



Strategy Appraisal Report

Authority scheme reference

IMTH000822

Defra/WAG LDW number

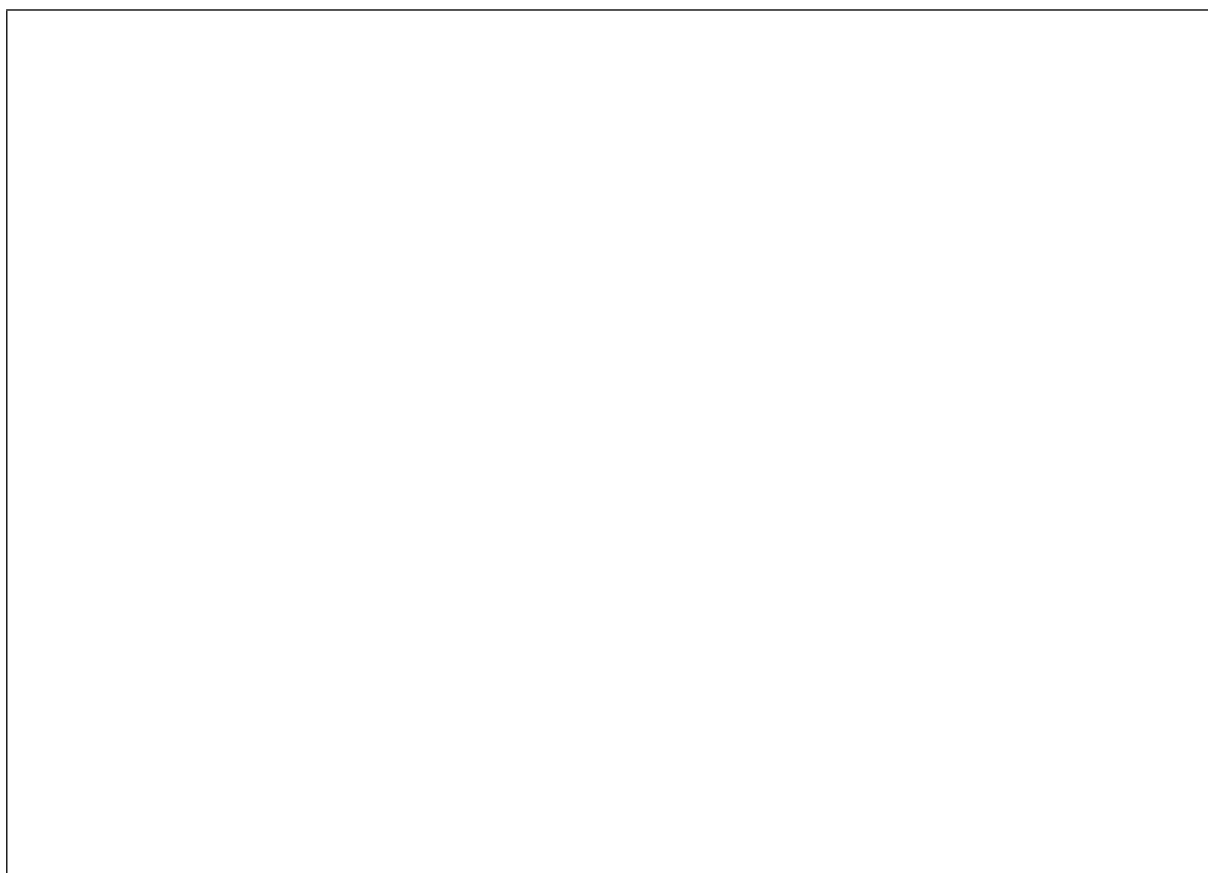
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Promoting authority

Environment Agency – South East Region
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Strategy name

River Roding Flood Risk Management Strategy



Flooding of the Chigwell Road in 2000

Date

August 2012

Version	6.0
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StAR for *River Roding Flood Risk Management Strategy*

Version	Status	Signed off by:	Date signed	Date issued
0.1	Draft			02/12/2011
0.2	Final Draft submission			08/12/2011
1.0	Issue to LPRG	Peter Nicholson	15/12/2011	16/12/2011
2.0	Re-issue to LPRG	Peter Nicholson	04/01/2012	04/01/2012
3.0	Re-issue to LPRG post meeting	Peter Nicholson	02/03/2012	02/03/2012
4.0	Modifications to Section 1 and 7	Peter Nicholson	27/03/2012	27/03/2012
5.0	Modifications to Section 2, 3, 5 and 6 post Ken Allison review	Peter Nicholson	11/05/2012	11/05/2012
6.0	Modified table 1.6 and text in Section 1.0 at request of David Jordan post approval	Peter Nicholson	16/08/2012	16/08/2012

Template version – April 2011

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For technical approval of the business case

Environment Agency South East Region

Project name: River Roding Flood Risk Management Strategy

Approval Value: £ 41,392,000

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.

Title	River Roding Flood Risk Management Strategy				
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Approval history sheet

APPROVAL HISTORY SHEET (AHS)			
1. Submission for review (to be completed by team)			
Project Title: River Roding Flood Risk Management Strategy		Project Code: IMTH000822	
Project Manager: Peter Nicholson		Date of Submission: 16/12/11	
Lead Authority: Environment Agency		Version No: 1.0	
Consultant Project Manager: Peter Nicholson		Consultant: Black & Veatch	
<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	Tim Chinn		14/12/11
	Job Title:	Project Team Manager	
2. Review by: Large Projects Review Group (LPRG)			
Date of Meeting(s): 18/01/12		Chairman: Ken Allison	
Recommended for approval: In the sum of £41,392,000		Date: 13/07/2012	Version No: 5.0
3. Environment Agency NFSoD approval <i>Officers in accordance with the NFSoD.</i>			
Version No: 5.0		Date: 11/05/1012	
Project Approval	By: David Jordan In the sum of: £41,392,000	Date: 31/07/2012	
4. Defra or WAG approval <i>(Delete as appropriate)</i>			
Not Applicable		Date:	
Version No. (if different):			
Not applicable		Date:	
Comments:			

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

1.	Project name	River Roding Flood Risk Management Strategy		Start date	2001
				End date	2022
	B u s i n e s s unit	South East Region, FRM	Programme	FDGIA (Capital)	
	Project ref.	IMTH000822	Regional SoD ref.	Head Office SoD ref.	-

2.	Role	Name	Post Title
	Project Sponsor	Graham Cowell	Area & Coastal Flood Risk Manager, North East Thames
	Project Executive	Tim Chinn	Project Team Manager
	Project Manager	Peter Nicholson	Project Manager

3.	Risk Potential Assessment (RPA) Category	Low		Medium		High	
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4.	NFSoD value	£k
	Whole Life Costs (WLC) of Complex Change Project / Strategic Plan	£41,392k

5.	Required level of Environmental Impact Assessment (EIA)	N/A	Low	Medium	High
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6.	NFSoD approver name	Post title	Signature	Date
	Howard Davidson	Regional Director/Director Wales		25/07/12
	David Jordan	Director of Operations		31/07/12
	NFSoD consultee name	Post title	Signature	Date
	Ken Allison	LPRG Chair		13/07/12
	Andrew Russell	On behalf of the National Capital Programme Manager		9/12/11
	Graham Cowell	Project Sponsor		23/12/11

1 Executive summary

Submission to obtain strategy approval

South East Region: River Roding Flood Risk Management Strategy
Sponsoring Director: David Jordan – Director of Operations

Approval route:

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.

Route: National Capital Programme Manager Miles Jordan
Large Projects Review Group Ken Allison
Regional Director Howard Davidson
Director of Operations D a v i d
Jordan

1.1 Introduction and background

- 1.1.1 The Roding Flood Risk Management (RFRM) Strategy has been developed to investigate long term flood risk management (FRM) options for the River Roding catchment over a 100 year appraisal period. This Strategy Appraisal Report (StAR) presents the business case for the preferred strategic FRM approach to underpin funding applications for future schemes. It includes recommendations for both structural and non-structural measures to be undertaken either by us or by supporting third parties.
- 1.1.2 The policies outlined by the River Thames Catchment Flood Management Plan (CFMP) align with this Strategy. The CFMP policies for the River Roding include: increasing the frequency of flooding in the upper catchment through flood storage; reducing flood risk downstream; and continuing with actions to manage flood risk at the current level elsewhere. The River Roding also falls within the Thames River Basin Management Plans (RBMP) which has been produced to set out the proposed measures to be undertaken to achieve 'Good Status' in accordance with the Water Framework Directive (WFD).
- 1.1.3 This Strategy covers the River Roding from its source to the tidal limit at the A118, at Wanstead (see figure 1.1) and includes the major tributaries Cripsey Brook and Loughton Brook. The River Roding downstream of Wanstead is covered by the Barking & Dagenham Embayment FRM Strategy, the Thames Barrier and Associated Gates FRM Strategy and also by the Thames Estuary 2100 Plan.
- 1.1.4 There is a clear land use divide between the north and south of the River Roding catchment. The Upper Roding catchment (north of the M25) is predominantly rural and the bulk of the land use is given over to arable farming with only a few isolated properties. In the Middle Roding catchment, downstream of the M25, the land adjacent to the Roding is also agricultural land. The Lower Roding catchment comprises densely populated urban centres supporting a significant manufacturing and industrial base though there is still a reasonable floodplain corridor.
- 1.1.5 The catchment includes 75 areas of environmental significance (SACs, SSSIs, SNCIs, LNRs) but very few of these are situated within close proximity to the River Roding or one of its tributaries. The key sites of relevance to the Strategy are the Roding Valley Meadows SSSI and LNR, the Roding Valley Park (located in Redbridge) and the Roding itself (designated as a SNCI from Chigwell to the River Thames).

1.2 Objectives

- 1.2.1 The strategic objectives have been developed taking into consideration the objectives of our existing and potential partner organisations, and are to:

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- a) develop and implement sustainable short and long-term flood risk management options;
- b) evaluate the existing maintenance programme for the River Roding with regards to existing and future conditions;
- c) ensure that the long term goals of the Thames Catchment RBMP and WFD objectives are considered, addressed and, where possible, met in the Strategy recommendations;
- d) adopt and agree the long-term framework for flood risk management in partnership with key stakeholders; and
- e) maximise cost effective environmental and social enhancement opportunities.

1.3 Problem

- 1.3.1 The River Roding demonstrates a “flashy” response to rainfall events. This is particularly so in the Middle and Lower Roding where there is less floodplain available for storage, and a greater number of properties at risk of flooding, particularly at Woodford. This part of the catchment is heavily urbanised, with rapid run-off into the river causing the river to rise quickly and flooding to result. This was demonstrated most recently in 2000 when fluvial and pluvial flooding caused damage to over 400 properties in Woodford following a breach of the raised flood defences and overflow from the surface water storage system.
- 1.3.2 As a result the two main sources of flooding that this Strategy seeks to address is: river flooding from overtopping or failure of the existing flood defence banks; and pluvial surface water flooding. There are 1581 properties at risk of fluvial flooding in a 1% AEP (1 in 100 year) event in the No Active Intervention (Do Nothing) scenario. The main flood prone areas are Woodford, South Redbridge (Roding Lane), Ilford and Loughton.
- 1.3.3 Climate change is projected to lead to increases in rainfall that may increase the risk of fluvial and surface water flooding. The middle change factors of the 2011 guidance is not as severe in terms of increasing fluvial flows in the early part of the appraisal period compared to the 2006 guidance, however the 2006 guidance has been able to inform the option selection on a cell by cell assessment as a sensitivity test to see if option selection would change under a significant increase in flows and damages. Both the 2006 and 2011 guidance have been used to inform a strategic option selection by sensitivity testing its performance to a range of different flows and implementation timings.
- 1.3.4 The current annual maintenance budget for this area averages £285k per year with most of this attributed to maintaining channels and assets in parts of the catchment that contain few properties or infrastructure.

