +12 ha man-made	-5 to +8 ha man-made
Sand dunes and other littoral sediment	0 to +1 ha uncertain 0 ha man-made	0 ha man-made	0 ha man-made
Grazing marsh, neutral grassland and other unclassified habitat	0 ha uncertain -15 to -16 ha man-made	-16 ha man-made	-15 to -16 ha man-made
Key: + habitat gain; - habitat loss Note: ¹ habitat change agreed to be the Environment Agency's responsibility Range given is the for the low 50%ile to upper end emissions CC scenarios			

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- 5.2.6 In the short term for the medium 95%ile emission scenario, the main loss is 38 ha of inter-tidal habitat. Other losses are 16 ha of grazing marsh.
- 5.2.7 Three preferred sites that offer habitat creation opportunities to compensate for losses within the European sites in the short-term were identified. The sites are the East and West Banks of the Lower Clyst and Kenn Valley. Discussions with landowners at these sites were undertaken and the sites were included in the public consultation on the Strategy.

Water Framework Directive

- 5.2.8 A detailed description of the surface water bodies and groundwater bodies potentially affected by the Strategy is provided in the WFD Assessment Report (Appendix E), which also assesses compliance with WFD requirements as discussed below.
- 5.2.9 The assessment concludes that implementation of the Strategy is not expected to cause deterioration in the status of any of the water bodies or prevent them from achieving their environmental objectives as follows:
- Lyme Bay West coastal (moderate potential) - progressive loss of upper inter-tidal habitats with sea level rise are minor compared to the large water body and will not compromise WFD objectives.
 - Exe transitional (moderate potential) - strategic options around the estuary mouth will support WFD objectives by restoring a considerably more natural system than exists at present.
 - Exe transitional and Kenn river (poor status) - localised intertidal habitat losses on the estuary shores that are likely to result from sustaining the defences for the railway and urban areas will be offset by establishing compensatory habitat along the Kenn.
 - Clyst river (moderate potential) - proposed measures will make a significant contribution to WFD objectives, helping the Clyst's transition towards good potential and complementing the WFD objectives for the adjacent Exe transitional water body.
 - Upstream water bodies - the Strategy will not affect their status/potential but when delivering local schemes it may be efficient to combine these with separate initiatives to increase tidal exchange on some of the tributaries.
 - Groundwater bodies - the Strategy proposals will have no effect.
- 5.2.10 There should be no change in the quality of designated bathing waters and no changes in the quality requirements of the Shellfish Water or Freshwater Fish Directives. Therefore, the quality requirements of the associated WFD Protected Areas should not be compromised. European designated nature conservation site Protected Areas have been considered above.
- 5.2.11 Defence maintenance and improvements along the Exe Estuary's eastern, northern and western shores, may result in small additional encroachment of engineered structures into the Exe transitional water body, and attention will therefore be needed at scheme level to ensure appropriate mitigation measures. However, when considering the overall complement of inter-tidal areas, squeeze and encroachment on narrow frontages in the functional estuary (as distinct from the Exe transitional water body) will be offset by the proposals for habitat creation on the Clyst and Kenn. Thus, WFD compliance is contingent on delivery of habitat creation sites that are required for Habitats Regulations compliance.
- 5.2.12 Therefore, with habitat creation schemes already being progressed, assessment of the Strategy against conditions listed in Article 4.7 of the WFD is not required.
- 5.2.13 Additionally, defending urban frontages will reduce risks that could otherwise arise from flooding of areas that may be contaminated or occupied by landfill in Exmouth and Topsham.

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Stakeholder Involvement and Consultation

- 5.2.14 Consultation was undertaken with statutory and other stakeholders during the Strategy and comprised email updates, newsletters, project website, targeted stakeholder meetings, public exhibitions and other reports/consultation brochures. In addition formal consultation has been undertaken as part of the SEA process. A full programme of the consultation undertaken is included in the SEA (Appendix E).
- 5.2.15 The main issues arising from stakeholder and public consultation (SEA and Strategy responses) influencing the Strategy include:
- Consider loss of life, businesses and livelihoods.
 - Understand implications for European wildlife sites.
 - Consider changes at the Maer with respect to the road, ecological and amenity value, and development conflicts.
 - Consider heritage implications, reclamation landscapes and coastal paths.
 - Consider fishing activity, the bass nursery and shellfish production areas within the estuary (waters outside the estuary are potential nursery/spawning grounds).
 - Need to balance needs of different users in the coastal environment, recognising wildfowling activities and sensitive habitats.
 - Consider impacts of MR on privately owned agricultural land, nature conservation (and legal obligations), Powderham Registered Park and Garden, and historic marshes of Clyst.
 - Concerns about the implications for estuary villages of allowing Dawlish Warren to follow a more natural pattern.
 - Political and social opposition to Managed Realignment in some areas e.g. Clyst.

Environmental Impacts of Alternative Options

- 5.2.16 Table 5.2 identifies the key environmental impacts of alternative options for each FCERM unit, and potential mitigation or enhancement opportunities. The significant environmental benefits of the Strategy are outlined in Section 6.

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Table 5.2 Key environmental impacts, mitigation and opportunities (environmental preferred option highlighted)

Option	Key positive impacts	Key negative impacts	Mitigation/enhance. opportunity
Sandy Bay (FCERM unit 1) – no other options considered as there is no flood risk to manage and erosion risk is limited			
Do Nothing	Allows naturally functioning system, benefiting designated conservation sites.	Potential erosion risk to caravans, MoD land, pump house & South West Coast Path.	Risk of contamination from MoD land will require further consideration.
The Maer (FCERM unit 2)			
Do Nothing and MR	Allows naturally functioning system.	Relocation of existing infrastructure required & conflicts with site being identified for development in Exmouth Plan.	
Hold the line (various options)	Continued/improved protection to promenade, Queens Drive, historic buildings, development land & recreation area. Maintains pedestrian safety & amenity value.	Coastal squeeze and potential for direct impacts on inter-tidal (sand and mud) habitat within Exe Estuary SPA & Ramsar site.	Compensatory inter-tidal habitat required. Opportunity to combine with beach mgt at Dawlish Warren and Exmouth .
Exmouth (FCERM unit 3)			
Do Nothing	Allows naturally functioning system.	No protection to people and properties in Exmouth.	
Hold the line (various options)	Improved flood protection to properties and recreation in Exmouth. Improved safety for pedestrians.	Coastal squeeze & direct impacts on inter-tidal habitat within Exe Estuary SPA and Ramsar site. Change in landscape & potential views. Continued hydromorphological pressure on Exe.	Compensatory inter-tidal habitat required. Opportunity to develop scheme with Exmouth Study.
Courtlands, Lypstone, Lypstone Commando, Exton (FCERM unit 4-7)			
Do Nothing	Allows naturally functioning system along cliff frontages.	Increases flood and/or erosion risk to Grades 1 and 3 agricultural land, East Devon Way, Sustrans route, branch railway & properties/sewerage works at Exton.	Consider alternative inland footpath routes. Implement principles of Be Prepared & Adapt to Flooding.
Hold the line (various options)	Protects branch railway, properties, agricultural land and infrastructure from increased flood and erosion risk. No change in historic military landscape at Lypstone Commando.	Constrains coastal processes & continued hydromorphological pressure on Exe waterbody. Potential change in landscape & views.	Finishes of engineered structures needs further consideration.
East Bank of the Lower Clyst (FCERM unit 8)			
Do Nothing	Allows naturally functioning system.	No protection to properties, listed structures, branch railway or C257.	
Hold the line (various options)	Protects properties, railway, C257, Clyst & Topsham Bridge, & agricultural land.	Coastal squeeze of inter-tidal habitat within Exe Estuary SPA and Ramsar site.	Compensatory inter-tidal habitat required.
MR	Allows naturally functioning system. Creation of significant inter-tidal, freshwater and reedbed habitat. Would also protect road and bridges.	Loss of Grade 4 agricultural land. Considerable stakeholder opposition. Change in landscape.	Assessment of historic landscape and archaeology impacts required. Erosion protection at Topsham Bridge required.
Clyst St Mary (FCERM unit 9)			
Do Nothing	Allows naturally functioning system & reduces hydromorphological pressure on Clyst waterbody.	Increases flood risk to properties, key transport routes, high grade agricultural land and historic assets (including Clyst St Mary Bridge SM).	
Hold the line	Protects properties, heritage assets in Clyst St Mary, terrestrial habitats and key transport routes.	Constrains natural processes & continued hydromorphological pressure on Clyst.	
Sowton (FCERM unit 10) – no other options considered as there are no economic assets to protect			
Do Nothing	Allows naturally functioning system & potential creation of wetland habitats.	Loss of water meadows. Increasing flood risk to high grade agricultural land & historic assets (including Clyst St Mary Bridge/Causeway Scheduled Monument (SM)).	
West Bank of the Lower Clyst (FCERM unit 11)			
Do Nothing	Allows naturally functioning system.	Loss of significant areas of agricultural land	
Hold the line (various options)	Protects properties in Clyst St Mary, Clyst Road, railway, historic landscapes & listed bridge.	Constrains natural processes & continued hydromorphological pressure on Clyst	
MR	Allows naturally functioning system. Protects Clyst Road, railway and properties. Creates up to 21 ha of inter-tidal habitat.	Potential impacts on Topsham Bridge. Loss of agricultural land, historic landscape and inundation of Clyst Marshes County Wildlife Site (CWS). Change in landscape/views.	Further consultation with affected parties. Ongoing discussions with NFU. representatives and landowners.

Option	Key positive impacts	Key negative impacts	Mitigation/enhance. opportunity
Topsham, Countess Wear (FCERM unit 12-13)			
Do Nothing	Allows naturally functioning system, benefitting designated conservation sites.	No protection to properties and built assets.	
Hold the line (various options)	Protects properties, infrastructure, heritage & amenity assets and high grade agricultural land.	Coastal squeeze of inter-tidal habitat in Exe Estuary SPA and Ramsar site. Potential community opposition to Topsham scheme.	Compensatory inter-tidal habitat required.
Exminster Marshes and Powderham Banks (FCERM unit 14)			
Do Nothing	Allows naturally functioning system, benefitting designated conservation sites.	No protection to properties and built assets in Exminster.	
Hold the line (various options)	Protects properties, heritage, amenity assets, main railway and high grade agricultural land. Protects coastal grazing marsh at RSPB Reserve.	Coastal squeeze of inter-tidal habitat in Exe Estuary SPA and Ramsar site. Constrains natural processes.	Compensatory inter-tidal habitat required. Landform profiles for embankment raising requires further consideration.
MR	Allows naturally functioning system and potential to create up to 87ha of inter-tidal habitat at Exminster Marshes. Protects properties in Exminster.	Loss of high grade agricultural land, roosting habitat for breeding waders and designated freshwater habitat. Impacts on RSPB Reserve	Compensatory freshwater habitat required.
Kenn Valley (FCERM unit 15)			
Do Nothing	Allows naturally functioning system, benefitting designated conservation sites.	No protection to properties and built assets. Loss of main railway.	
Hold the line	Protects properties, Powderham Registered Park and Garden, amenity assets & infrastructure (railway, A379)	Coastal squeeze of inter-tidal habitat in SPA and Ramsar site. Constrains natural processes and hydromorphology of Kenn.	Compensatory inter-tidal habitat required.
MR	Allows naturally functioning system. Creates up to 30 ha of inter-tidal habitat and 5ha of grazing marsh. Improves fish access to River Kenn.	Loss of agricultural land. Change in landscape and views. Potential changes in channel morphology. Impacts on Powderham Registered Park and Garden.	Opportunity to improve existing problem with flapped outfall.
Starcross (FCERM unit 16)			
Do Nothing	Allows naturally functioning system, benefitting designated conservation sites.	No protection to properties, built assets and main railway.	
Hold the line (various options)	Protects properties, material assets, critical infrastructure, high grade agricultural land & listed buildings in Cockwood and Starcross.	Coastal squeeze of inter-tidal habitat in SPA and Ramsar site. Constrains natural processes and hydromorphology of Exe. Potential loss of amenity value. Change in landscape.	Compensatory inter-tidal habitat required.
Dawlish Warren (FCERM unit 17)			
Do Nothing	Enables natural evolution of spit.	No protection to Dawlish Warren village or estuary if spit breaches. Changes in geomorphology and shellfisheries. Increasing flood risk to freshwater habitats.	
Hold the line (various options)	Protects Dawlish Warren village and freshwater habitats.	Constrains natural processes and potential impacts on Dawlish Warren SAC.	Compensatory habitat will be required.
Mixed option: hold the line (ground raising, dune mgt), do nothing & MR (gabion removal)	Allows natural evolution of most of spit, benefitting conservation sites and reactivating dunes. Protects Dawlish Warren. Maintains amenity value and beach landscape. Beneficial to Exe water body.	Potential changes in geomorphology in estuary. Increasing flood risk to some freshwater habitats.	Requires close monitoring of coastal change and beach levels at Dawlish Warren. Continued liaison with Natural England.
Dawlish to Holcombe (FCERM unit 18)			
Do Nothing	Allows naturally functioning system.	Loss of main railway.	
Hold the line	Maintains railway embankment & protects properties.	Constrains natural processes and potential to impact on Dawlish Cliffs geological SSSI. Potential loss of views.	Work with Network Rail to avoids SSSI impacts and improves condition.

5.3 Option costs

- 5.3.1 Cost estimates for all options, prepared to a 2012 Q4 price date, include the capital costs and future operation, maintenance and repair costs for a 100 year appraisal period. A detailed summary of the costs for each option (for each FCERM unit) is included in the Options Assessment report (Appendix D, see Annex M and O).
- 5.3.2 A unit cost database developed for the Strategy included actual out-turn construction costs from Environment Agency projects. The quantities for each option were derived using a Bill of Quantities (BoQ) type method. Capital costs were determined based on the unit rates described and including construction allowances for general items and preliminaries. Remaining costs such as design and supervision costs were determined based on a percentage of the capital construction costs, dependent on scale of construction.
- 5.3.3 Maintenance requirements and costs for the various strategic options were identified and included in the whole life present value costs. Costs were included for options where future works would be required to enable the option to adapt for climate change.

5.4 Options benefits (damages avoided)

- 5.4.1 Benefit estimates for all options were based on depth damage data taken from the Multi Coloured Manual (MCM) Handbook, updated to a 2012 Q4 price date.
- 5.4.2 The benefits of each option include flood damage avoidance to properties, emergency services and railway infrastructure in line with FCERM-AG. Temporary accommodation costs of £6,695 for residential properties and £5,461 for non-residential properties are included, following guidance from the Flood Hazard Research Centre (FHRC).
- 5.4.3 Residential and non-residential property market values were obtained from the National receptor Database and Land Registry rateable values. Threshold levels were obtained from LiDAR data with adjustment for floor level. These values were used to cap recurrent flood damages, such that the sum of PV damage over time did not exceed the market value of the asset.
- 5.4.4 Damages were determined avoiding double counting by removal of flood risk damages to properties lost to erosion. The proposed Improve schemes provide protection against both risks.
- 5.4.5 Depth damage values were increased to account for additional salt water damage in line with guidance from the MCM.
- 5.4.6 Distributional impact (DI) factors were calculated and applied to the market value of the residential property. Property flood and erosion damages have been capped at this adjusted market value.
- 5.4.7 Environmental benefits were calculated using the standard (EFTEC) approach in line with Environment Agency guidance.
- 5.4.8 For each analysis reach the options benefits were calculated at each of Years 0, 20, 50 and 100, in order to take account of both rising sea levels and degrading defence condition.
- 5.4.9 The benefits are summarised in Section 6 and further details included in the Baseline Report (Section 4, Annex E) and Options Assessment Report (Annexes N and P).
- 5.4.10 The effect on the business case of risk to life has been considered in sensitivity testing and shown not to affect the option selection.

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Gains not quantified

- 5.4.11 Estimates of losses to road infrastructure were not included since the roads affected by flooding are either relatively minor, or have short diversion routes, and as a result would incur minimal economic damages. However, as the C527 road is an important route, used as a short-cut from Exmouth to Exeter via Topsham and no similar route exists, it was considered in selection of the preferred option.
- 5.4.12 The loss of public Right of Way footpaths including parts of the South West Coastal Path, East Devon Way and Sustrans cycle routes (which would be lost for Do Nothing and Do Minimum options) were not determined since there are alternative routes for recreational value, and the loss to the UK would be negligible. However, as the footpath/cycleway round the estuary is of significant importance, as an alternative 'car free commuter' route and no similar route exists, it was considered in selection of the preferred option.
- 5.4.13 There are four landfill sites located which could potentially be at risk of erosion without the erosion defences present, in particular the Imperial Recreation Ground at Exmouth and playing field at Topsham. No monetary benefits from protecting these sites are included.
- 5.4.14 Quantifying the full benefits of the options for Dawlish Warren SAC is difficult. This option would improve the site's status by re-activating the sand dunes by beach recharge, restoring it to a more naturally functioning system, helping the dunes reach favourable condition by removing the gabions, and releasing more available beach for natural habitat development.

6 Selection and details of preferred Strategy

6.1 Selecting the preferred options

- 6.1.1 This section details the selection of the preferred option for the strategy appraisal reaches. In each case a benefit-cost assessment table is presented (in Tables 6.1 to 6.11) to determine the preferred economic option following the decision process of FCERM-AG. The environmental issues and preferred option are also summarised for each reach to determine the overall preferred option - highlighted (by shading) in the tables.
- 6.1.2 The selection process is ordered as follows:
- A. Dawlish Warren: strategically, options for the sand spit affect the inner estuary.
 - B. Preferred reaches for Managed Realignment to meet the strategic need for compensatory inter-tidal habitat to offset coastal squeeze in the Strategy area.
 - West Bank of Lower Clyst
 - Kenn Valley, part of Exminster Marshes, Powderham and Kenn Valley reach
 - East Bank of Lower Clyst
 - C. Other reaches prioritised in order of greatest risk to property and assets.
 - Exmouth
 - Topsham and Countess Wear
 - Clyst St Mary
 - The Maer
 - Starcross and Cockwood
 - Courtlands to Exton, including Lymptone
 - Dawlish to Holcombe
- 6.1.3 The reaches of Sandy Bay and Sowton are not detailed below as Do Nothing is the preferred option, due to no properties being at risk of flooding or erosion.
- 6.1.4 Further selection details are given in the Options Assessment Report (Appendix D – refer to Sections 4 and 5, Annex I-P).