1.4 Options

- 1.4.1 In the earlier stages of the Strategy development a long list of FRM options was derived through consultation. From this list we selected a short list for further consideration that included: Do Nothing (implemented as Withdrawal of Maintenance (WoM)); Do Minimum (maintain channel only); Maintain (maintain channel and assets); and an option to Reduce Surface Water Flood Risk. We also considered Flood Storage on the upper catchment and resistance and resilience measures as strategic options to improve the standard of protection.
- 1.4.2 Do Minimum and Maintain options were appraised on a cell by cell basis across the 18 different flood cells in comparison to the Do Nothing baseline. The option to reduce surface water flooding was considered in Woodford only as this was the only area adjacent to the river where such flooding has occurred within the study area. We selected Shonks Mill Bridge as the best location for a strategic Flood Storage option, as it provides appropriate space for holding flood water upstream of the major conurbations in the catchment. Resistance and resilience measures were considered for any isolated properties still at significant risk post implementation of the Strategy.

1.5 Recommended Strategy

- 1.5.1 The preferred Strategy (summarised in Table 1.1) sets out the flood risk management needs of the catchment with an appropriate focus on those areas with property at risk. It comprises the following:

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- a) continued channel, conveyance, and asset maintenance on the urbanised Roding tributaries, Cripsey Brook and Loughton Brook;
- b) channel maintenance in the middle Roding flood cells;
- c) improved management of the pluvial flood risk to properties in Woodford;
- d) withdrawal of maintenance from the rural upper Roding and lengths of the middle/lower Roding, to be implemented over the first two years of the Strategy;
- e) upstream storage at Shonks Mill Bridge, to be implemented in year 10 (or before year 2040 depending upon developing climate change effects on fluvial flows).

- 1.5.2 The Strategy will reduce the fluvial flood risk to around 899 properties within the Roding catchment (upstream of the tidal limit). However, up to 15 properties in the Upper Roding could be at increased risk of flooding and up to 23 could remain at Very Significant risk. However it should be noted that this is an estimate based on current fluvial flow levels, and that Climate change predictions ranging from significant increases to moderate reductions in fluvial flows would affect these predictions. Also because the predicted changes are within modelling tolerances fewer properties may actually be affected.
- 1.5.3 *Continued maintenance.* We will continue maintenance of the channel and repairing and replacing of existing flood defence assets as required on the Cripsey Brook and Loughton Brook. Without climate change, this option will continue to provide the existing standard of protection for the assets in these areas over the 100 year strategy period. If climate change results in increased fluvial flows over that period the standard of protection will deteriorate. This is essentially a maintain Standard of Service (SoS) option as there is no allowance for climate change.
- 1.5.4 *Conveyance maintenance only.* Channel maintenance including grass cutting, weed and debris clearance (light maintenance) and, where appropriate, silt removal (heavy maintenance) would be continued through Woodford to Wanstead Weir. Except on the right bank through Woodford, flood defences in these areas would not be maintained, as the costs of continued maintenance outweigh the protection provided. Works will be undertaken to keep structures safe for users and the public as the assets deteriorate. This represents a partial withdrawal of maintenance, but also makes best use of our investment in flood risk in these cells. No properties would be flooded as a result.
- 1.5.5 *Improved management of pluvial risk.* We will work in partnership with Thames Water, Transport for London (TfL) and the London Borough of Redbridge (LBR) to implement a new surface water flood storage area (FSA) in Woodford at Dartnell's Field, Chigwell Road, along with two pumping stations to enhance the capacity of an existing FSA at Woodford Green and to handle the surface water flooding at the Charlie Brown Roundabout. In conjunction with maintaining the channel and assets in this area, this will provide an improved standard of protection to over 400 homes.
- 1.5.6 *Withdrawal of maintenance.* The rural unpopulated nature of the upper Roding, from its source in Molehill Green to just above Woodford, means there is insufficient economic justification for us to improve or continue with existing flood risk management activities over this length (53km) of the river. This is also the case for 4.5 km of the Roding in the lower part of the catchment (See Figure 1.2). Withdrawing maintenance from the upper catchment does reduce fluvial flows in the urban Roding but this mostly mitigates for the loss of defence structures. It would save us an average of £200,000 annual maintenance costs, including irregular maintenance activities such as tri-yearly dredging. It should be recognised that levels of maintenance in these low risk areas have been reducing over the last 10 years as a result of funding reductions.
- 1.5.7 *Upstream flood storage at Shonks Mill Bridge.* A climate change related increase to fluvial flows would result in a reduced standard of protection throughout the catchment. For example, in Woodford, it would fall from a 1.33% AEP (1 in 75 year) event to a 2% AEP (1 in 50 year) event, and similarly in other cells. The preferred Strategy includes upstream storage to allow us to improve the standard of protection, even under the effects of the predicted climate change impact. It provides the flexibility to adapt to future changes and the increased pressure on flood risk that these could present to the catchment. This has been tested for a range of construction periods but is recommended for construction in year 10 of the strategy. This allows for enough time to take a view on any developing climate change impacts and to secure funding.

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- 1.5.8 The new flood storage reservoir (FSR) upstream of the M25 at Shonks Mill Bridge will hold back flood waters in extreme events and thereby provide an increased standard of protection for 996 properties downstream (FC5 - 17). It will provide storage up to a 0.5% AEP (1 in 200 year) event, allowing only a 2% AEP (1 in 50 years) flood flow to pass downstream.

1.6 Economic case

Table 11 Summary of preferred strategy

Item	Cell 3* Cripsey	Cell 7	Cell 8 Woodford	Cell 9	Cell 10	Cell 11	Cell 12	Loughton Brook	Shonks Mill FSR	Resist & Resil'nce	WoM** and H&S	Total
Preferred Option	Maintain	Do Min	Improve	Do Mn	Do Min	Do Min	Do Min	Maintain	Improve	N/A	N/A	
Standard of Protection	1 in 50	1 in 20	1 in 200	1 in 200	1 in 200	1 in 200	1 in 200	1 in 20	1 in 200	N/A	N/A	
PV Costs (£k)												
Capital	175	0	6,213	0	0	0	0	2,619	3,335	0	0	12,342
Non-capital	2,453	215	1,340	63	69	72	140	897	94	295	454	6,092
Total PV Costs	2,628	215	7,553	63	69	72	140	3,516	3,429	295	454	18,434
PV Benefits (£k)	34,007	N/A	101,798	452	121	577	638	25,437	11,464	N/A	N/A	174,494
Average B/C Ratio	12.94	N/A	13.5	7.16	1.8	8	4.5	7.2	3.3	N/A	N/A	
Cash Costs (£k)												
Capital	408	0	13,667	0	0	0	0	3,674	4,785	0	0	22,533
Non-capital	8,250	722	4,592	212	232	235	473	3,008	374	300	461	18,859
Total Cash Costs	8,658	722	18,258	212	232	235	473	6,682	5,159	300	461	41,392

*Refer Figure 1.2 for cell locations. **Applies to cells 1,2,4,5,6,13,14,15,16,17 where no active intervention could be justified

1.7 Environmental and social considerations

- 1.7.1 A strategic level environmental appraisal of the short listed options is presented in the Strategic Environmental Assessment (SEA) and the SEA Addendum. Natural England was consulted about the Strategy recommendations. In summary their view is that the proposal is likely to lead to an environmentally acceptable solution and is not likely to require an appropriate assessment under the Conservation (Natural Habitats &c) Regs 1994.
- 1.7.2 An assessment of the preferred option against the Water Framework Directive objectives has been completed. This demonstrated that the recommendations made in the Strategy went some way to meeting those of the Thames RBMP and did not impede future efforts to meet the objectives. However, one potential exception was the Flood Storage Area at Shonk Mill Bridge. It was therefore necessary to address this risk by carrying out an Article 4.7 assessment to test if this element would fail to meet requirements. The favourable outcome of this assessment means that we are able to take all the economically preferred options forward.
- 1.7.3 Two drop-in sessions were also held: one at Ongar Town Council, Chipping Ongar, and one at Broadmead Baptist Church, Chigwell Road, Woodford Green. There was support from the residents in Woodford but concerns from those that lived in the upper reaches of the catchment.
- 1.7.4 The Strategy implementation plan is to give 2 years notice to Riparian Owners of the intention to withdraw maintenance as supported by our legal team. Where an expectation exists for us to continue to sustain a certain standard of service (SoS) by residents and riparian owners, the 2 year period will enable us to inform those affected of their responsibilities, allow them to adapt and change their expectations. This period is supported by Defra guidance, "Protocol for the maintenance of flood and coastal risk management assets" published in November 2011). Initial efforts during the 2 year period will focus on disseminating information and working with land and properties

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owners to manage the change in river management. Beyond this we will start to plan for the cessation of activities and continue to support the needs of the affected parties. We will continue to work with property owners who are worse or off qualify for individual property protection funding to help this to be obtained and implemented.

1.8 Risks to the Strategy

Table 12 High Level Risk Schedule and Mitigation

Key Project Risk (and Where)	Category	Risk* Owner	Adopted Mitigation Measure
Risk of funding shortfall for the Woodford Scheme and partnership funding issue	Funding	EA/L BR	Project team have support and commitments from LBR to exhaustively seek sources of funding, both within their own budgets where possible and from external sources. TFL and Thames Water are both beneficiaries and have been open to further contribution discussions. The team have presented options to RFCC and received support which may be revisited should further funding be sought.
No partnership funding provided for FSR upstream of Shonks Mill Bridge (Shonks Mill FSR)	Funding	EA/LBR	Ongoing liaison with RFCC who are considering this FSR as a potential candidate for funding. Thames Water may contribute to providing the bund around the STW. LB Redbridge are adding the project to their CIL register and continue to seek further funding opportunities.
Public and local opposition to the Strategy. (ALL)	WoM	EA/LBR	Public consultation throughout the strategy process has reduced risk. All those predicted to be worse off have been informed and discussions have taken place. All are willing to work with us to help them reduce risks. No significant issues were raised during the consultation. Communications, including meetings have taken place with the Ilford golf club and will continue as we look to hand over assets.
Riparian land owners decide to implement channel management of upper catchment, increasing potential downstream flows.	WoM	EA	The team assessed the risk of the likely intervention by riparian owners and decided that due to the relatively minor changes in floodplain extent and frequency, this would be limited to householders in limited locations and would have no affect on the downstream areas.
Landowners not maintaining assets that have been transferred back to them including maintaining a free passage for flood water	WoM	Riparian Owners	Inform riparian owners of liability in accordance with advice from legal; make sure that suitable and sufficient legal agreements are in place. Hydraulic modelling and economic appraisal has considered what if scenarios of landowners maintaining in areas of Do Nothing.

*Environment Agency (EA), London Borough of Redbridge (LBR), Regional Flood and Coastal Committee (RFCC)

1.9 Contributions and funding

- 1.9.1 The preferred options offers the opportunity to work in partnership with other organisations, principally LBR, who wish to lead on the Woodford project from design stage. Other significant organisations include Thames Water and TfL.
- 1.9.2 The Woodford scheme has already secured £200k of local levy funding from RFCC sources. In addition, the local authority is contributing land with an estimated value of £30k for the Woodford FSA and the pumping station, and will operate the scheme in the long term. Based on the aforementioned secured contributions, funding calculations for the scheme (without climate change) show that the Woodford scheme achieves a score of 101%.
- 1.9.3 Further to contributing land and maintenance resources LBR is bidding for funding. In the first instance they have bid for £500k from the Mayor of London's 'Outer London Fund'. The Outer London Fund is a three-year initiative dedicated to strengthening the vibrancy and growth of town centres and surrounding areas. It is believed that improved flood protection for Woodford would help regenerate the Woodford Green area of Redbridge. A contribution of this magnitude would provide a 120% funding score for the Woodford project.
- 1.9.4 Timing is significant regarding potential contributions for Shonks Mill FSR with implementation most cost effective from 2020 to 2040. Obtaining firm contributions with this timeline is difficult but, the project has been presented to RFCC and they are bearing it in mind as a possible candidate for funding. Additionally, the London Borough of Redbridge have stated that this will be added to their new Community Infrastructure

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Levy register and to seek funding where possible. Over the next few years we must ensure we make best use of the time available to explore funding options outside of FDGiA from private, public and voluntary organisations and communities who will benefit most from this work. This element of the Strategy is therefore subject to funding availability. The FDGiA funding calculator score for the Shonks Mill works is 25.7%

- 1.9.5 Completion of individual property measures will also depend on a number of factors, including funding, planning permission, partnership working and, significantly, public support. Maintaining good and trusting relationships with local stakeholders will be key in encouraging them to invest in their own flood risk management schemes individually or in small communities.

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1.10 Directors Briefing Paper

Region:	South East	Project Executive:	Tim Chinn		
Function:	Flood Risk Management	Project Manager:	Peter Nicholson		
Project Title:	River Roding Strategy			Code:	IMTH000822
NEECA Consultant:	Black & Veatch	NCF Contractor:	n/a	Cost Consultant:	n/a
The Problem:	Strategic review of the Rover Roding Catchment. Key risk area is Woodford where a dual fluvial / pluvial flood risk exists in 5% AEP events. Also many rural stretches of the river are maintained with little potential benefit.				
Assets at risk from flooding:	1581 properties at risk of fluvial flooding in a 1% AEP (1 in 100 year) event in the No Active Intervention (Do Nothing) scenario, along with key roads (South circular).				
Existing standard of flood protection:	5% to 1.3% AEP (1 in 5 to 1 in 75 year) event	Proposed standard of flood protection:	1.3% to 0.5 % EAP (1 in 75 to 1 in 200 year) event		
Description of proposed scheme:	The recommendations of the Strategy consist of Withdrawal of Maintenance with associated Individual Property Protection, constructing a local Flood Storage Area and Pumping Stations (Woodford) and, in the medium term, a strategic Shonks Mill Flood Storage Area				
Costs (PVc): (100 year life inc. maintenance)	£18.5m	Benefits: (PVb)	£ 174.5m	Ave. B: C ratio: (PVb/PVc)	9.4
NPV:	£ 156m	Incremental B: C ratio:	n/a	Whole life cost (cash value):	£41.4m
Choice of Preferred Option:	Withdrawal of Maintenance on upper and lower study area Individual Property Protection in areas with withdrawal of maintenance Local Flood Storage Area and Pumping Stations (Woodford) Up Stream Shonks Mill Flood Storage Area				
Total cost for which approval is sought:			£ 41,392k inc £12,800k contingency		
Delivery programme:	Withdrawal of Maintenance carried out: mid 2014 Individual Property Protection installed by: mid 2012 Local FSA and Pumping Stations at Woodford constructed: mid 2013 Up Stream Shonks Mill FSA constructed: 2022 - 2042				
Are funds available for the delivery of this project?			Yes		
External approvals:	London Borough of Redbridge, Natural England, and English Heritage have agreed the Strategy				
Outcome measures	OM2 Woodford: 406 properties OM2 Shonks Mill: 899 properties Overall FDGiA calculator Woodford: 101% (incl. currently secured contributions) Overall FDGiA calculator Shonks Mill FSA – 25.7%				

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Figure 1.1 Plan of Study Area

(To be inserted – sent separately due to file size – refer Figure 1 Appendix C)

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Figure 1.2 Plan showing preferred Strategy

(To be inserted – sent separately due to file size – refer Figure 3 Appendix C)

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2 Introduction and background

2.1 Purpose of this report

- 2.1.1 The Roding Flood Risk Management (RFRM) Strategy has been developed to investigate long term flood risk management (FRM) options for the River Roding catchment. This Strategy Appraisal Report (StAR) presents the business case for the preferred strategic FRM approach to underpin funding applications for future schemes. It includes recommendations for both structural and non-structural measures to be undertaken either by the Environment Agency or by supporting third parties.
- 2.1.2 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. A strategic approach is required as the problems are long-term and large-scale, with inter-connected benefit areas. The period of strategic appraisal is 100 years.

2.2 Background

Strategic and legislative framework

- 2.2.1 The policies outlined by the River Thames Catchment Flood Management Plan (CFMP) align with this Strategy. The CFMP policies for the River Roding include: increasing the frequency of flooding in the upper catchment through flood storage; reducing flood risk downstream; and continuing with actions to manage flood risk at the current level elsewhere.
- 2.2.2 The Water Framework Directive (WFD), implemented in England and Wales by the Water Environment (WFD) (England and Wales) Regulations, aims to ensure that by 2015 all water bodies (in England and Wales) achieve 'Good Status'. River Basin Management Plans (RBMP) have been produced to define the current status against the define criteria and set out the proposed measures to be undertaken to achieve 'Good Status'. Any new activities to be undertaken within the water environment need to take into account the WFD to reduce any potential negative impact on the water 'status' and to seek out opportunities to enhance the 'status'. The Roding falls within the Thames RBMP. The strategic flood risk management options were agreed in 2009 prior to the requirement for WFD assessments and therefore an assessment has been undertaken retrospectively. Section 6 provides a summary of the WFD assessment (The assessment is included the SEA ER Addendum in Appendix J).
- 2.2.3 Further information on the relevant legislation, policy and plans can be found in the SEA (2006) in Appendix J and the subsequent SEA ER Addendum (2011) also found in Appendix J (The addendum was prepared to cover such issues as potential for environmental and social enhancements, retrospective assessment of the options against the Water Framework Directive (WFD), and updates the policy and baseline sections).
- 2.2.4 Works identified by the Strategy will be implemented using powers under Section 165 of the Water Resources Act 1991. The fluvial flood storage areas will be designed and constructed in accordance with the Reservoirs Act 1975 (as amended), our Fluvial Design Guide and the Flood and Water Management Act 2010. All new works will be subject to the Town and Country Planning Regulations and will be screened on the need for statutory Environmental Impact Assessment (EIA). Other consents that may be required include consent to temporarily divert Public Rights of Way, Discharge, Flood Defence and Impounding Licence Consent.

Previous studies

- 2.2.5 In 2006 we published a River Restoration Strategy for all river catchments in north London, including the River Roding, which aims to identify areas of restoration opportunity. Subsequently a backwater has been created for a reach of channel between Loughton and Redbridge.

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2.2.6 We have been involved in the following partnership projects within the study area that aim to improve recreational amenity and provide ecological enhancements associated with the river and its corridor. The aims of these partnership projects have been considered in developing the environmental objectives of the RFRM Strategy.

a) East London Green Grid (led by Design for London): Aims to create, improve, manage and maintain high quality green infrastructure in East London for wildlife and enhanced public recreation and enjoyment. One such scheme is considering enhancements at land opposite Wanstead Park.

b) London Rivers Action Plan (led by The River Restoration Centre): This plan provided a delivery mechanism for taking forward London's river restoration strategies for the benefit of people, businesses and wildlife. Along the River Roding, including its tributaries and the Lower Roding, thirteen projects have been completed (The River Restoration Centre, 2009 and The River Restoration Centre website). This has included backwater creation and improvements to enhance biodiversity at Ray Lodge Park, Redbridge.

2.2.7 Partnership projects been explored, in particularly with London Borough of Redbridge. It is anticipated that we will continue to work towards delivering enhancements, particularly as part of the projects coming out of the strategy, using those already identified and included within this document.

Location and designations

2.2.8 The River Roding is approximately 45km in length and rises at Molehill Green (National Grid Reference 556550, 220920) situated to the east of Stansted Airport and to the west of Great Dunmow. The river runs through the Essex districts of Epping and Uttlesford and the London Boroughs of Redbridge, Newham and Barking, before discharging into the Thames at Barking Creek (National Grid Ref 545650, 181670). This Strategy covers the River Roding from its source at Molehill Green to the tidal limit at A118, just west of Ilford town centre (National Grid Reference 543205, 186383) (see Figure 1 in Appendix C). The River Roding downstream of Ilford is covered by the Barking & Dagenham Embayment FRM Strategy and also by the Thames Estuary 2100 Plan. The Barking Barrier itself is included within the Thames Barrier and Associated Gates FRM Strategy.

2.2.9 The River Roding has several tributaries entering it (see Figure 2 in Appendix C) and a high level assessment has been undertaken to identify which are appropriate to include in economic appraisal of the Strategy. This is summarised in Table 21. Maintenance of these tributaries is the responsibility of the riparian owners.

2.2.10 The study area is shown on Figure 1 in Appendix C. The river (and its floodplain) is split for hydraulic modelling into the Upper Roding (upstream of the M25 to the source), Middle Roding (between the M25 and Wanstead) and Lower Roding (downstream of Wanstead to the confluence with the River Thames), as shown on Figure 1.2 and Figure 3 in Appendix C. In the urban areas (Middle and Lower Roding) we have used the 0.2% AEP (1 in 500 yr) No Active Intervention flood extent (plus a buffer of 50m to ensure property on the periphery of the flood extent is included) to define the extent of the study area, excluding the reach south of Ilford. While for the rural upper Roding we have used the 0.5% AEP (1 in 200 yr) No Active Intervention flood extent (plus a buffer of 50m). For budgetary and management purposes, the River Roding has been further split into asset systems to define stretches of the river of similar function and management needs and, for the Strategy, some of these systems have been further sub-divided into flood cells along topographical features (see Figure 1.2 and Figure 3 in Appendix C).

Table 21 Tributaries to the River Roding (north to south)

Tributary	Included in Strategy? (Yes/No)	Reason for Inclusion / Exclusion
Strood Hall Brook	No.	Low risk of property flooding
Coopers Brook	No.	Low risk of property flooding
Miller Green Brook	No.	Low risk of property flooding
Clattersford Brook	No.	Low risk of property flooding
Cripsey Brook including Shonks Brook and Thornwood Common Brook	Yes.	A major tributary with significant flood risk and several major assets
Stondon Hall Brook	No.	Low risk of property flooding

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Standford Hall Brook	No. Low risk of property flooding
Lambourne End Brook	No. Low risk of property flooding
Brookhouse Brook including Ivy Chimney Brook and Garnish Hall Brook	No. Low risk of property flooding
Little London Brook	No. Low risk of property flooding
Pyrles Brook including Loughton Hall Farm Ditch	No. Low risk of property flooding
Loughton Brook	Yes. A tributary with significant flood risk
Overflow Brook	No. Low risk of property flooding
Chigwell Brook including Grange Hill Brook	No. Low risk of property flooding
Ashton Brook	No. Low risk of property flooding
Wells Brook	No. Low risk of property flooding
Cranbrook	No. Significant tributary with FSA. To be reviewed in separate appraisal. As this was en-mained at a late stage of the Strategy.
Alders Brook	Yes. Part of FC14
Loxford Water	Outside of study area

2.2.11 There is a clear land use divide in the River Roding catchment: the Upper Roding (north of the M25) is predominantly rural with the majority of the land being classified as high quality Grade B or C agricultural land according to the Defra Agricultural Land Classification system with potatoes, cereals and oil seed rape being the main crops produced. For the Middle Roding, downstream of the M25, the land adjacent to the river is designated as low quality agricultural land. The Lower catchment comprises densely populated urban centres supporting a significant manufacturing and industrial base.

2.2.12 In the Upper Roding, the main urban areas are Fyfield, Thornwood, North Weald Bassett, and Chipping Ongar. Along the middle and lower reaches, the Roding passes through east London and the increasingly urban areas of Abridge, Loughton, Chigwell, Woodford, Wanstead and Ilford.

2.2.13 The most recent physical changes to the Roding and its valley have been due to:

a) Construction of M11 from Chigwell to Wanstead (1970's): As part of these construction works the River Roding was straightened and realigned in FCs 11/12 and 13/14 and as a result the river is now in a concrete engineered channel at this location. The aim of this design was to evacuate flood waters from this area downstream as quickly as possible. In addition, the motorway is on a raised embankment where it crosses FCs 13 and 15, which will provide protection to the properties located behind should the river flood defence be overtopped or fail. This is owned and maintained by Transport for London.

b) River Roding Flood Alleviation Scheme (1980's): This included works at Wanstead, Woodford and Abridge.

c) Barking Barrage (1990's): Although outside of the study area, the construction of the Barking Barrier prevents the progression of tidal waters upstream.

d) Implementation of two flood storage areas at Thornwood (Cripsey Brook) in the 1990's.

2.2.14 Several major roads lie within the floodplain, including the A113 (Chigwell Road) and the M11/A406 junction through Woodford. All rail infrastructure is situated outside the floodplain or on embankments that are not susceptible to flood risk.