A. Dawlish Warren – strategically, options for the sand spit affect the inner estuary

Table 6.1 Benefit-cost assessment: Dawlish Warren

Option and SoP (% probability)	PV costs, PVc (£k)	PV damages, PVd (£k)	PV benefits, PVb (£k)	Benefit/Cost Ratio, BCR	Incremental BCR
Option 1: Do Nothing	0	55,283*	-	-	-
Option 2: Do Minimum	1,083	12,948	42,336	39	-
Option 3a: Sustain 2%	9,167	5,078	50,205	5.5	6.2
Option 3b: Improve 1%	9,176	4,323	50,960	5.6	81
Option 3c: Improve 0.5%	9,223	3,846	51,437	5.6	10
Option 3d: Improve 0.1%	9,316	613	54,670	5.9	35

*the damages are drawn from the loss of sheltering function to the wider estuary, particularly at Powderham Banks, Kenn Valley, Starcross and Exmouth, as well Dawlish Warren village locally.

- 6.1.5 Do Minimum returns the highest BCR and for the Sustain and Improve options are within the range 5.5 to 5.9. The benefits derive mainly from the wider estuary benefits due to the sheltering function of the sand spit, particularly for Starcross and Kenn Valley, and also the local benefits to Dawlish Warren village (30% of Do Minimum PVb). The highest SoP for Improve 0.1% SoP is selected as the economically preferred option as all the IBCR's are above 5, following the decision rule.
- 6.1.6 The preferred environmental option comprises a combination of measures to improve the currently unfavourable condition of Dawlish Warren SAC, protect Dawlish Warren village and maintain the amenity and geological value of the site. These measures, including soft beach management, removal of gabions and local ground raising, are part of the Improve option.

- 6.1.7 The preferred option is Improve 0.1% SoP, recommended as a priority scheme for delivery within five years due to the strong economic case and need to improve the condition of the Dawlish Warren SAC.

B. Preferred reaches for Managed Realignment – for compensatory inter-tidal habitat

West Bank of Lower Clyst

- 6.1.8 This reach offers high potential for Managed Realignment for up to 21 ha of habitat creation combined with Improve options for local-scale Individual Property Protection to a group of four properties at risk only in 0.1% AEP. The environmentally preferred option is Managed Realignment as it supports a more naturally functioning system and significant compensatory habitat creation. The cost of habitat creation at this site is £35k/ha, based on the limited engineering required (localised breaches and IPP)

Table 6.2 Benefit-cost assessment: West Bank of Lower Clyst

Option and SoP (% probability)	PV costs, PVc (£k)	PV damages, PVd (£k)	PV benefits, PVb (£k)	Benefit/Cost Ratio, BCR	Incremental BCR
Option 1: Do Nothing	0	706	-	-	-
Option 2: Do Minimum	1,391	706	-	-	-
Option 5a: MR/Improve 2%	1,391	110	3,323	2.4	-
Option 5b: MR/Improve 1%	1,534	38	3,395	2.2	0.5
Option 5c: MR/Improve 0.5%	1,548	29	3,404	2.2	0.6
Option 5d: MR/Improve 0.1%	1,674	21	3,412	2.0	0.1

- 6.1.9 All options return similar BCRs in the range 2.0 to 2.4, and therefore 2%-0.1% SoP are potentially leading options. Compensatory habitat schemes are a key Strategy requirement providing the large benefit of enabling overall Strategy compliance. The additional expenditure to provide a high 0.1% SoP to property in the reach is justified in this context.
- 6.1.10 The preferred option is Managed Realignment to be promoted as a priority scheme for habitat creation within five years (in principle landowners support this option), with Improve 0.1% SoP for the properties at risk (if justified).

Exminster Marshes, Powderham and Kenn Valley

- 6.1.11 Kenn Valley offers high potential for up to 35ha of habitat creation. The cost of habitat creation at this site is £48k/ha based on the engineering required (RTE and localised embankments). The options at Exminster Marshes and Powderham Banks mainly relate to localised erosion management, independent of SoP. The benefit-cost assessment is presented for Kenn Valley in Table 6.3a separate from Exminster Marshes and Powderham Banks in Table 6.3b.

Table 6.3a Benefit-cost assessment: Kenn Valley

Option and SoP (% probability)	PV costs, PVc (£k)	PV damages, PVd (£k)	PV benefits, PVb (£k)	Benefit/Cost Ratio, BCR	Incremental BCR
Do Nothing	0	10,703	-	-	-
Do Minimum	890	1,574	9,129	10	-
Option 5a: MR/Improve 2%	4,795	662	13,494	2.8	1.1
Option 5b: MR/Improve 1%	4,847	433	13,723	2.8	4.4
Option 5c: MR/Improve 0.5%	6,054	292	13,864	2.3	0.1
Option 5d: MR/Improve 0.1%	6,283	170	13,986	2.2	0.5

- 6.1.12 For Kenn Valley, Do minimum returns the highest BCR of 10 and all MR/Improve options return similar BCRs in the range 2.8 to 2.2. Improve 1% SoP can be selected as the IBCR of 4.4 is above the minimum requirement (threshold set at 3).
- 6.1.13 The environmentally preferred option is MR for a naturally functioning system and significant compensatory habitat creation. This option requires consideration of the impacts on Powderham Registered Park and Garden.

- 6.1.14 For Kenn Valley the preferred option is MR / Improve 1% SoP to be promoted as a priority scheme for habitat creation within five years with an appropriately integrated heritage and landscape design. In principle, landowners support this option.

Table 6.3b Benefit-cost assessment: Exminster Marshes and Powderham Banks

Option and SoP (% probability)	PV costs, PVc (£k)	PV damages, PVd (£k)	PV benefits, PVb (£k)	Benefit/Cost Ratio, BCR	Incremental BCR
Do Nothing	0	37,027	-	-	-
Do Minimum	9,534*	30,518	6,509	0.7	-
Option 5a: Improve 2%	10,659	4,366	32,660	3.1	23
Option 5b: Improve 1%	11,277	3,203	33,824	3.0	1.9
Option 5c: Improve 0.5%	11,859	2,488	34,539	2.9	1.2
Option 5d: Improve 0.1%	12,140	1,740	35,287	2.9	2.7

*the Do Minimum option includes for geotechnical stability/toe protection works.

- 6.1.15 Exminster Marshes and Powderham Banks includes a section of the London to Penzance railway, with known embankment stability and flood risk concerns.
- 6.1.16 All Improve options return BCRs that are similar, in the range 3.1 to 2.9 and the economically preferred option is at least Improve 2% SoP. For the next 1% SoP the IBCR (1.9) is below the threshold of 3 set as the minimum requirement for the option to be preferred. The highest 0.1% SoP may be taken forward as it would be in line with Network Rail policy. Delivery is scheduled within 15 years as any scheme requires Partnership Funding and detailed geotechnical studies.

East Bank of Lower Clyst

- 6.1.17 This reach offers high potential for Managed Realignment for up to 38 ha of habitat creation combined with Improve options to protect the locally important C527 road at risk in 20% AEP. The environmentally preferred option is MR as it supports a naturally functioning system and significant compensatory habitat creation. The cost of MR at this site is £58k/ha based on the engineering required (C527 road embankment and localised scour protection).

Table 6.4 Benefit-cost assessment: East bank of Lower Clyst

Option and SoP (% probability)	PV costs, PVc (£k)	PV damages, PVd (£k)	PV benefits, PVb (£k)	Benefit/Cost Ratio, BCR	Incremental BCR
Option 1: Do Nothing	0	4,852	-	-	-
Option 2: Do Minimum	169	4,880*	-28	-	-
Option 5a: MR/Improve 2%	3,267	766	7,598	2.3	2.5
Option 5b: MR/Improve 1%	3,668	537	7,827	2.1	0.6
Option 5c: MR/Improve 0.5%	4,479	387	7,977	1.8	0.2
Option 5d: MR/Improve 0.1%	4,865	272	8,092	1.7	0.3

*Do Minimum damages greater than Do Nothing due to continuation of Annual Average Damages

- 6.1.18 The MR/Improve 2% SoP with BCR of 2.3 is the economically preferred option based on Managed Realignment. The next higher 1% SoP option is not selected as the IBCR is less than unity (0.6).
- 6.1.19 The public consultation presented MR as the preferred option for the East Bank of Lower Clyst. However, the consultation responses clearly indicated that landowner and public support would not be forthcoming for this option and consequently the risks to delivery would be significantly increased. The other two preferred sites for habitat creation provide sufficient compensatory habitat for the short term. MR was therefore not taken forward and the selected option is Do Minimum.

C. Other reaches – prioritised in order of greatest risk to property and assets

Exmouth

Table 6.5 Benefit-cost assessment: Exmouth

Option and SoP (% probability)	PV costs, PVc (£k)	PV damages, PVd (£k)	PV benefits, PVb (£k)	Benefit/Cost Ratio, BCR	Incremental BCR
Option 1: Do Nothing	0	354,911	-	-	-
Option 2: Do Minimum	1,794	216,365	138,546	77	-
Option 5a: MR/Improve 2%	3,993	34,682	320,229	80	83
Option 5b: MR/Improve 1%	4,363	19,190	335,722	77	42
Option 5c: MR/Improve 0.5%	4,929	8,851	346,061	70	18
Option 5d: MR/Improve 0.1%	5,278	1,451	353,461	67	21

- 6.1.20 All options return high BCRs, with the highest BCR for Improve 2% SoP. The highest Improve 0.1% SoP is selected as the economically preferred option as the iBCRs are all robustly above 5 (minimum threshold set for options greater than 0.5% SoP).
- 6.1.21 The preferred environmental option is Improve, with no clear preference for SoP, as a reduction in flood risk will benefit people, property, infrastructure and historic assets. All Improve options continue to cause inter-tidal habitat loss by coastal squeeze and increase the (defence) footprint within the Exe Estuary SPA and Ramsar site.
- 6.1.22 The selected preferred option for Exmouth is Improve 0.1% SoP, recommended as a priority scheme for delivery within five years due to the strong economic case. Compensatory habitat will be provided in the Lower Clyst and Kenn Valley reaches.