2.2.15 While the catchment includes part of a Special Area of Conservation (SAC), seven Sites of Special Scientific Interest (SSSIs), eight Local Nature Reserves (LNRs) and over sixty Sites of Nature Conservation Importance (SNICIs), very few of these are situated within close proximity to the River Roding or one of its tributaries. The key sites of relevance to the Strategy are the Roding Meadows SSSI, Roding Valley Meadows LNR, the Roding Valley Park (located in Redbridge) and the Roding itself (designated as a SNCI from Chigwell to the River Thames). There are some key Biodiversity Action Plan (BAP) Habitats in close proximity to the river. Large areas of agricultural land in the upper catchment are under Environmental Stewardship Agreements (ESAs) and under the old Countryside Stewardship Agreements.

History of Flooding

- 2.2.16 Flood events have been recorded on the River Roding since 1926 (records of flooding before this date are not readily available). The largest flood event occurred in 1947 which was an estimated 1% annual exceedence probability (AEP) or 1 in 100 years return period event. Other events have occurred in 1939, 1974 and 1988, 1993, 2000 and 2007. In 1993, 186 properties were flooded in Thornwood and North Weald Bassett.
- 2.2.17 The most recent significant flooding of the Roding was in October 2000, with an estimated 1.4% AEP (1 in 71 years). Flooding to properties was particularly significant in Woodford where over 300 properties were affected. Properties were also affected in other areas including Hillmans Cottages and Boxted Close. The flood mechanisms in October 2000 were:

- Flood water overtopping the flood defences (at low points of banks at Woodford); and
- Insufficient drainage of urban rainfall runoff due to high river water levels preventing drainage to the river, leading to the back up of surface water drainage (in Woodford).

- 2.2.18 The most recent event occurred in February 2009 when surface water run-off was stored in the existing Woodford Allotments flood storage area next to the Winn Brook (no properties were flooded).

2.3 Current approach to flood risk management

Measures to manage the probability of flood risk

- 2.3.1 There are no formal flood defences on the River Roding north of the M25, but there are some localised defences and flood storage on the Cripsey Brook tributary. Between the M25 and Woodford there are some localised defences and flood storage on the Loughton Brook. There is some flood water storage in Woodford (Ray Park FSA) and raised defences (or natural high ground) through Woodford and all the way south to the southern boundary of our study area. The majority of the raised floodbanks on the River Roding have, on average, an estimated residual life of 15 years. Some are significantly lower and require immediate action should they need to be sustained (see Appendix D).
- 2.3.2 Surface water runoff within Woodford enters the local drainage network, which discharges to the river under gravity. Flap valves on these drains prevent the river water entering the drainage network. The drainage network in Woodford was designed to accommodate between a 5.0% AEP (1 in 20yr) and 3.3% AEP (1 in 30yr) rainfall event with some in line culvert sections providing flood storage under Ray Park. There is also an FSA on Woodford Green, Chigwell Road connected to the Winn Brook outfall.

The current standard of protection (CSoP) for each flood cell is set out in

- 2.3.3 Table 22. It is important to remember that the river management regime strongly impacts on the number of properties protected by the structures listed.

Table 22 Current Standard of Protection (CSoP) by flood cell

Flood cell	Watercourse	Existing Defences	Existing CSoP, by AEP for onset of flooding	No. properties protected
1+2	Upper Roding (u/s Cripsey Brook)	Some minor informal embankments, created with river clearance material	>10% (<1 in 10 yr)	N/A
3	Cripsey Brook	Some formal embankments. 2 flood storage areas on the Cripsey Brook and 2 more on its tributary, the North Weald Brook	>2% (1 in 50 yr)	127
4	Upper Roding	None	<0.5% (>1 in 200 yr)	N/A
5	(Cripsey Brook to M25)	Wall and embankments at Passing ford Mill	>10% (< 1 in 10 yr)	3
6	Middle Roding	Wall at Boxted Close and several major culverts	5% (1 in 20 yr)	6
7		Some raised defences and flap valves on tributaries	5% (1 in 20 yr)	7
8		Raised flood defence embankments and walls, flood storage area	1.3% (1 in 75 yr) fluvial; 5% (1 in 20 yr) pluvial	1688 322

9	Middle Roding (M25 to Wanstead)	Raised flood embankment	1.3% (1 in 75 yr)	N/A (M11)
10		Raised flood embankment	0.5% (1 in 200 yr)	38
11		Raised flood embankment and concrete lined channel	1.3% (1 in 75 yr)	30
12		Raised flood embankment	10% (1 in 10 yr)	3
13	Lower Roding (Wanstead to Ilford)	Raised flood embankment/wall	1.3% (1 in 75)	0 (Golf Club)
14		Raised flood embankment	20% (1 in 5)	0 (Wanstead Park)
15		Raised flood embankment/wall	1% (1 in 100 yr)	9
16		Raised flood embankment	1.3% (1 in 75)	0 (Golf Club)
17		Raised flood embankment	1.3% (1 in 75)	0 (Golf Club)
1LB	Loughton Brook	Raised flood embankment and wall, FSA and concrete lined channel and culverts	5% (1 in 20 yr)	79

- 2.3.4 On the Upper and Middle Roding irregular maintenance (such as clearing fallen trees, channel clearance and occasional dredging in Abridge) is undertaken to allow the river to develop naturally and to restrict flood flows downstream by temporarily storing flood water on the open floodplains. This costs the Environment Agency over £150,000 per year. Over the last 10 years these activities have been reducing and this cost is lower than that allocated in past years. On the lower Roding more frequent maintenance (activities include bank repairs, new localised flood banks, vegetation clearance / debris removal and dredging / siltation removal at Woodford) is undertaken to maximise the channel capacity to pass flood flows quickly, while maintaining an environmentally acceptable approach in accordance with the London Rivers Action Plan.
- 2.3.5 The local authority currently operates and owns several flow control assets (including flap valves in to the River Roding) and defences, particularly on the smaller tributaries of the river.

Measures to manage the consequences of flood risk

- 2.3.6 The study area is covered by an existing flood warning system. Currently 2,076 properties within the Roding catchment (which extends southwards of our study area to the River Thames) are registered with Flood Warnings Direct.
- 2.3.7 Epping District Council Emergency Planning department operates an 'Emergency Response Plan'. As this is the location where several properties may remain at significant flood risk this will be updated to address the Roding Strategy recommendations. Our own Flood Incident Management department will also work with the affected residents to develop Personal Flood Plans. They were made aware of this during the consultation period.

3 Problem definition and objectives

3.1 Outline of the problem

Current Flood Risk

- 3.1.1 The River Roding is underlain by impermeable London Clay along most of its length, and therefore any rainfall tends to flow over the surface rather than soak into the ground. As a result the catchment tends to demonstrate a “flashy” response to rainfall events and is prone to flooding after large storm events and / or prolonged periods of heavy rainfall. The Upper Roding catchment is very rural and the natural floodplain copes well with the flood water following heavy rainfall (although there are a small number of properties at high risk of flooding in this upper section). However, further south in the Middle and Lower Roding where there is less floodplain available for storage, there are a greater number of properties at risk of flooding, particularly at Woodford. This part of the catchment is heavily urbanised, which means that the water flows very quickly into the river (either as surface run off or through man-made drains) causing the river to rise rapidly and flooding may result.
- 3.1.2 There are two main sources of flooding that this StAR seeks to address:
- a) River flooding: overtopping or failure of the existing flood defence banks; and
 - b) Pluvial/Surface Water flooding (in Woodford only): following intense rainfall over heavily urbanised areas, surface water runoff is not able to drain via gravity to the river as the flap valves to the drainage outfalls are submerged by the higher river water levels. This causes surface water to back up in the drainage system and flood urban areas via manholes.
- 3.1.3 Table 22 shows the CSoP provided by the existing defences. For many flood cells the CSoP is at a reasonable level for the highly urbanised nature of the Middle and Lower Roding. The significant exception being the pluvial SoP for Woodford. In 2000 pluvial sourced flooding caused flood damage to around 400 properties in this area. Despite there being some acceptable defence standards, many of the defences are nearing the end of their useful life and will need replacing in the short term. Some defences, in particular at Woodford, Redbridge and Wanstead (FC7, 8, 9, 11, 13, 15, 16, 17) have a residual life of less than 10 years. Replacing these defences has a potential cost of up to £3 million which is significant when reviewing the assets they protect.
- 3.1.4 Development within the floodplain of the Lower Roding has reduced the overall capacity of the surface water drainage system and has led to a reduced standard of protection overall to about 5% AEP (1 in 20 years). Inappropriate development in the floodplain is less likely to happen today due to the introduction of Planning Policy Statement 25 (Development and Flood Risk). After the 2000 flood event, Thames Water agreed to work with us in partnership, along with London Borough of Redbridge, to resolve pluvial flooding risk in Woodford.

Future Flood Risk

- 3.1.5 Following Defra’s October 2006 guidance on climate change, the effects of a 20% increase in river flows arising from climate change have been considered. Further analysis has been undertaken following Defra’s revised climate change guidance ‘Adapting to Climate Change’ published in September 2011. The 2011 guidance recommends including climate change, in terms of increased fluvial flows, in the base case study rather than a simple sensitivity test. As the 2011 guidance is not as severe in terms of increasing fluvial flows in the early part of the appraisal period compared to the 2006 guidance, the 2006 guidance has been able to inform the option selection on a cell by cell basis, whilst both the 2006 and 2011 guidance have been used to inform the strategic option selection.
- 3.1.6 The 2006 guidance has the effect of doubling the frequency of occurrence of a given flood flow and increases the number of properties at risk in a 1% AEP (1 in 100 year) event by approximately 30% over the lifetime of the Strategy (refer to Table 31 for more

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information). Future increases in rainfall as a result of climate change will also increase the risk of surface water flooding. To sustain a 1% AEP (1 in 100 year) standard of protection with a 20% rise in flood flows will require defences that are capable of providing a 0.5% AEP (1 in 200 year) standard of protection with the currently adopted flood flows.

- 3.1.7 The 2011 guidance has a more moderate increase in fluvial flows for the Thames Region with around a 20% increase not occurring until 2040 (as opposed to 2025 in the 2006 guidance). This is an important consideration for the option selection.
- 3.1.8 In terms of future development within the catchment, the local planning authorities have indicated that any development (including any expansion of Stansted Airport) that would cause a direct risk of flooding or increase flood risks elsewhere will be refused.
- 3.1.9 The catchment is expected to continue to be protected against tidal flooding as sea levels rise by the continued operation of the Barking Barrier to the south of our study area (as recommended in the Thames Barrier and Associated Gates Strategy and TE2100).
- 3.1.10 We have consulted Drain London to determine the nature of surface water flood risk management proposed for urbanised areas in the London Borough of Redbridge. Apart from trying to attenuate surface water with the use of more green space one of the main strategies being adopted is to direct surface water to watercourses.

3.2 Consequences of doing nothing

- 3.2.1 Without the continued maintenance of the existing flood defence assets, failures of the existing defences would be expected within the next 10 years. Even with the current defences in place, some regular flooding, particularly in the urban areas of the Lower Roding will continue, and will increase in the future with climate change impacts.
- 3.2.2 In the Roding strategy study area there are 1581 properties at risk of fluvial flooding in a 1% AEP (1 in 100 year) event in the No Active Intervention (Do Nothing) scenario. The main flood prone areas are Woodford, South Redbridge (Roding Lane), Ilford and Loughton, which cover 1337 properties within Flood Zone 3, whilst the remaining 244 properties are largely located in the upper and middle parts of the catchment. Table 31 provides further information on the assets at risk in each flood cell.
- 3.2.3 Without a coordinated approach with the local authorities and Thames Water on issues associated with surface water flooding in the Woodford area, regular flooding through this mechanism will continue.
- 3.2.4 With many properties at significant risk of regular flooding, individual property owners will struggle be able to obtain insurance against flooding and this will lead to reduced investment and general decline of the area.
- 3.2.5 If defence structures are abandoned in areas which are not intensely urbanised we have the potential to save over £200k annual maintenance costs and significant replacement and remediation coats.
- 3.2.6 Many isolated properties are at significant risk in the rural areas of the catchment with little chance of a viable capital works solution. Resistance and resilience measures may be the only solution for such properties.

Table 31 Properties at Risk from a 1% AEP (1 in 100 year) Event

Flood cell	Assets at Risk from 1% AEP event			Assets at Risk from 1% AEP event, with climate change		
	No. of residential property	No. of non-residential property	O t h e r significant assets	No. of residential property	No. of non-residential property	O t h e r significant assets
1 & 2	20	1	-	25	1	-
3	190	16	-	211	20	-
4	0	0	S e w a g e Treatment Works	0	1	S e w a g e Treatment Works
5	15	2	-	15	2	-
6	26	1	-	30	1	-

Flood cell	Assets at Risk from 1% AEP event			Assets at Risk from 1% AEP event, with climate change		
	No. of residential property	No. of non-residential property	O t h e r significant assets	No. of residential property	No. of non-residential property	O t h e r significant assets
7	23	11	-	25	11	-
8	897	15	2 Sub station Gas storage tank North Circular, 2 A-roads	906	15	2 Sub station Gas storage tank North Circular, 2 A-roads
9	0	0	M11	0	0	M11
10	0	0	-	0	0	-
11	41	0	Sub station	44	0	Sub station
12	4	3	-	5	3	-
13	0	0	-	0	0	-
14	0	0	Wanstead Park	0	0	Wanstead Park
15	14	0	T f L R o a d Embankment	15	0	T F L R o a d Embankment
16	0	0	Golf Club	0	0	Golf Club
17	0	0	Golf Club, Network Rail Embankment	0	0	Golf Club, Network Rail Embankment
LB	176	23	-	210	23	-

3.2.7 Several key roads, electricity substations and a sewage treatment works are at risk of flooding in the catchment. This is particularly significant in Woodford as a key interchange on the London North Circular and several A roads are affected by both pluvial and fluvial flooding. In 2000 Chigwell Road (A113) and the Charlie Brown Roundabout (A1400) were both forced to close due to flooding.

3.3 Strategic issues

3.3.1 Due to the flashy nature of the catchment, changing the flood risk in one part of the river is likely to lead to changes in flood risk elsewhere. Whilst we have split the catchment into separate 'flood cells' which have been addressed individually, it is not possible to adequately understand the flood risk needs and consequences of the whole study area in this way. A strategic approach is therefore required to ensure a coordinated action plan is in place to tackle flood risk going forwards. By taking an overall strategic approach we can ensure that we do not, as far as is reasonably possible, adversely impact other communities and the environment.

3.3.2 The study area is divided into 17 flood cells as shown in Figure 3 of Appendix C. These have been split using 2 methodologies depending upon the nature of the area. In the urban areas the floodplain has been separated into hydraulically separate areas which would flood independently of one another. This has been done so that defences and interventions are justified only by the benefits they provide. There is no interconnection between the flood cells and boundaries are dictated by topography and barriers to flood flows. In the rural areas the System Asset Management Area boundaries have been used. In these areas the floodplain is wider, interconnected and no defences exist. Justification of the channel maintenance regime is more significant in these areas. However, as explained above, flood risk management activities have the ability to change flood risk management at other locations and effects of this nature have been accounted for in the development of the preferred Strategy.

3.3.3 The preferred Strategy has been developed in accordance with the aims and objectives of the local CFMP and the Thames RBMP. This is covered in greater detail in the SEA and SEA Addendum (See Appendix J).

3.4 Key constraints

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Legal constraints

- 3.4.1 It is not possible for us to continue to invest public funds into flood defences that have been shown to be uneconomic (i.e. the costs of protection are greater than the benefits), unless there is an overriding reason for protection such as withdrawal from flood risk management would increase the risk to an internationally designated environmental asset. In some flood cells within our study area where there is insufficient economic justification and limited environmental risk from flooding we will seek to discontinue maintenance of the existing assets. Although there is no legal right to a flood defence, many flood defences would have been in place and maintained for many years, and landowners / property owners may have assumed that this would continue indefinitely. Withdrawal from any existing flood defence therefore needs to be handled sensitively and guidance has been developed to assist flood risk managers in this process. Although there is no provision for financial compensation in such circumstances, we endeavour to ensure that those affected are aware of the increased risk and the options available to them. In some cases, we may transfer the maintenance of an asset to a landowner. A period of notice is generally given (usually two years) from the point at which the decision to withdraw was communicated to the landowner / property owner to the time of the actual withdrawal to enable those affected to adjust to the new arrangements.
- 3.4.2 Where our positive actions (as opposed to “doing nothing”) lead to the increased risk in flooding locally or elsewhere, then we may have a legal obligation to compensate or provide protection to a standard at least commensurate with that in place previously (although this protection may be provided by an alternative means such as property level flood protection and / or resilience measures).
- 3.4.3 Any flood storage areas (existing or new) need to be managed in accordance with the requirements of the Reservoirs Act 1975 and the Flood and Water Management Act 2010 (once implemented).

Funding constraints

- 3.4.4 It is likely that any works arising from this Strategy will fall under the new Flood and Coastal Resilience Partnership Funding, “partnership funding”, mechanism meaning that a funding plan will therefore become an integral part of the developed action plan.

Environmental Constraints

- 3.4.5 A non-statutory Strategic Environmental Assessment (SEA) has been undertaken in parallel with the technical and economic considerations during the development of the Strategy (see Appendix J). The baseline environment is described in the SEA Environmental Report with updates in the SEA ER Addendum (both in Appendix J). The key environmental constraints are:
- 3.4.6 *Abstractions, Discharges and Water Quality:* Surface water abstractions are largely for agriculture. There are over 300 consented discharges in the River Roding catchment, the most significant being from Thames Water sewage treatment works. General Quality Assessment scheme identifies the water quality of the Roding and its tributaries as being very good in the northern part of the catchment, decreasing to fair in lower reaches.
- 3.4.7 *The Water Framework Directive - Heavily Modified Water Bodies:* The Roding (Upper Roding to Norton Ditch) and Roding (Cripsey Brook to Loxford Water) are assessed as being ‘Highly Modified Water Bodies’ (HMWBs). Under the WFD a heavily modified waterbody needs to meet Good Ecological Potential rather than good ecological status. Mitigation measures are used as a proxy to determine the potential of the waterbody. The strategy must not reduce the overall Ecological potential of a waterbody or prevent the implementation of mitigation measures at a later date. The WFD must be taken into account when planning all new activities in the water environment.
- 3.4.8 The Roding Strategy study area contains six waterbodies as identified in the Thames River Basin Management Plan. On four waterbodies, forming tributaries of the Roding, no changes are proposed to the rivers or the current maintenance regimes.

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- 3.4.9 The Roding is split into two waterbodies, separated at the Cripsey Brook. Both of these are classified as being heavily modified. It is only on the course of the Roding itself where any changes are proposed. The Roding (upper Roding to Norton Ditch) Waterbody has moderate potential and has four Biological quality elements (BQEs) that are at moderate status. Achievement of 'Good Ecological Potential' (GEP) is determined by the implementation of mitigation measures, 40% of which are currently in place. The Roding (Cripsey Brook to Loxford Water) Waterbody has poor potential and has five BQEs that are at either moderate or poor status. Achievement of GEP is determined by the implementation of mitigation measures, 43% of which are currently in place.
- 3.4.10 *Flora and Fauna:* A small part of the Epping Forest Special Area of Conservation (SAC) lies within the catchment at Chingford, although it is well outside the Roding floodplain and therefore unlikely to be affected by flood risk management. Only four of the Sites of Special Scientific Interest (SSSI) within the catchment lie adjacent to or in close proximity to the Roding or one of its tributaries. In particular, the Roding Valley Meadows SSSI, situated adjacent to the Roding south of Loughton, is the largest surviving area of traditionally managed river-valley habitat in Essex. Two key Sites of Nature Conservation Importance (SNCI) for this study are the Roding itself from Chigwell to the mouth of the river and the Roding Valley Park within Redbridge. Biodiversity Action Plan (BAP) habitats are located along the Roding in certain locations, for example floodplain grazing marsh is located from the M25 motorway to the Roding Valley Meadows. BAP species are also present in the catchment, particularly water voles that are prevalent throughout the middle reaches from Chipping Ongar to Wanstead. The Cripsey Brook and the Roding upstream of Passingford Weir are designated as Cyprinid fisheries.
- 3.4.11 *Recreation:* The catchment is popular for a wide variety of recreation types such as walking, cycling, canoeing and angling. There are several land based recreational facilities located adjacent to the river, such as golf courses at Abridge and Wanstead Park and sports grounds at Ray Park and Woodford Bridge. There is club fishery along the Roding, between Passingford Bridge and Loughton, but informal free fishing is also permitted.
- 3.4.12 *Landscape:* The Roding valley within Essex is locally designated as a 'Special Landscape Area' and part of the catchment within the Epping district is located within a green belt.
- 3.4.13 *Contaminated land:* The long history of industrial activity in the lower reaches of the Roding has left some areas of land potentially contaminated.
- 3.4.14 *Cultural heritage:* The River Roding catchment contains over 20 Scheduled Monuments, although only a few of these are situated in close proximity to the river. The land adjacent to the river holds a wealth of archaeological remains, particularly in the lower reaches. There are nine landscape conservation areas adjacent to the Roding and its tributaries. The main Conservation Areas are located at Moreton and Chipping Ongar on the Cripsey Brook and Abridge, Chigwell, Woodford and Wanstead Park on the Roding. There are four historic parks and gardens in the River Roding catchment: these include two near Loughton, one at Chipping Ongar and part of Wanstead Park in Wanstead. Listed buildings are located in close proximity to the River Roding intermittently throughout the catchment, particularly within Chipping Ongar, Abridge and Woodford.

3.5 Objectives

3.5.1 We developed the strategic objectives, presented below, taking into consideration the objectives of our existing and potential partner organisations:

- develop and implement sustainable short and long-term flood risk management options;
- evaluate the existing maintenance programme for the River Roding with regards to existing and future conditions;
- ensure that the long term goals of the Thames Catchment RBMP and WFD objectives are considered, addressed and, where possible, met in the Strategy recommendations;
- adopt and agree the long-term framework for flood risk management in partnership with key stakeholders; and

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e) maximise cost effective environmental and social enhancement opportunities.

3.5.2 More detailed environmental and WFD objectives were also developed as part of the SEA process (see WFD Assessment in Appendix J). The short listed options were assessed against the environmental objectives.

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4 Options for managing flood risk

4.1 Potential FCRM measures

4.1.1 The potential FRM measures identified are set out in Table 41.

Table 41 Potential FRM measures

Category	Flood Risk Management Options
No active intervention	Do nothing Withdrawal of maintenance
Do Minimum	Do minimum/reduce service levels
Maintenance / management measures	Preserve flood plain areas Designate land for particular uses Place certain controls on development Improve maintenance of river Modify runoff within catchment Provide public information and education
Non-Structural measures	Flood warning Evacuation Emergency Drainage Measures
Structural measures	River training and straightening Embankments and floodwalls Pumping Reinstatement of floodplain (including realignment) Upstream storage of water Diversion of flow between river basins Flood resistance and / or resilience

4.2 Long list of options

4.2.1 In the earlier stages of the Strategy development a long list of FRM options was derived through consultation on the generic options listed in Table 41. The long list options include generic catchment wide, location specific structural flood risk management and flood storage area options. For more detail on the options and issues, refer to Appendix F.

4.3 Options rejected

4.3.1 A high level technical, economic and environmental assessment of the options was undertaken to screen out options that were clearly technically not feasible, environmentally unacceptable and / or not cost effective. Rejected "long list" options and their reason for rejection are presented in Appendix F. This resulted in a short list of options for more detailed consideration.

4.4 Options short-listed for appraisal

4.4.1 The short-list of options for detailed consideration for each flood cell (where applicable) are summarised in Table 4.2. Each option is described in more detail below with additional information provided in Appendix F. The preferred Strategy has been developed based on the detailed assessment of these options, taking into account interrelations between flood cells. Options 1 to 4 have been considered on a 'flood cell' by 'flood cell' basis, whilst option 5 was considered once the individual flood cell options had been summed together to comprise our strategic approach. Option 6 is designed to pick up any remaining properties which will be at Very Significant risk after the implementation of the Strategy.