Starcross and Cockwood

Table 6.6 Benefit-cost assessment: Starcross and Cockwood

Option and SoP (% probability)	PV costs, PVc (£k)	PV damages, PVd (£k)	PV benefits, PVb (£k)	Benefit/Cost Ratio, BCR	Incremental BCR
Option 1: Do Nothing	0	145,441	-	-	-
Option 2: Do Minimum	923	50,894	94,547	102	-
Option 5a: MR/Improve 2%	2,883	11,102	134,340	47	20
Option 5b: MR/Improve 1%	3,728	5,945	139,497	37	6.1
Option 5c: MR/Improve 0.5%	3,943	2,707	142,734	36	15
Option 5d: MR/Improve 0.1%	4,254	473	144,968	34	7.2

- 6.1.23 All options return high BCRs, with the highest BCR for Do Minimum. The highest Improve 0.1% SoP is selected as the economically preferred option as the iBCRs are all robustly above 5 (minimum threshold set for options greater than 0.5% SoP).
- 6.1.24 The preferred environmental option is Improve, with no clear preference for SoP, as a reduction in flood risk will benefit people, property, infrastructure, historic assets and high grade agricultural land. All Improve options continue to cause inter-tidal habitat loss by coastal squeeze and increase the (defence) footprint within the Exe Estuary SPA and Ramsar site.
- 6.1.25 The selected preferred option for Starcross and Cockwood is Improve 0.1% SoP, recommended as a priority scheme for delivery within five years due to the strong economic case. Compensatory habitat will be provided in the Lower Clyst and Kenn Valley reaches.

Topsham and Countess Wear

Table 6.7 Benefit-cost assessment: Topsham and Countess Wear

Option and SoP (% probability)	PV costs, PVc (£k)	PV damages, PVd (£k)	PV benefits, PVb (£k)	Benefit/ Cost Ratio, BCR	Incremental BCR
Option 1: Do Nothing	0	17,488			
Option 2: Do Minimum	1,616	18,767	-1,279		
Option 5a: Improve 2%	2,203	1,020	16,468	7.5	-
Option 5b: Improve 1%	2,673	619	16,869	6.3	0.9
Option 5c: Improve 0.5%	4,434	326	17,162	5.0	0.4
Option 5d: Improve 0.1%	4,484	57	17,431	3.9	0.3

*Do Minimum damages greater than Do Nothing due to continuation of Annual Average Damages

- 6.1.26 All options return BCRs above unity. For this reach the Improve 2% SoP with IBCR of 34 is selected as the economically preferred option following the decision rule. For the higher Improve 1% SoP the IBCR is less than unity.
- 6.1.27 The preferred environmental options are Sustain and Improve as they would continue to protect the built environment, heritage and amenity assets and high grade agricultural land. These options continue to cause inter-tidal habitat loss by coastal squeeze and increase the (defence) footprint within the Exe Estuary SPA and Ramsar site.
- 6.1.28 The selected preferred option is Improve 2% SoP, which in the short term provides 0.5% SoP. Compensatory habitat will be provided in the Lower Clyst and Kenn Valley reaches. Delivery is scheduled within 15 years as any scheme requires Partnership Funding and further engagement with the local community to find a solution appropriate to the Topsham area.

Courtlands to Exton

- 6.1.29 This reach from Courtlands to Exton, includes Lymptone as the main flood risk area. The benefit-cost assessment is therefore presented for the full reach in Table 6.8, with the standalone case for Lymptone also indicated – figures in brackets

Table 6.8 Benefit-cost assessment: Courtlands to Exton

Option and SoP (% probability)	PV costs, PVc (£k)	PV damages, PVd (£k)	PV benefits, PVb (£k)	Benefit/Cost Ratio, BCR	Incremental BCR
Option 1: Do Nothing	0	22,023 (22,051)	-	-	-
Option 2: Do Minimum	2,463 (373)	281 (14,985)	21,742 (7,066)	8.8 (19)	-
Option 4: Sustain 2% (Sustain 0.5%)	2,463 (2,803)	156 (1,482)	21,867 (20,568)	8.9 (7.3)	- (5.6)
Option 5a: Improve 1%	2,741 (2,813)	145 (838)	21,878 (21,213)	8.0 (7.5)	- (64)
Option 5b: Improve 0.5%	2,781 (2,945)	119 (408)	21,904 (21,642)	7.9 (7.3)	0.6 (3.2)
Option 5c: Improve 0.1%	2,918 (3,048)	24 (72)	21,998 (21,979)	7.5 (7.2)	0.7 (3.3)

*figures in brackets relevant to a standalone Lymptone scheme only

- 6.1.30 For this reach the Sustain 2% SoP is selected as the economically preferred option. For the higher Improve 1% SoP the IBCR is less than unity. The highest 0.1% SoP may be taken forward as it would be in line with Network Rail policy.
- 6.1.31 For Lymptone (figures in brackets in table), the economically preferred option is the Improve 0.5% SoP. Improve 0.1% SoP is almost justified, with IBCR just below the minimum requirement (threshold of 5 for options greater than 0.5% SoP). At project level further analysis may identify partnership funding and/or reduction in costs that would justify Improve 0.1% as the preferred option.

- 6.1.32 The environmentally preferred options are Maintain, Sustain and Improve along the built frontages, as they continue to protect significant built environment and infrastructure assets. No active intervention is environmentally preferred along the natural cliff frontages at Courtlands and Lympstone. At Lympstone, these options continue to cause inter-tidal habitat loss by coastal squeeze and increase the (defence) footprint within the Exe Estuary SPA and Ramsar site.
- 6.1.33 The selected preferred option for the reach is generally Sustain 2% SoP and Improve 0.1% SoP at Lympstone in the medium to long term.

Clyst St Mary

Table 6.9 Benefit-cost assessment: Clyst St Mary

Option and SoP (% probability)	PV costs, PVc (£k)	PV damages, PVd (£k)	PV benefits, PVb (£k)	Benefit/ Cost Ratio, BCR	Incremental BCR
Option 1: Do Nothing	0	4,219	-	-	-
Option 2: Do Minimum	141	3,217	1,002	-	-
Option 3: Maintain 2%	804	624	3,595	4.5	3.9
Option 5a: Improve 1%	870	564	3,655	4.2	0.9
Option 5b: Improve 0.5%	936	513	3,706	4.0	0.8
Option 5c: Improve 0.1%	1,268	454	3,765	3.0	0.2

- 6.1.34 All options return BCR well above unity and the economically preferred option is Maintain 2% SoP with the highest BCR of 4.5. The higher Improve 1% SoP is not selected as the IBCR is less than unity (0.9). There is no clearly preferred environmental option.
- 6.1.35 The selected preferred option is Maintain 2% SoP, requiring maintenance into the long term. Recent flooding in November 2012 indicates a greater fluvial flood risk than currently assessed, which is being further investigated at project level in order to confirm the preferred option.

Dawlish to Holcombe

Table 6.10 Benefit-cost assessment: Dawlish to Holcombe

Option and SoP (% probability)	PV costs, PVc (£k)	PV damages, PVd (£k)	PV benefits, PVb (£k)	Benefit/ Cost Ratio, BCR	Incremental BCR
Option 1: Do Nothing	0	3,760	-	-	-
Option 2: Do Minimum	0	3,760	-	-	-
Option 4a: Improve 2%	157	354	3,406	21	-
Option 4b: Improve 1%	196	215	3,544	18	3.6
Option 4c: Improve 0.5%	227	131	3,629	16	2.7
Option 4d: Improve 0.1%	259	47	3,712	14	2.7

- 6.1.36 For this reach the Improve options involve Individual Property Protection for up to 40 properties in the medium to long term, as currently they are naturally protected to above 0.1% SoP.
- 6.1.37 All options return high BCRs, with the highest BCR (21) for Improve 2% SoP. The economically preferred option is Improve 1% SoP, with an IBCR above the minimum requirement (threshold of 3). For Improve 0.5% SoP the IBCR is less than the minimum requirement (threshold of 5).
- 6.1.38 The preferred environmental option is Sustain and Improve the existing main railway embankment, and no active intervention elsewhere to benefit natural processes and geological conservation features.

The selected preferred option for the Dawlish to Holcombe reach is Improve 1% SoP, for delivery in the medium to long term. For the section of the Penzance to London railway in this reach, Network Rail are promoting wider improvements that are broadly supported by the Strategy.

The Maer

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Table 6.11 Benefit-cost assessment: The Maer

Option and SoP (% probability)	PV costs, PVc (£k)	PV damages, PVd (£k)	PV benefits, PVb (£k)	Benefit/Cost Ratio, BCR*	Incremental BCR
Option 1: Do Nothing	0	19,166*	-	-	-
Option 3a: Maintain: rock armouring of seawall	5,039	0	19,166	3.8	-
Option 3b: Maintain: beach recharge/recycling	9,796	0	19,166	2.0	-
Option 3c: Maintain: breakwaters	11,923	0	19,166	1.6	-

* includes £19,161k for public health and safety measures

- 6.1.39 Do Nothing option requires the removal of the failing seawall, promenade, road and associated infrastructure to avoid public health and safety risks, the costs of which are included as a dis-benefit for this option.
- 6.1.40 The Maintain options, by avoiding the public health and safety measures, all return BCRs above unity. The beach recharge/recycling option is the preferred option for the following reasons:
- safeguards the beach amenity providing significant benefit– see sensitivity testing below
 - potential for major cost saving (£5,000k) by combining with beach recharge/recycling at Dawlish Warren.
- 6.1.41 The environmental preferred option is Do Nothing (no active intervention) as it supports a naturally functioning system, including sand dunes, and avoids impact on the N2K sites. This option is not affordable or socially acceptable as it requires the relocation of infrastructure at high cost. Beach recharge/recycling is the next preferred option as ‘soft’ management leads to more natural coastal processes with limited impacts on the Exe water body, recreation, landscape and visual amenity.
- 6.1.42 The preferred option for The Maer is beach recharge/recycling, recommended within 15 years as it relies on securing external funding contributions. If this option can be combined with beach recharge/recycling at Dawlish Warren sand spit there would be a cost saving and it may be possible to bring the option forward earlier.