Table 4.2 Short list of Flood Risk Management Options

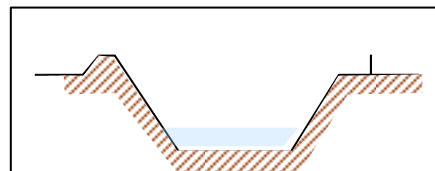
Option No.	Option Name
1	Do Nothing (No Active Intervention)
2	Do Minimum

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3	Maintain
4	Reduce Surface Water Flood Risk in Woodford
5	Flood Storage Upstream at Shonks Mill Bridge
6	Resistance and Resilience Measures

Option 1: Do Nothing (No Active Intervention) / Withdrawal of maintenance

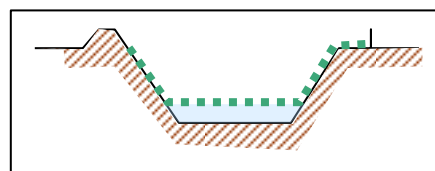
4.4.2 Do Nothing / No active intervention (NIA) is used as the baseline option against which the impacts and benefits of all other options are measured. It is assumed that all maintenance and repairs to existing structures are ceased, allowing nature to take its course. Defence structures will be allowed to deteriorate and fail. The channel will be allowed to vegetate and silt up.



4.4.3 Where all other options are not justified economically then NIA becomes the preferred option but would be implemented as Withdrawal of Maintenance (usually over 2 years). There will be some reactive maintenance and inspections to maintain public safety during the withdrawal period.

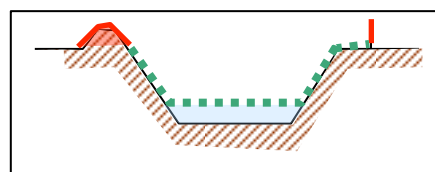
Option 2: Do Minimum – channel maintenance only

4.4.4 This option comprises grass cutting, weed and debris clearance (light maintenance) and, where appropriate, silt removal (heavy maintenance). It has been assumed that the application of this option would lead to the eventual loss of any flood defence structures, at the end of the structure's residual life where the costs of continued maintenance would outweigh the protection provided. Works would be undertaken to keep structures safe for users and the public as the assets deteriorate.



Option 3: Maintain – maintain assets and channel

4.4.5 This option comprises continuing an efficient channel maintenance programme whilst repairing and replacing assets as required. It also includes asset inspections and all ongoing maintenance works needed to keep structures safe for users and the public. If adopted, this option will continue to provide the Sustain Standard of Service (SoS) for the assets over the 100 year strategy period (without accounting for climate change).



4.4.6 A higher standard of protection such as Sustain Standard of Protection has not been assessed due to the physical constraints within the catchment. Raising defence levels is not feasible due to compensatory storage requirements and the significant costs associated with this.

Option 4: Reduce Surface Water Flood Risk in Woodford

4.4.7 This option comprises a combination of a flood storage area (FSA) and pumping stations designed to protect the properties behind the Woodford flood embankments in FC 8 to a 1.33% AEP (1 in 75year) SoS. Although these properties are protected from fluvial flooding by an existing embankment (to a 1.33% AEP) they are currently at risk of surface water flooding.

Option 5: Flood Storage Upstream from Shonks Mill Bridge

4.4.8 This option involves the addition of a flood storage reservoir (FSR) upstream of the M25 at Shonks Mill Bridge. The FSR will hold back flood waters in extreme events (from a 2% to a 0.5% AEP event). This option has been considered as an additional option to improve flood risk management, on top of the preferred options for flood cells identified from the assessment of Options 1 to 4. Without the flood storage area many downstream properties would remain or possibly move to significant risk levels under recent climate change predictions. Different sizes and implementation timings of FSAs were considered.

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Option 6: Resistance and Resilience Measures – Individual property protection

- 4.4.9 Many of the properties in the catchment that are already at 'Very Significant' flood risk (greater than a 5% AEP) will remain at 'Very Significant' risk after the strategy is implemented. Typically these are isolated rural properties in the upper catchment where a financial viable flood protection scheme is difficult to justify. Individual property protection could reduce the risk and impacts of flooding where no other options are possible. Where these comprise small groups of properties there may also be scope to consider small community schemes. Under this option the property owners will be responsible for maintaining the equipment and structures.

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Options appraisal and comparison

5.1 Technical issues

- 5.1.1 The mixed nature of the study area (i.e. the Upper and Middle catchments being predominantly rural whilst the lower catchment is highly urbanised) requires a range of management approaches to be adopted in different parts of the study area to ensure cost effectiveness. However, the nature of a river system, particularly ones that exhibit flashy characteristics like the Roding catchment, means that careful consideration is needed to explore upstream and downstream impacts of a variable management approach. Hydraulic modelling was therefore a key element to the development of the Strategy (see Hydraulic Modelling report in Appendix G).
- 5.1.2 In undertaking the modelling studies, we have made use of existing models that were previously developed for other studies, in particular Section 105 studies. The existing ISIS models have been reviewed, with minor modifications made in order to better represent certain features such as gauging stations and to improve model stability. The input rainfall run-off hydrograph was also revised to reflect changing guidance.
- 5.1.3 To avoid a long and complex process of multiple model run scenarios we decided to take a simplistic approach to assessing the relative impacts of each option along the river by running study wide Do Nothing, Do Minimum and Maintain scenarios. These were used to select the preferred option in each flood cell. The conclusions of the modelling and technical analyses were:

a) Do Nothing (No Active Intervention): increased channel roughness means flood water is held back in the upper catchment thereby reducing the extent of flooding in downstream reaches.

b) Do Minimum: Comprises channel maintenance to improve conveyance, leading to higher risk of flooding downstream when compared with Do Nothing scenario.

c) Maintain: Maintains the existing situation, therefore not assessed technically but used as a comparison for all other options.

d) Reduce surface water flood risk in Woodford: Modelling has been carried out by Thames Water to assess the required additional storage capacity for surface run off. ISIS modelling has been undertaken to assess the impact that increased inflow has on the Roding further downstream: this was shown to be insignificant. The conclusions of the surface water modelling were tested against the modelling undertaken by Drain for London and were seen to correlate well.

e) Flood Storage Upstream from Shonks Mill Bridge: The most effective way to operate this FSA is to reduce the frequency of fluvial flooding at downstream locations that are currently protected against floods up to 2% or 1% likelihood of occurrence. For Option 5, the fluvial flood storage embankment and spillway design will ensure that the structures meet the requirements for reservoir safety. This will avoid increasing flood flows downstream above those that would naturally occur.

5.2 Environmental assessment

- 5.2.1 A strategic level environmental appraisal of the short listed options has been undertaken and is presented in the SEA ER and the SEA ER Addendum (both in Appendix J). The short listed options have been scored against the environmental objectives, assuming that the identified mitigation measures are undertaken, with Options 4 and 5 having noticeably higher scores than the other options.
- 5.2.2 The baseline environmental issues are summarised in Section 3.4. An Indicative Landscape Plan prepared for the scheme is provided in Appendix J.
- 5.2.3 We undertook a WFD assessment which was split into two main sections detailing:

- (i) Potential impacts on the current status
- (ii) Whether the Thames RBMP mitigation measures could be put in place post-strategy.

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- 5.2.4 The first section showed that no deterioration was predicted on the waterbodies.
- 5.2.5 The second identified that the Shonks Mill flood storage area could potentially be in conflict with some of the mitigation measures for the Roding (Cripsey Brook to Loxford Water) waterbody as detailed below:
- Preserve and, where possible, restore historic aquatic habitats
 - Preserve and, where possible, enhance ecological value of marginal aquatic habitat, banks and riparian zone.
 - Removal of hard bank reinforcement / revetment, or replacement with soft engineering solution
 - Re-open existing culverts
 - Improve floodplain connectivity
- 5.2.6 The first two of these would only be the case where the structure crosses the River Roding and suitable mitigation can be found within and surrounding the flood storage area itself.
- 5.2.7 The installation of a large flood bund would conflict with the third point. However, being perpendicular to the river rather than along the river bank, this will be a small section of river. The removal of any maintenance upstream will mitigate for this and enhance the Roding.
- 5.2.8 The potential for downstream defences to be removed would directly reduce the amount of embankments parallel to the river, increasing the length of river for point three. However, the length of this is currently uncertain, as riparian owners have the opportunity to take on maintenance of these assets.
- 5.2.9 There is potential that the detailed design will involve a culvert to control flows through the flood embankment. This would go against the forth point. The flow control structure is to allow flows up those in a 1 in 50 year event pass through. This is equivalent to providing at least bank full flows. There is some uncertainty here as the final design and width of the bund is not known, which could influence the design of the control structure.
- 5.2.10 The last point is conflicted by the creation of a bund to hold back floodwater and prevent areas downstream from flooding. Floodplain connectivity would be reduced downstream of the flood embankment, where urban areas are removed from the floodplain. However, upstream of the embankment the floodplain connectivity would be improved – in areas where biodiversity can utilise the improved connectivity.
- 5.2.11 The document 'Managing flood risk: our recommendations for managing flood risk in the Roding catchment' with supporting SEA information, as included in Appendix J was published on our website and made available in hard-print at various locations readily accessible to the public. Two drop-in sessions were also held: one at Ongar Town Council, Chipping Ongar, and one at Broadmead Baptist Church, Chigwell Road, Woodford Green. Consultation was open from 12 July to 16 October 2011 (the consultation period was extended due to the number of comments received). Refer to Appendix L for a report summarising the responses.

5.3 Social and community impacts

- 5.3.1 Options 1 and 2 will lead to an increase in flood risk to over 15 properties in the upper catchment but has the consequential impact of contributing to reduced flood risk downstream. Where there are existing defences (from which we will withdraw from maintaining after an appropriate notice period), we will seek to transfer maintenance to others and explore funding from other sources for individual property protection flood risk management solutions. Providing those affected with the information about the risk and what they can do themselves will enable communities to make informed decisions about flood risk management. However Options 4 and 5 will lead to a reduction in flood risk for areas in the middle and lower catchment.

5.4 Option costs

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- 5.4.1 The details of the costing approach are set out in Appendix D. The option costs have been phased to reflect the anticipated time and costs required to carry out feasibility studies, detailed design and construction. It has been assumed that no capital spend will commence until the financial year 2012.
- 5.4.2 Spons has been used as a basis for generating construction costs. However, where recent actual construction costs are available for a very similar scheme (in this instance Banbury FSA which had both pumping stations of a similar size and a Flow control structure as part of a FSA) these have been used to inform the cost build up. Spons sourced costs originate from Spons Civil Engineering and Highway Price Book, updated to August 2011 using the BIS Output Price Index for New Construction:Public Non Housing.
- 5.4.3 All cost estimates include optimism bias, as required by HM Treasury guidelines, to account for the appraiser's initial optimism in the production of cost estimates. This is recommended as 60% for a Strategy study. Lower values of Optimism Bias have been applied where costs are based on actual catchment expenditure totals or on FCDPAG3 Economic Appraisal - Supplementary Note to Operating Authorities, March 2003, Annex 2. Details can be found in Appendix D, section 6.1.4. Lower estimates stand at 42% and were generated using the analysis outlined in Appendix D.
- 5.4.4 The Do Nothing 'No active intervention' option, by nature, has no costs associated with it but this approach is not practical, legal and does not meet guidance, so in reality activities associated with Withdrawal of Maintenance, described in the implementation plan, will have operation costs associated with them. These costs include annual general maintenance costs of managing the assets and channel until withdrawal of maintenance is implemented. They also include potential costs associated with the decommissioning for the Alders Brook Barrage or any costs that arise from negotiations with land owners for handover of the asset (a commuted sum). These have not been included in the economic assessment but an allowance has been made in the project budget of £345k for 2 years maintenance and £150k for costs associated with withdrawal; of maintenance including fulfilling our Health and Safety Liabilities. The same approach has been adopted for implementing individual property protection with a further allowance of £300k based on an average cost of £12k for each candidate property.
- 5.4.5 Maintenance costs for each Option include channel maintenance, asset maintenance and inspection, where these elements of maintenance are part of the option under consideration. The costs have been based on information provided from the actual 2009/10 System Asset Management Plan System (SAMPS) budgets. The costs have been distributed within each system to the flood compartments based on supporting evidence from the local operations teams and through allocation based on frontage length. This has occurred with both the Do Minimum and Maintain options and been included over the 100 year Strategy.
- 5.4.6 Replacement schedules for the existing assets were used to derive the capital cost estimates for options involving 'maintain assets'.
- 5.4.7 Costs associated with the design and construction of new structures have been based on data obtained from recent similar works or from unit cost databases.
- 5.4.8 Land costs have been provided by land specialists with local specialist knowledge.
- 5.4.9 A summary of present value costs for each option in each flood cell is provided in Appendix D.

Table 51 Key environmental impacts, mitigation and opportunities

Option		Key positive impacts	Key negative impacts	Environmental design and mitigation opportunity	Enhancement opportunity
1	Do Nothing (Withdrawal of Maintenance)	<ul style="list-style-type: none"> Potential to increase biodiversity through increased habitat and flow variability and reconnection with floodplain. Siltation and vegetation succession will lead to increased variability of riparian vegetation and diversity of flow patterns. 	<ul style="list-style-type: none"> Impacts upon local sites of nature conservation. Loss of access to public recreational areas, public rights-of-way, cycle ways and footpaths. Possible damage/ loss of heritage features. Increased inundation and potential loss of quality agricultural land. Flooding of contaminated land causing contamination of watercourses and land. 	<ul style="list-style-type: none"> Opportunities for freshwater habitat creation to improve diversity of habitats. Potential to contribute towards WFD mitigation measure 'increase in-channel morphological diversity' as 'do nothing' allows natural processes to take place. Potential to contribute towards WFD mitigation measure 'preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone'. 	<ul style="list-style-type: none"> Environmental Stewardship Schemes and catchment sensitive farming.
2	Do Minimum	<ul style="list-style-type: none"> Siltation and vegetation succession will lead to increased variability of riparian vegetation and diversity of flow patterns. 	<ul style="list-style-type: none"> Intermittently affect water quality in the river during heavy maintenance (silt removal). 	<ul style="list-style-type: none"> Adopt ecological and archaeological best practice during works (e.g. surveys consultation and timing). 	<ul style="list-style-type: none"> No opportunities for enhancement identified.
3	Maintain	<ul style="list-style-type: none"> Avoids displacement of significant employers, infrastructure and services. Avoids inundation of abstraction or consented discharge points. 	<ul style="list-style-type: none"> Intermittently affect water quality in the river during heavy maintenance (silt removal). Will maintain existing landscape character of river habitat. 	<ul style="list-style-type: none"> Work in partnership with London Borough of Redbridge to improve access, signage and interpretation along the Roding Valley Way and in the Roding Valley Park to mitigate for disruptions to recreation activities. 	<ul style="list-style-type: none"> Possible partnership scheme with London Borough of Redbridge to improve ecological and recreational value of land opposite Chigwell Road.

Option		Key positive impacts	Key negative impacts	Environmental design and mitigation opportunity	Enhancement opportunity
4	Reduce Surface Water Flood Risk in Woodford	<ul style="list-style-type: none"> Improvement to water quality impacts during flood events as surface water is captured in FSA, and stored allowing pollutants to settle out before flowing into the River Roding. Intermittent inundation will not impact discharge and abstraction licences. 	<ul style="list-style-type: none"> Will permanently change visual amenity as grassed area will be intermittently inundated in long term. Potential for disturbance of contaminated land. Large volumes of excavation and disposal required to create storage area. Sustainability issue with the use of electricity for pumping. 	<ul style="list-style-type: none"> Potential to contribute towards WFD mitigation measure 'preserve and, where possible, restore historic aquatic habitats' through creation of wet grassland BAP habitat. Re-use of materials on site or for construction of the embankment at Shonks Mill. Sensitive landscape and environmental design of FSA with the creation of freshwater habitats and reed beds, and landscaping. Incorporate bunds to avoid contaminated land inundation. 	<ul style="list-style-type: none"> Introduction of structure planting, footpaths, seating and interpretation on site to increase public amenity value of land.
5	Flood Storage Upstream from Shonks Mill Bridge	<ul style="list-style-type: none"> Minor benefit to Roding Valley Meadows SSSI by reducing extreme flood flows (>1 in 50). No change for flood flows >1 in 50. In long term land and water based recreation will be maintained. 	<ul style="list-style-type: none"> Potential long-term intermittent water quality impacts, over contaminated land. Structure holding back water will permanently change landscape character of area. Construction of embankment will require the use of large amounts of earth material. Construction may disturb undiscovered archaeological remains within and adjacent to the riverbed. Long-term intermittent inundation of high quality agricultural land (grade 2) and loss of area to locate the bund. 	<ul style="list-style-type: none"> Sensitive design of the control structures will include mammal ledges and other specific measures to allow passage of fish. Existing PRoW will need to be realigned after construction. Bunds should be incorporated to avoid inundation of contaminated land. Sensitive landform design and planting to minimise visual impact of dam upon existing landscape character. Archaeological watching brief during construction. 	<ul style="list-style-type: none"> Environmental Stewardship Schemes and catchment sensitive farming. Potential to contribute towards WFD mitigation measures 'preserve and, where possible, restore historic aquatic habitats' and 'preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone' through creation of wet woodland and lowland meadow habitat. Strengthen existing landscape character through hedgerow planting and contribute towards delivery of Essex Biodiversity Action Plan.

5.5 Options benefits (damages avoided)

- 5.5.1 The economic values of losses and damages arising from flooding have been calculated based on standard methodology as outlined in the 'Multi-coloured' Manual (Middlesex University Flood Hazard Research Centre, 2005). Where appropriate, costs have been capped at their market value, obtained from Land Registry data for Residential properties and The Valuation Office for commercial property.
- 5.5.2 All damages have been updated to August 2011 using the Retail Price Index (RPI). Damages have been calculated over a 100 year appraisal period. All damages have been discounted to present value (PV) using the HM Treasury variable discount rate. In accordance with MCM, 10.7% has been added to the PV property damages to allow for the costs incurred by the emergency services following flooding. Other receptors, generally insignificant, include:
- a) Electrical sub-station (FC8 and 11 only)
 - b) Key road Traffic disruption (FC1, 8 and 9 Only)
 - c) Willingness to pay for Eton Manor rugby club (FC12 only)
 - d) Intangible health benefits
 - e) Additional electricity costs
 - f) Alternative rental accommodation costs
 - g) Risk to Life / Injury benefits
 - h) Social Equity factor.
- 5.5.3 Ecosystem benefits were considered but not assessed due to the nature of the potential habitat available being minimal / not available without the purposeful removal of flood defences. This would leave us liable for compensation, as opposed to allowing a defence to fail under our permissive rights or handing it over.
- 5.5.4 Agricultural land was also considered but on assessment of the floodplain changes, with and without management intervention, there was very little difference in the flood extents so it was therefore, in the interests of proportionality, not included. Very little maintenance actually takes place in the upper catchment which means the changes are minimal.
- 5.5.5 If flows exceeding the design event occur, overtopping and flooding of properties in the floodplain is expected. Flood embankments may also fail causing greater flooding. Both of these effects are incorporated within the economic analysis.
- 5.5.6 Within the Do Nothing scenario channel siltation resulting in decreased conveyance is expected to take place over a 10 year period. The existing defences will eventually fail through lack of maintenance and overtopping. The timing of defence failures has been estimated from the residual life given in our National Flood and Coastal Defence Database (NFCDD). From this information, we expect the first defence failure to be within 2 to 4 years.
- 5.5.7 As the appraisal was complete before the September 2011 climate change guidance was issued, each flood cell has been assessed both with and without climate change based on the 2006 guidance. The 2006 climate change guidance represents an increase in flows of 10% until 2025, thereafter 20%. This allows us to understand how sensitive the option selection is to increased flows and the consequent increase in option damages.
- 5.5.8 The preferred option for each flood cell (as determined by a cell by cell appraisal basis) have been added together in a strategic option. The impact of upstream storage at Shonks Mill Bridge (option 5) has then been appraised to investigate the additional benefits it provides. This has then been tested for sensitivity for various variables, outlined in Appendix M.

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Selection and details of the preferred option

6.1 Selecting the preferred option

- 6.1.1 Options taken forward to shortlist have been costed and the associated benefits assessed. A two stage approach has been used to select the preferred strategy. The first stage is the assessment of the individual flood cells to clarify the most economically sustainable approach along the catchment. The second stage is the strategic option assessment, using the results from stage 1 in combination with the upstream storage options.
- 6.1.2 The benefit assessment results for stage 1 (each flood cell) are shown below in Table 61. The preferred option for each cell is highlighted. The analysis does not include the affects of climate change. Further detail on the preferred options is presented in the Appraisal Summary Table included in Appendix D.
- 6.1.3 In accordance with the FCERM-AG decision rule, options have been ordered to reflect increasing benefit and incremental benefit cost ratios (iBCRs) and has been used to justify additional expenditure to achieve higher standards of protection.
- 6.1.4 Each flood cell has been assessed in turn for Do Nothing, Do Minimum and Maintain options, including relevant sensitivity testing, to inform the decision making process. This includes testing the 2006 climate change scenario which represents an increase in flows. Details of the sensitivity testing can be found in Appendix D. Option 4, reducing surface water run off at Woodford, was assessed separately for FC8.
- 6.1.5 Once stage 1 has delivered a preferred option for each flood cell, this has then been tested in stage 2 with the additional affects of the strategic upstream flood storage area at Shonks Mill. The resultant benefits of this on the affected downstream cells have been added together with appropriate costs and are shown below in Table 62.
- 6.1.6 The stage 2 preferred option has been selected by adding together the associated benefits and costs of the stage 1 preferred options and the strategic option. These have been compared with the total stage 1 Do Nothing damages and the total stage 1 recommended options. The IBCR has then been used to test if the additional cost of the strategic option is justified by the additional benefits it provides. This allows us to make the step from the preferred cell options to justify the strategic scheme.
- 6.1.7 The damages and costs associated with the strategic upstream storage option at Shonks Mill reflect construction in year 10.