6.2 Sensitivity testing

- 6.2.1 The latest climate change guidance ‘Adapting to Climate Change: Advice for FCERM Authorities’ (EA, 2010) sets out in Annex B how to apply variable climate change scenarios to options development, to enable adaptive, flexible approaches. This methodology was applied in the Strategy, with the methodology agreed with the climate change guidance authors and LPRG representatives (October 2011).
- 6.2.2 The climate change testing determined the potential for options to switch significantly to different forms of intervention. Assessments were made on switching of options due to the range of low 50%ile, medium 95%ile, upper end and lower end plus surge climate change scenarios. Further testing assessed alternative forms of options, particularly where continued defence raising could become impractical.
- 6.2.3 A summary of the sensitivity testing for specific reaches is given below, with further details the Options Assessment Report (Appendix D, section 4 and annex L).
- 6.2.4 **Dawlish Warren:** The preferred option is assessed as robust against climate change scenarios. The balanced approach to managing engineering, economic, habitat and environmental interests provides limited opportunity for option variation at a strategic level.
- 6.2.5 **Exminster Marshes, Powderham Banks and Kenn Valley:** Options for much larger defence realignments are one alternative to the preferred option to improve defences along the existing alignment into the long term, and alternative Managed

Realignment sites. The preferred option is robust against climate change scenarios, although the height of defence raising is sensitive in the longer term. The preferred option is also robust, but the SoP is sensitive to variations in costs or damages as the BCR and IBCR values are low.

- 6.2.6 **Exmouth:** Options for wider community level resilience and a mix of primary and secondary defence alignments are one alternative to the preferred option to improve defences along the existing alignment into the long term. The preferred option is robust against climate change scenarios, with the height of defence raising sensitive in the medium to long term. The preferred option is robust against variations in costs or damages due to the very high benefits.
- 6.2.7 **Topsham and Countess Wear:** Options for wider community level resilience and a mix of primary and secondary defence alignments are one alternative to the preferred option to improve defences along the existing alignment into the long term. The preferred option is robust against climate change scenarios, with the height of defence raising sensitive in the longer term. The economic case is sensitive to variations in costs or damages, as the BCR and IBCR values are low and similar between different forms of options.
- 6.2.8 **The Maer:** potential tourism benefits specific to the beach recharge/recycling option give an estimated PVb of £45,000k. Inclusion of these benefits in the business case then make this the highest BCR option, increasing the Partnership Funding score from 5% to 50%, still requiring significant non-FCRM GiA contributions.

6.3 Details of the preferred options

Technical aspects

- 6.3.1 The Strategy is likely to benefit the Dawlish Warren SAC, but adversely affect the Exe Estuary SPA and Ramsar site. Compensatory habitat is required to address coastal squeeze and footprint habitat losses within the SPA/Ramsar site, which will be delivered through Managed Realignment on the West Bank of the Lower Clyst and Kenn Valley (see below).
- 6.3.2 **Dawlish Warren:** Management of the risks at Dawlish Warren, sand spit and village is an over-arching issue that affects FCERM in the wider estuary, particularly in the lee of the sand spit. In detail, the preferred option in the short and medium term consists of embankment raising to provide 0.1% SoP to the village, beach recharge/recycling, groyne works, and phased gabion removal. In the long term, embankment raising would continue, with the sand spit naturally evolving. This option is supported by Natural England.
- 6.3.3 **Exmouth:** In the short term (priority project), the preferred option is to provide 0.1% SoP, via localised defence raising of 0.5m and with property resilience works to around 20 properties. In the medium to long term (after 2030), the preferred option is still to provide 0.1% SoP, with more extensive defence raising of up to 1.2m and further property resilience works. **Courtlands to Exton:** In the short term, the preferred option is to provide continued maintenance to the existing 0.1% SoP defences. In the medium to long term, the preferred option is still to provide 0.1% SoP with defence raising of up to 1.4m (due to combined tide and wave action).
- 6.3.4 **East bank of Lower Clyst:** In the short term or until alternative measures are agreed, the preferred option is to continue maintaining the tidal flood embankments in accordance with existing agreed management measures. In the medium and long-term, a review will be undertaken of this location in the Strategy update.
- 6.3.5 **Clyst St. Mary:** In the short to long term, the preferred option is to provide continued maintenance to the existing defences, with fluvial flood risk being reviewed to confirm this option.
- 6.3.6 **West Bank of Lower Clyst:** In the short term (priority project), the preferred option is to enable Managed Realignment of up to 21ha, with individual property protection to

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up 4 properties. Whilst analysis has indicated that the risk of scour to Fisher's Bridge abutments is low, monitoring is recommended to address public consultation responses.

- 6.3.7 **Topsham and Countess Wear:** In the short term, the preferred option is continued maintenance, with localised road/pavement raising of 0.1m and individual property protection to provide 0.5% SoP. In the medium to long term, the preferred option is to provide 2% SoP via more extensive defence raising of up to 0.3m.
- 6.3.8 **Exminster Marshes and Powderham Banks:** In the short term, the preferred option is continued maintenance, with toe protection, embankment widening and raising of 0.5m at Powderham Banks to provide 0.1% SoP. In the medium to long term, the preferred option is to provide 0.1% SoP, via more extensive defence raising of up to 0.7m (due to combined tide and wave action). Opportunities for habitat creation in this reach will remain under consideration at future Strategy reviews.
- 6.3.9 **Kenn Valley:** In the short term (priority project), the preferred option is continued maintenance, with Managed Realignment of up to 35ha of land via a regulated tidal exchange and localised embankments or individual property protection to provide 2% SoP. In the medium to long term (after 2030), the preferred option is to provide 1% SoP via more extensive defence raising of up to 1.1m (due to combined tide and wave action).
- 6.3.10 **Starcross:** In the short term (priority project), the preferred option is to provide 0.1% SoP, with harbour wall and/or road raising of up to 0.5m. In the medium to long term, the preferred option is to still provide 0.1% SoP, via more extensive defence raising of up to 1.6m (due to combined tide and wave action).
- 6.3.11 **Dawlish to Holcombe:** The preferred short-term option of improvements to the main railway are broadly in agreement with Network Rail's more detailed studies. In the medium to long term, the preferred option is continued improvements to the main railway, along with individual property protection for up to 40 properties near Dawlish Water.

Environmental aspects

- 6.3.12 The Strategy will manage tidal flood and erosion risks to the majority of properties in towns and villages around the estuary, through an adaptive approach to rising sea levels.
- 6.3.13 Significant beneficial impacts of the Strategy will include:
- Managing the risk of flooding and coastal erosion to 4,993 properties as well as community, recreational and amenity facilities in the major centres of population over 100 years.
 - Reduced flood and erosion risk to critical infrastructure and key transport routes including roads and the main railway.
 - Continued protection of areas designated for future development.
 - Where Do Nothing and Managed Realignment policies form part of the Strategy, the coastal system will be allowed to function naturally, significantly benefiting existing designated inter-tidal habitats in most parts of the Strategy area, with potential to create inter-tidal habitat in West Bank of Lower Clyst and Kenn Valley.
 - In total, the Strategy has the potential to create up to 51ha of inter-tidal saltmarsh, 10ha of inter-tidal mudflats and sandflats and 5ha of grazing marsh. This will contribute to the biodiversity strategy for England.
 - Reduced flood and erosion risks to known landfill sites bordering the estuary.
 - Do Nothing and Managed Realignment policies will help to restore a more natural system, which will make significant contributions to the achievement of the WFD.
 - Reduced flood risk to the historic areas of Exmouth, Topsham, Exminster Marshes and Powderham Banks and Starcross, and protection of and potential to

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restore historic landscapes and protection of archaeological remains behind defences.

6.3.14 Mitigation measures are proposed for all negative impacts arising from the Strategy, as detailed in the SEA Environmental Report (Appendix E). The mitigation measures will be reviewed and assessed as projects are taken forward and design details become available. Negative impacts include:

- Some caravans, isolated properties (e.g. at Topsham, Countess Wear and on the east bank of the Clyst), minor roads, railways and small areas of agricultural land may continue to be affected by an increasing flood and erosion risk.
- Potential for a deterioration in views for recreational users, road users and property occupants in later epochs, as defences are raised to manage flood risk from rising sea levels.
- Increasing flood and erosion risk to parts of the South West Coast Path, East Devon Way and Sustrans cycle routes in areas of NAI.
- Likely loss of internationally designated inter-tidal habitat in the footprint of new defences, and change due to coastal squeeze within the Exe Estuary SPA and Ramsar site as a result of Hold the Line policies, with associated impacts on waterbirds (these will be offset by habitat gains elsewhere – see beneficial impacts).
- Some impacts on local conservation sites will need to be carefully managed at project level to avoid adverse impacts.
- Defence works may result in additional encroachment of engineered structures into the Exe Estuary, and attention will be needed at scheme level to ensure that these are delivered with appropriate mitigation measures.
- Potential loss of areas of post-medieval reclaimed enclosures. Managed Realignment in Kenn Valley has the potential to harm the Powderham Registered Historic Park and Garden and affect the setting of key designated heritage assets.

6.3.15 Uncertain impacts include:

- Changes in coastal processes, in areas of Do Nothing, has the potential to affect fishing activities and the distribution of commercial fish/shellfish in the estuary – these impacts remain uncertain (which may be positive and negative) but would occur in the absence of the Strategy.
- Potential changes in landscape character, which will require further consideration at project level.

6.3.16 Strategy implementation will result in long-term geomorphological changes at Dawlish Warren and in the surrounding Strategy area, as parts of this area evolve naturally. Changes in geomorphology will need to be monitored to improve our understanding of the implications of these changes on population, the natural environment and future flood and erosion risks.

6.3.17 The environmental effects of implementing the Strategy against the predictions made by the SEA will be monitored to ensure that the mitigation measures are effective and identify any unforeseen environmental effects. The monitoring plan is provided in the Environmental Report (Appendix E).

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6.4 Summary of preferred strategy

- 6.4.1 Table 6.12 below (next page) shows a summary of the costs for each reach preferred option, split by capital and non-capital expenditure for maintenance.

Contributions and funding

- 6.4.2 Different organisations are responsible for flood and coastal erosion risk management within the Strategy areas. As partners in this Strategy the respective local authorities will promote their frontages, applying for FCRM GiA where appropriate. Network Rail will fund maintenance and improvement of the main and branch railways as necessary.
- 6.4.3 The Flood and Coastal Resilience Partnership Funding model has been applied to the schemes recommended in this Strategy. Table 7.4 provides the key Outcome Measure data and shows the amount of FCRM GiA potentially available for each capital improvement scheme. Contributions will be sought from partners for all FCRM schemes.
- 6.4.4 Initial discussions have been held with Network Rail, Exeter City Council, EDDC and Devon County Council, identifying the need for contributions at The Maer, Topsham and Powderham Banks for schemes to proceed.
- 6.4.5 Existing defences will continue to be maintained (using revenue budget) whilst contributions are pursued for the Improvement schemes recommended in this Strategy.
- 6.4.6 There will not need to be any upgrade works on the main or branch railways that perform a flood defence function for another 50 years generally (after 2060), except locally along Starcross and Kenn Valley to address increased exposure from the predicted separation and flattening of the Dawlish Warren sand spit distal end (in the 2040s).

Health, safety and sustainable construction

- 6.4.7 Health and safety elements form a key consideration in design development. At this stage the options are not sufficiently developed to allow a comprehensive assessment of all the health and safety issues. However, the following generic risks have been considered as part of the option appraisal process.
- 6.4.8 **Flood risk:** The majority of the strategy area is low lying with a flat topography and extreme water levels will lead to rapid flood water progression.
- 6.4.9 **Tidal inundation:** Under certain managed realignment scenarios, local access ways may be at risk of being inundated during extreme tides. This will require appropriate warning systems and signage. Consideration of these changes will be included within emergency arrangements and the emergency plans modified accordingly.
- 6.4.10 **Defence structures:** These are often open to public access and appropriate design and signage will be required to alert members of the public to the local hazards.
- 6.4.11 **Access over defences:** Steep embankments and sea walls can create difficulties with access. Consideration should be given during the design of the structures for appropriate access and any signage arrangements required.
- 6.4.12 A fundamental aim of option development has been to identify and achieve integrated engineering, environmental and sustainable solutions. This approach will be further developed within the future scheme detailed appraisal development and subsequent detail design stages.

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Table 6.12 Summary of preferred strategy

	The Maer	Exmouth	Court-lands to Exton	East bank, Lower Clyst	Clyst St. Mary	West bank, Lower Clyst*	Topsham, Countess Wear	Exminster Marshes, Powderham Banks and Kenn Valley*	Starcross	Dawlish Warren	Dawlish - Holcombe	Total for Strategy area
SoP - short term	0.1	0.1	0.1	20.0	0.1	0.1	0.5	0.1	0.1	0.1	0.1	
SoP - longer term	0.1	0.1	0.1	100.0	2.0	0.1	2.0	0.1	0.1	0.1	0.1	
PV costs (£k) Capital	8,688	3,484	2,675	0	663	283	881	15,196	3,332	8,233	196	43,693
Maintenance	1,109	1,794	2,835	169	141	1,391	1,322	1,791	923	1,083	0	12,558
Total PV costs (£k)	9,796	5,278	5,510	169	804	1,674	2,203	16,987	4,254	9,316	196	56,251
PV Benefits (£k)	19,166	353,461	43,846	-28	3,595	3,412	16,468	49,010	144,968	54,670	3,544	692,280
Avg. benefit/cost ratio	2.0	67.0	8.0	-0.2	4.5	2.0	7.5	2.9	34.1	5.9	18.1	
Cash costs (£k) Capital	33,102	8,348	12,294	0	663	1,450	2,153	27,189	6,133	11,298	1,294	103,925
Maintenance	3,708	6,156	9,451	563	470	2,134	5,387	6,061	3,075	3,610	0	40,615
Total cash costs (£k)	36,810	14,504	21,745	563	1,133	3,584	7,540	33,250	9,209	14,908	1,294	144,540

*Managed Realignment schemes – legally required as compensation for coastal squeeze

PV costs include Optimism Bias at 60%

7 Implementation

7.1 Project planning

Phasing and approach

- 7.1.1 The Strategy aims to promote and encourage long term sustainable and strategic management of flood and erosion risk. It provides a framework for planning the implementation of capital projects, further studies, surveys and investigations, and will help with targeting and prioritisation of day-to-day activities.
- 7.1.2 A 5 year programme of capital investment for the FCERM schemes at Exmouth, Starcross and Dawlish Warren (and if efficiently combined, The Maer also) at schedules increased spend levels when construction starts from 2015.
- 7.1.3 Capital investment for the Managed Realignment schemes in Clyst Valley and Kenn Valley to create compensatory inter-tidal habitat, which are being developed in more detail under the Exe Estuary Habitat Delivery project, is also over five years.
- 7.1.4 Preferred options for the other reaches do not require capital investment in the first 10 years, except where erosion changes such as beach erosion at Dawlish Warren – requires future monitoring.
- 7.1.5 Engagement with communities and stakeholders will need to continue in order to manage the risk and consequences of flooding, and this includes:
- Pursue contributions for the schemes recommended in this Strategy.
 - Encourage all parties with responsibility for maintenance of defences, including private landowners, to monitor and maintain their defences.
 - Continued discussion regarding potential habitat creation sites.
 - Promote resilience measures.

Programme and spend profile

- 7.1.6 The key actions recommended by this Strategy over the next 15 years are presented in Table 7.1, which identifies the outline programme for the priority FCERM, Managed Realignment and short term FCERM projects. Funding for these schemes is anticipated to be mainly through FCRM GiA.
- 7.1.7 As the other FCERM projects at The Maer, Topsham and Powderham Banks return low FCRM GiA PF scores they are delayed until after five years (unless funding can be made available from sources in addition to FCRM GiA).
- 7.1.8 Implementation of the preferred Strategy is dependent on the availability of funding. The Environment Agency will continue to work with the local authorities, other partners, riparian owners and local communities to identify and secure alternative funding sources to provide contributions.
- 7.1.9 The strategic environmental monitoring plans in Appendix H provide an overview of monitoring proposed in relation to the predicted significant environmental effects of the Strategy or where uncertain effects have been identified.

Table 7.1 Outline programme for next 15 years

Activity	Target
Exmouth, Starcross and Dawlish Warren FCERM schemes	
Commence detailed appraisal	2013
Approval	2014
Construction start	2015
Construction completion	2018
Clyst Valley and Kenn Valley Managed Realignment schemes	
Commence detailed appraisal	2012
Approval	2014
Construction start	2015

Activity	Target
Construction completion	2018
The Maer, Topsham, Powderham Banks FCERM schemes*	
Commence detailed appraisal	2020
Approval	2021
Construction start	2022
Construction completion	2023

*subject to securing Partnership Funding

- 7.1.10 An outline programme for the preferred Strategy for capital investment and maintenance over 100 years is given in Table 7.2. Based on this programme a summary of the annualised spend profile and Partnership Funding scores is given in Table 7.3.

Table 7.2 Outline programme

Flood Reach	Element		Operating Authorities
The Maer	Year 1-100	beach recharge/recycling, with groyne maintenance	EA, EDDC
Exmouth	Year 1-5	improve 0.1% AEP scheme – raise defences	EA, EDDC
	Year 6-15	ongoing maintenance	
	Year 15-100	improve 0.1% AEP scheme – wider raising of defences	
Courtlands to Exton*	Year 1-15	ongoing maintenance	EA, EDDC, NR
	Year 15-100	improve 0.1% AEP scheme – raise defences	
	*incl. Lympstone, Lympstone Commando		
East bank, Clyst St George	Year 1-15	continue maintaining the tidal flood embankments in accordance with existing agreed management measures, until alternative measures are agreed.	EA, EDDC, DCC
	Year 15-100	alternative measures, if agreed	
Clyst St Mary	Year 1-5	ongoing maintenance, review of fluvial flood risks	EA, EDDC, DCC
	Year 6-100	ongoing maintenance, dependent on above review	
West bank, Clyst	Year 1-5	managed realignment scheme with IPP	EA, EDDC, DCC
	Year 6-100	ongoing maintenance	
Topsham, Countess Wear	Year 1-5	ongoing maintenance, further contribution discussions	EA, ECC
	Year 6-15	improve 0.5%AEP scheme – IPP and road/pavement raising	
	Year 15-100	improve 0.1%AEP scheme – wider raising of defences	
Exminster Marshes, Powderham	Year 1-5	ongoing maintenance, further contribution discussions	EA, ECC, NR
	Year 6-15	improve 0.1%AEP scheme – toe protection, embankment widening and raising	
	Year 15-100	improve 0.1%AEP scheme – wider raising of defences	
Kenn Valley	Year 1-5	managed realignment scheme with RTE, IPP/embankments	EA, TDC, NR
	Year 6-15	ongoing maintenance	
	Year 15-100	improve 0.1%AEP scheme – wider raising of defences	
Starcross, Cockwood	Year 1-5	improve 0.1%AEP scheme – raise defences	EA, TDC, NR
	Year 6-15	ongoing maintenance	
	Year 15-100	improve 0.1%AEP scheme – wider raising of defences	
Dawlish Warren	Year 1-5	sustainable management scheme – embankment raising, beach recharge/recycling, groyne works and gabion removal	EA, TDC
	Year 6-15	sustainable management scheme – maintenance and further gabion removal	
	Year 15-100	improve 0.1%AEP scheme - embankment raising, natural evolution of sand spit	
Dawlish to Holcombe	Year 1-15	railway improvements	EA, TDC, NR
	Year 15-100	improve 0.1%AEP scheme – railway improvements and IPP	
Estuary-wide	Year 1-10	ongoing maintenance, monitoring of assets, sea level rise, geomorphology and habitat change	All operating authorities (via PCO)
	Year 11-15	as above and overall strategy review	
	Year 15-100	ongoing maintenance, monitoring of assets, sea level rise geomorphology and habitat change, multiple strategy reviews	
DCC – Devon County Council		EA – Environment Agency	ECC – Exeter City Council
EDDC – East Devon District Council		TDC – Teignbridge District Council	NR – Network Rail

Table 7.3 Annualised spend profile and Partnership Funding score summary (£k)

	2013-14	2014-15	2015-16	2017-18	2018-19	Future 10 years	Total 15 years	Total 100 years
Dawlish Warren, sustainable management, PF score 120% – flood embankment, groyne works, etc.								
Capital	507	507	1,062	4,393	507	3,405	10,381	11,298
Non-capital	48	48	48	48	48	481	722	3,610
Replacement inter-tidal habitat (by 2030)								
Kenn Valley: managed realignment, PF score 130% – realign/secondary flood embankments								
Capital	53	53	158	158	158	473	1,052	9,365
Non-capital	40	40	40	40	40	395	593	2,966
West Bank, Lower Clyst: managed realignment, PF score 120% – realign flood embankments, IPP								
Capital	45	45	134	134	134	401	890	1,450
Non-capital	28	28	28	28	28	284	427	2,134
Priority FCERM schemes (within 5 years)								
Exmouth: improve flood defence, PF score >200% – revetments, flood walls, protect property								
Capital	94	94	752	564	376	0	1,880	8,348
Non-capital	80	80	80	80	80	798	1196	6,156
Starcross, Cockwood: improve flood defences, PF score >200% – raise harbour/sea wall								
Capital	0	163	654	490	327	0	1,635	6,133
Non-capital	41	41	41	41	41	410	615	3,075
Short to medium term FCERM schemes (by 2030)								
The Maer, Exmouth: erosion protection, PF score 5% – beach recharge/recycling, maintain groynes								
Capital	0	500	500	2,500	1,500	0	5,000	33,102
Non-capital	49	49	49	49	49	494	742	3,708
Topsham, Countess Wear: improve flood defences, PF score 40% – raise ground, protect property								
Capital	0	0	0	0	0	271	271	2,153
Non-capital	72	72	72	72	72	718	1,077	5,387
Powderham Banks: improve flood defence, PF score 10% – raise embankments								
Capital	0	0	0	0	0	852	852	17,824
Non-capital	559	559	559	559	559	5,588	8,381	3,005
Remaining strategy area: ongoing maintenance, refurbishment								
Capital	0	0	0	0	0	0	0	14,251
Non-capital	179	179	179	179	179	1,790	2,684	10,574

Notes: Costs include 60% Optimism Bias; excludes inflation; PF raw score over 15 years, non-capital is maintenance costs only.

Outcome Measures contributions

7.1.11 A summary of the Outcome Measures and Partnership Funding contributions is given in Table 7.4. The delivery of these contributions will depend on the timing of implementation for each project.

Table 7.4 Partnership Funding summary

Outcome Measure	Priority FCERM projects			Priority compensatory habitat projects		Short term FCERM projects		
	Exmouth	Starcross	Dawlish Warren	West bank, Lower Clyst	Kenn Valley	The Maer	Topsham	Powderham Banks
Duration of benefits ¹ (years)	15	15	30*	15	15	15	15	15
PV cost ² £k*	2,768	677	8,334	880	1,548	4,310	271	9,083
PV benefit ² £k	222,644	81,043	50,776	1,182	8,070	5,486	1,906	13,373
OM2 total households with reduced flood risk ⁴	1,560	661	2,881	4	20	0	9	157
OM3 households with reduced erosion risk ⁴	0	0	0	0	0	0	0	0
OM4 statutory environmental obligations met (ha)	0	0	0	21	35	0	0	0
FCRM GiA contribution £k	2,768	677	8,334	880	1,548	299	112	795
Partnership Funding score (%)	>200	>200	>100	>100	>100	5	40	10
Contribution needed for 100% PF score £k**	0	0	0	0	0	4,011	159	8,288

Notes:

1. data presented only for flood cells requiring capital investment in the short term
2. duration of benefits for the period of intervention
3. PV cost and benefit for the duration of benefits
4. all households with reduced risk (OM2 and OM3) fall within the 60% least deprived category.

*Dawlish Warren management would provide a residual benefit into the medium term

**Contributions will be sought from partners for all FCERM schemes

7.2 Procurement strategy

7.2.1 Table 7.5 summarises the key staff involved in the preparation of the Strategy. The Project Board included representatives from Local Authorities, the Area Flood Risk Manager, NEAS Unit Manager (South-West), ncps (Project Executive) and the NEECA2 consultant alliance project directors.

7.2.2 A Procurement Strategy meeting will take place during the start-up of any funded projects from the Strategy. The Environment Agency will use their Framework Suppliers to carry out capital works and local Operations Delivery teams to undertake maintenance activities, as appropriate. Planning for the priority FCERM and MR projects (Table 7.4) has commenced.

Table 7.5 Key staff

Environment Agency		Framework Suppliers	
Client		NEECA2 Team – Atkins / Halcrow Alliance	
Project Sponsor (Area Flood Risk Manager)	Gordon Trapmore	Project Directors	Richard Samphier Jonathan Rogers
Business User	Martin Davies	Project Manager	Russell Corney
Project Executive	John Taberham	Environmental Consultant	Corinna Morgan
Project Manager	Fiona Geddes	Technical Advisors	Paul Canning Paul Rayner
NEAS Officer	Sarah Kingdom		
Devon County Council		Exeter City Council	
Steering Group member	Aidan Winder	Steering Group member	Dave Hubbard
East Devon District Council		Teignbridge District Council	
Steering Group member	Keith Steel	Steering Group member	Graeme Smith
Network Rail		Natural England	
Steering Group member	Peter Haigh	Steering Group member	Amanda Newsome
Title Exe Estuary Flood and Coastal Erosion Risk Management Strategy			
No.	IMSW001380	Status:	Final
		Issue Date:	June 2013
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7.3 Delivery risks

High level risk register

7.3.1 The key risks with the implementation of this Strategy are shown in Table 7.6.

Table 7.6 High level risk schedule and mitigation

Key project risk	Adopted mitigation measure
Financial: Cost estimates based on broad assessment of principal quantities and rates; and confirmation required of potential benefits achievable.	<ul style="list-style-type: none"> Optimism bias of 60% applied to all costs
Landowner: Objections to final options, particularly Managed Realignment.	<ul style="list-style-type: none"> Continued engagement with landowners.
Environmental: Presence of potential environmental constraints e.g. protected or invasive species, buried archaeology, particularly at Managed Realignment sites	<ul style="list-style-type: none"> Carry out desk-based assessments and field surveys at project level to identify constraints Continued consultation with relevant stakeholders
Environmental: Failure to deliver habitat creation at Managed Realignment sites.	<ul style="list-style-type: none"> Continued liaison with landowners and key stakeholders to agree acceptability of schemes Understand likely changes at sites and implement project level mitigation, where required
Political: Significant changes by partners (e.g. Network Rail) causes changes to the strategy area frontage necessitating an alternative strategic approach,	<ul style="list-style-type: none"> Local planners to take account of any proposed changes that impact on the Strategy recommendations.
Political: Limited influence of Environment Agency over spatial planning in the Strategy area, which is key to delivery of non-structural options relating to planning and development control.	<ul style="list-style-type: none"> Ensure Strategy is fully delivered to Area Partnerships Officer, planning liaison and development control. Provide indications of key partners and in what areas to influence them.
Political: Regional/local authority planning may conflict with objectives for habitat creation, flood resilience and reverting at risk areas to floodplain.	<ul style="list-style-type: none"> Use NPPF and planning liaison to influence planning Continue to consult with regional/local authority planners and feed into regional/local plans.
Delivery: Implementation, including the level of funding available and change in procedures.	<ul style="list-style-type: none"> Ensure that non-structural measures are taken forward in case of funding shortfall for structural options.
Force majeure: Flood event causes damage to Dawlish Warren and requires an alternative strategic approach.	<ul style="list-style-type: none"> Initiate further study to evaluate options.

Safety plan

7.3.2 The design decisions made at this strategic stage considered the possible solutions for minimising the health and safety risks whilst still achieving the required flood and coastal erosion risk management. The initial high level risks associated with the options considered include:

- construction and buildability
- operation and maintenance
- foreseeable emergency requirements
- alterations to the existing situation
- adjacent land users.

7.3.3 On the basis of the initial risk assessment, the development of any PAR will include:

- continued early input from the CDM co-ordinator
- use of ECI
- health and safety input into detailed design, buildability and planning
- designers to identify specific risks/mitigation as part of the Design Risk Register
- identify specific residual risks to the contractor
- include SHE boxes on design drawings

Title	Exe Estuary Flood and Coastal Erosion Risk Management Strategy					
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- provide the contractor with high quality Pre-construction Information
- Public Safety Risk Assessment.

7.3.4 During the construction phase, site health and safety will be the responsibility of the principal contractor supported by the CDM co-ordinator, supervisor, designers and client. The site will be subject to regular checks and audit by the principal contractor, supervisor and the client.

Title	Exe Estuary Flood and Coastal Erosion Risk Management Strategy					
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Appendix A Project appraisal report data sheet

Entries required in clear boxes, as appropriate.

GENERAL DETAILS

Authority Project Ref. (as in forward plan):

IMSW001380

Project Name
(60 characters
max.):

Exe Estuary Flood and Coastal Erosion Risk Management Strategy

Promoting Authority: Defra ref (if known)
Name

Emergency Works:

No

Yes/No

Strategy Plan Reference:

n/a

River Basin Management Plan

n/a

System Asset Management Plan

n/a

Shoreline Management Plan:

South Devon and Dorset

Project Type:

Strategy Plan

Shoreline Management Study/ Preliminary Study/ Strategy Plan/Prelim. Works to Strategy/ Project within Strategy/Stand-alone Project/
Strategy Implementation/Sustain SOS. Coast Protection/Sea Defence/Tidal Flood Defence/Non-Tidal Flood Defence/Flood Warning
Tidal/Flood Warning - Fluvial/Special

CONTRACT DETAILS

Estimated start date of works/study:

2013

Estimated duration in months:

On-going

Contract type*

(*Direct labour, Framework, Non Framework, Design/Construct)

COSTS

Appraisal:

APPLICATION (£000's)

£600

Costs for Agency approval:

£144,540 (Whole Life Cost)

Total Whole Life Costs (cash):

£144,540

For breakdown of costs see Table in Section 2.4

CONTRIBUTIONS

Windfall Contributions:

none

Deductible Contributions:

none

ERDF Grant:

none

Other Ineligible Items:

none

LOCATION - to be completed for all projects

EA Region/Area of project site (all projects):

South-West

Name of watercourse (fluvial projects only):

n/a

District Council Area of project (all projects):

Devon CC, Exeter CC, East Devon DC,
Teignbridge DC

EA Asset Management System Reference:

Varies

Grid Reference (all projects):

SX 920921

(OS Grid reference of typical mid point of project in form ST064055)

DESCRIPTION

Specific town/district to benefit:

Exmouth, Starcross, Dawlish, Topsham, Powderham Banks

Brief project description including essential elements of proposed project/study

(Maximum 3 lines each of 80 characters)

Strategy recommends a range of schemes for the next 15 years. FCERM schemes: The Maer, Exmouth, Topsham, Powderham Banks, Starcross. Sustainability/habitat schemes: Dawlish Warren, West bank of the Lower Clyst, Kenn Valley. Then incremental 100yr improvement programme to address climate change.

DETAILS

Design standard (chance per year):

1 in 1000 Exmouth
1 in 1000 Starcross
1 in 1000 Dawlish Warren
Other schemes variable

yrs

Existing standard of protection (chance per year)

Varies, 1 in 20 lowest

yrs

Design life of project:

Generally 20yrs until significant sea level rise

yrs

Fluvial design flow (fluvial projects only):

n/a

m³/s

Tidal design level (coastal/tidal projects only):

3.4 to 3.7mAOD

m

Length of river bank or shoreline improved:

TBA

m

Number of groynes (coastal projects only):

0

Total length of groynes* (coastal projects only):

0

m

Beach Management Project?

No

Yes/No

Water Level Management (Env) Project?

No

Yes/No

Defence type (embankment, walls, storage etc)

Walls and embankments

* i.e. total length of all groynes added together, ignore any river training groynes

ADDITIONAL AGREEMENTS:

Maintenance Agreement(s):

n/a

Not Applicable/Received/Awaited

EA Region Consent (LA Projects only):

n/a

Not Applicable/Received/Awaited

Non Statutory Objectors:

n/a

Yes/No

Date Objections Cleared:

Other:

n/a

Not Applicable/Received/Awaited

ENVIRONMENTAL CONSIDERATIONS

Natural England (or equivalent) letter:

Received

Not Applicable/Received/Awaited

Date received

/ /

SITES OF INTERNATIONAL IMPORTANCE

(Answer Y if project is within, adjacent to or potentially affects the designated site)

Special Protection Area (SPA):

Yes

Yes/No

Special Area of Conservation (SAC):

Yes

Yes/No

Ramsar Site

Yes

Yes/No

World Heritage Site

Yes

Yes/No

Other (Biosphere Reserve etc)

Yes (MPA)

Yes/No

SITES OF NATIONAL IMPORTANCE (Answer Y if project is within, adjacent to or potentially affects the designated site)

Environmentally Sensitive Area (ESA):	Yes	Yes/No
Site of Special Scientific Interest (SSSI):	Yes	Yes/No
National/Regional Landscape Designation:	Yes	Yes/No
National Park/The Broads	No	Yes/No
National Nature Reserve	Yes	Yes/No
AONB, RSA, RSC, other	Yes	Yes/No
Scheduled Ancient Monument	Yes	Yes/No
Other designated heritage sites	Yes	Yes/No

OTHER ENVIRONMENTAL CONSIDERATIONS

Listed structure consent	No	Not Applicable/Received/Awaited
Water Level Management Plan Prepared?	No	Yes/No
MMO consent required?	Yes	Not Applicable/Received/Awaited
Statutory Planning Approval Required	Yes	Yes/No/Not Applicable

COMPATIBILITY WITH OTHER PLANS

Shoreline Management Plan	Yes	Yes/No/Not Applicable
River Basin Management Plan	Yes	Yes/No/Not Applicable
Catchment Flood Management Plan	Yes	Yes/No/Not Applicable
Water Level Management Plan	n/a	Yes/No/Not Applicable
Local Environment Agency Plan	Yes	Yes/No/Not Applicable

SEA/ENVIRONMENTAL IMPACT ASSESSMENT

SEA	Agency voluntary	Statutory required/Agency voluntary/not applicable
EIA	Yes	Yes (schedule 1); Yes (schedule 2); SI1217; not applicable
SEA/EIA status	SEA prepared	Scoping report prepared/draft/draft advertised/final

Other agreements	Detail	Result	(Not Applicable/Received/Awaited for each)

Costs, benefits and scoring data

(Apportion to this phase if part of a strategy)

Local authorities only: For projects done under Coast Protection Act 1949, please separately identify: FRM = Benefits from reduction of asset flooding risk; CERM = Benefits from reduction of asset erosion risk**Benefit type** (DEF: reduces risk (contributes to Defra SDA 27); CM: capital maintenance; FW: improves flood warning; ST: study; OTH: other projects)

DEF

LAND AREA

Total area of land to benefit:	1073		Ha
of which present use is:	FRM	CERM	
Agricultural:	856		Ha
Developed:	198		Ha
Environmental/Amenity:	19		Ha
Scheduled for development	0		Ha

PROPERTY & INFRASTRUCTURE PROTECTED

	Number		Value (£'000s)	
	FRM	CERM	FRM	CERM
¹ Residential	2,215		667,000	
Commercial/industrial	580			
Critical Infrastructure	NA			
Key Civic Sites	NA			
Other (description below):	Railway			
Description:	- mainline London-Penzance - branchline Exeter-Exmouth			

costs and Benefits

¹ Present value of total project whole life costs (£'000s):	£56,000	
Project to meet statutory requirement? Y/N	Y	
	Value (£'000s)	
	FRM	CERM
Present value of residential benefits:	667,000	
Present value of commercial/industrial benefits:		
Present value of public infrastructure benefits:		
Present value of agricultural benefits:	Minimal	
Present value of environmental/amenity benefits:	6,000	
¹ Present value of total benefits (FRM & CERM)	£673 m	
Net present value:	£617 m	
Benefit/cost ratio:	12 (estuary)	
Base date for estimate:	2013	
FCERM-AG Decision Rule stage 3 applied	Yes	Yes/No
FCERM-AG Decision Rule stage 4 applied	Yes	Yes/No

OTHER OUTCOME MEASURE SCORING DETAILS

Super Output Area No*:	varies	Indicate if deprived:	No	Yes/No
(*as ranked by Indices of Multiple Deprivation)				
Risk:	N/A	VH, H or N/A		
		Wetland	Saltmarsh/ Mudflat	
Net gain of BAP habitat:			13	Ha
SSSI protected:	182	Ha		
Other Habitat:		Ha		
Heritage Sites:	170	"I or II" , "II or other" or "N/A"		

Exemption Details (if exempt from OM scoring system)

Exempt from Scoring: ☐ Yes/No

Reason (max 100 chars):