Table 61 Flood Cell Benefit-cost Assessment

Preferred Option highlighted in blue

Flood Cell	Option No.	Option name	PV Costs (£k)	PV Damages (£k)	Asset protection benefits (£k)	Total PV Benefits (£k)	Av. Benefit/Cost Ratio	iBCR	Option for Incremental Calculation
1 & 2	1	Do Nothing		1,687					
	2	Do Minimum	1,152	720	61	1,028	0.9	-	-
	3	Maintain	4,444	199	76	1,565	0.4	-	-
3	1	Do Nothing		33,574					
	2	Do Minimum	2,067	815	580	33,339	16.1	-	-
	3	Maintain	2,628	407	841	34,008	12.9	1.2	2

Flood Cell	Option No.	Option name	PV Costs (£k)	PV Damage s (£k)	Asset protection benefits (£k)	Total PV Benefits (£k)	Av. Benefit/Cost Ratio	iBCR	Option for Incremental Calculation
	1	Do Nothing		11					

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4	2	Do Minimum	127	-	-	11	0.1	-	-
	3	Maintain	1,560	-	-	11	0.0	-	-
5	1	Do Nothing		718					
	2	Do Minimum	681	488	0.3	231	0.3	-	-
	3	Maintain	1,068	486	-0.1	231	0.2	-	-
6	1	Do Nothing		280					
	2	Do Minimum	579	Not estimated as costs are greater than Do Nothing Damages and options are clearly uneconomic.			-	-	-
	3	Maintain	1,108				-	-	-
7	1	Do Nothing		1,601					
	2	Do Minimum	215	1,645	-4	-49	-0.2	-	-
	3	Maintain	503	1,645	-4	-49	-0.1	-	-
8	1	Do Nothing		118,106					
	2	Do Minimum	980	81,098	332	25,995	26.5	-	-
	3	Maintain	3,919	44,607	2,315	75,814	19.4	17.0	2
	4	Maintain + reduce SW flood risk in Woodford	7,553	19,840	3,531	101,798	13.5	7.15	3
9	1	Do Nothing		844					
	2	Do Minimum	63	392	-	452	7.2	-	-
	3	Maintain	489	383	-	460	0.9	-	-
10	1	Do Nothing		859					
	2	Do Minimum	69	738	-	121	1.75	-	-
	3	Maintain	290	795	-	64	0.22	-	-
11	1	Do Nothing		1,569					
	2	Do Minimum	72	1,116	125	578	8.0	-	-
	3	Maintain	681	871	148	846	1.2	0.4	-
12	1	Do Nothing		846					
	2	Do Minimum	141	221	13	638	4.5	-	-
	3	Maintain	423	401	13	458	1.1	-	-
15	1	Do Nothing		417					
	2	Do Minimum	144	432	-20	-34	-0.2	-	-
	3	Maintain	1,463	155	48	310	0.2	-	-
LB	1	Do Nothing		26,748					
	2	Do Minimum	546	16,733	-61	9,953	18.2	-	-
	3	Maintain	3,516	1,771	460	25,437	7.2	5.2	2

6.1.8 The results of the stage 2 assessment are compiled and summarised in Table 62, below.

Table 62 Shonks Mill FSA Benefit-Cost Assessments

Strategic Option: Shonks Mill Flood Storage Area				
Options	1- Do Nothing	2 - Preferred option	3 - Preferred option with Shonks Mill FSA A	4 - Preferred option with Shonks Mill FSA B

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Costs (£k)		-	8,114	10,207 (8,114 + 2,093)	11,543 (8,114+3,430)
Flood Cell Damages (£k)	5	718	718	703	690
	6	280	280	266	252
	7	1,601	1,601	1,521	1,446
	8	118,106	19,840	15,955	11,038
	9	844	392	360	332
	10	859	738	738	729
	11	1,569	1,116	882	591
	12	846	221	163	129
	15	417	417	335	272
Asset protection benefits for Cells		-	3,669	4,851	5,291
Total benefits		-	103,586	109,168	115,052
BCR		-	12.7	10.7	10.0
iBCR		-	-	2.7	3.3
iBCR compared				Option 2	Option 2*

*Compared with Option 2 as further analysis and sensitivity testing, outlined in Appendix M suggests that FAS A should be discarded

- 6.1.9 **Flood Cells 1 & 2:** The benefit cost ratios (BCR) presented for Flood Cell 1 & 2 show that carrying out maintenance is not cost beneficial with all base case options scoring below 1. Sensitivity testing using the 2006 climate change scenario supports this decision. Further investigation of the damages shows that only two properties and the road traffic losses are the main contributors. Therefore **Withdrawal of Maintenance** is recommended for Flood Cells 1 & 2 with consideration of Individual Property Protection (IPP) for the properties at risk.
- 6.1.10 **Flood Cell 3:** Using the FRCM_AG decision rule process, the results show maintaining the current management and maintenance regime is the economically preferred option. Option 2 has the highest BCR, but we can move on to Option 3 (which will achieve a 2% AEP) as the iBCR is greater than 1. Inclusion of climate change impacts increases the BCR and iBCR and reinforces this decision. Providing an increased standard of protection was not investigated because the only viable scheme would be to increase the storage capacity. With the upper areas of the Brook being located within a SSSI (Epping Forest), it was decided that this would not be appropriate and cost inhibitive to do so, so therefore discarded. The recommended approach for Flood Cell 3 is to **Maintain the existing channel and assets** (provides a 2%AEP standard of protection).
- 6.1.11 **Flood Cells 4 & 5:** The preferred option for Flood Cells 4 & 5 is **Withdrawal of Maintenance**. Even with increased fluvial flows the BCR is significantly below 1.
- 6.1.12 **Flood Cell 6:** The preferred option for Flood Cell 6 is **Withdrawal of Maintenance**. Even with increased fluvial flows the cost of the maintenance options is greater than the Do Nothing damage. This is because under the Do Nothing scenario siltation and vegetation of the channel upstream reduces the upstream channel capacity and reduces the flood flow downstream.
- 6.1.13 **Flood Cell 7:** The results show that the defence structures in this location offer no additional benefits compared to just maintaining the channel in the Do Minimum option and that ordinarily the economically preferred option for Flood Cell 7 would be Do Nothing. However, the channel of Flood Cell 7 also borders Flood Cell 8. Channel Maintenance is part of the preferred option for Flood Cell 8 and, in reality, can only occur on the whole channel and not just one bank. A sensitivity test has been carried out on the preferred option of Flood Cell 8 to include the costs of maintaining the Channel in Flood Cell 7 and this proved robust. The preferred option for Flood Cell 7 is therefore **Do Minimum** based on the practicalities of channel maintenance.

- 6.1.14 **Flood Cell 8:** The results show that Maintain with surface water reduction measures is the preferred option in the Flood Cell, demonstrated by a high IBCR both in the base case and with increased fluvial flows due to climate change. We considered raising localised defences to provide a higher standard of protection but this was unviable as the increased water levels would increase flood risk to the M11 and no feasible location for compensatory storage could be identified. As mentioned in the analysis of Flood Cell 7, Flood Cell 8 has been sensitivity tested with the additional costs for maintaining the whole channel which has shown that the benefits provided within Flood Cell 8 can carry the burden on the costs for the whole channel maintenance, with only a minor reduction in BCR and iBCR. The recommended approach for Flood Cell 8 is to **Maintain, maintain the channel and assets** and **provide surface water reduction measures at Woodford** to a 1.33% AEP (1 in 75yr) standard of protection.
- 6.1.15 **Flood Cell 9:** This contains no assets other than the M11 road from Essex in to North London. This would flood directly from the River Roding which runs alongside a particular low point. As this is direct flooding from the river, as occurred in the year 2000, it is felt to be appropriate for inclusion in the base case economics. The recommended approach for Flood Cell 9 is **Do Minimum**. We considered building a flood defence but no compensatory storage was available.
- 6.1.16 **Flood Cell 10:** Under the base case scenario, only the Do Minimum option is economical, and this is marginal. With climate change, the Do Minimum option is bordering on being uneconomic. The recommended approach for Flood Cell 10 is **Do Minimum**. However, if flows increase significantly in the future this option should be reviewed to ensure it continues to be economically viable.
- 6.1.17 **Flood Cell 11:** The Do Minimum option has the highest BCR. Although the Maintain option is economic, its iBCR is not sufficient to justify its selection over Do Minimum. Model sensitivity testing shows that the decision is sound based on increased climate change flows. Therefore the **Do Minimum** option is recommended for Flood Cell 11.
- 6.1.18 **Flood Cell 12:** Do Minimum is the economically preferred option for Flood Cell 12. Model sensitivity testing shows that the decision is sound based on increased climate change flows. Therefore **Do Minimum** is the recommended option for Flood Cell 12 with IPP considered for the rugby club.
- 6.1.19 **Flood Cells 13 & 14:** Flood Cell 13 has not been economically assessed as it contains no property or infrastructure. The land use consists of rough scrub and a field. Flood Cell 14 has not been economically assessed as it contains no property or infrastructure. Land use consists of Wanstead Park. No raised defences exist in this area. The recommended approach for Flood Cells 13 and 14 is **Withdrawal of Maintenance**.
- 6.1.20 **Flood Cell 15:** None of the options appraised, even with the inclusion of climate change impacts are economic. Model sensitivity testing show that the decision is sound based on increase climate change flows. The **Withdrawal of Maintenance** is the economically preferred option for Flood Cell 15.
- 6.1.21 **Flood Cells 16 & 17:** These cells have not been economically assessed as they contain no property or infrastructure. The land use consists of Ilford Golf Club. A cursory evaluation of the golf club and the loss of business was carried out and revealed defence maintenance would be uneconomical. The recommended approach for Flood Cells 16 & 17 is **Withdrawal of Maintenance** (although maintenance may be transferred to Ilford Golf Club).
- 6.1.22 **Loughton Brook Flood Cell:** Under the base case economic assessment, Do Minimum has the highest BCR, but we can justify the selection of the Maintain option through the application of the decision rule as the iBCR is higher than 1. With climate change impacts, the Maintain option has the highest BCR. A higher standard of protection has not been assessed due to the physical constraints of this highly urban tributary. Raising defence levels is not feasible as there are no available areas for compensatory storage requirements, and upstream storage already exists with significant costs associated with increasing this capacity. Benefits for doing this would be limited as the majority of the properties in the cell already have a standard of protection in excess 5% AEP. The economically preferred option for The Loughton Brook Flood Cell is **Maintain Channel and Assets**.

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Flood Cell Summary

6.1.23 Table 63 below, shows the stage 1 Flood Cell preferred option summary. This combination forms the basis of the strategic option review (Option 5) which will be combined with the options below.

Table 63 Flood Cell Preferred Options

Flood Cell & System		Option	Current SoP	Strategy Cell SoS	Benefiting properties/ other	Properties increased risk
1,2	R005/04	Do Nothing	1 in 10	<1 in 5	0	10
3	CB	Maintain – Maintain assets and channel	1 in 50	1 in 50	0	0
4	RO 03	Do Nothing	1 in 200	1 in 100	0	3
5	RO 03	Do Nothing	1 in 10	1 in 5	0	2
6	RO 02	Do Nothing	1 in 50	1 in 50	20	0
7	RO 02	Do minimum – Channel maintenance only	1 in 20		0	0
8	RO 02	Do Something – Maintain assets & channel and reduce pluvial flood risk (pumping and FSA)	1 in 75 / 1 in 20	1 in 75	405 / Road, sub stations	0
9	RO 02	Do minimum – Channel maintenance only	1 in 50	1 in 50	M11 Only	
10	RO 02	Do minimum – Channel maintenance only	1 in 200	1 in 200	0	0
11	RO 02	Do minimum – Channel maintenance only	1 in 75	>1 in 50	0	37
12	RO 02	Do minimum – Channel maintenance only	1 in 10	1 in 50	2	0
13	RO 01	Do Nothing	1 in 5	1 in 5	Golf course -No properties	
14	RO 01	Do Nothing	1 in 75	1 in 5	Park -No properties	
15	RO 01	Do Nothing	1 in 100	1 in 50	0	14
16	RO 01	Do Nothing	1 in 75	1 in 5	Golf course -No properties	
17	RO 01	Do Nothing	1 in 75	1 in 5	Golf course -No properties	
Loughton Brook		Maintain – Maintain assets and channel	1 in 20	1 in 20	0	0
					427	66

Strategic Option: Shonks Mill Flood Storage Area

6.1.24 As the stage 1 assessment preferred options result in an SoP which is felt to be inadequate, particularly for the urban areas of Redbridge, it was felt necessary to investigate the viability of an upstream storage option. As the SoP provided would be likely to further reduce under the effect of predicted climate change (to significant risk levels) the FSA is an ideal way to mitigate climate change increases, should they occur, and to reduce overall risk levels

6.1.25 Two different sized flood storage options (Shonks Mill FSA-A and FSA-B) have been considered, each constructed in year 10. Shonks Mill FSA-A impounds water from between a 2% AEP (1 in 50 yr) event and a 1% AEP (1 in 100yr) event whilst FSA-B impounds water from between a 2% AEP (1 in 50yr) event and a 0.5% AEP (1 in 200yr) event. A larger FSA was not tested as a suitable site was not viable in the catchment.

6.1.26 Under the base case economic assessment, Option 2 has the highest BCR. However we can move directly from Option 2 to Option 4 (as discussed in Appendix M) as the iBCR is 3.3, which meets the criteria. The inclusion of climate change impacts increases both the BCR and iBCR for Option 4 and therefore robustly justifies the decision to move to the higher standard of protection, as shown in Table 64.

Table 64 Shonks Mill iBCR compared to flood cell preferred options (strategic option 2) only

	No Climate Change	2006 Climate Change	2011 Climate Change
--	-------------------	---------------------	---------------------

Service year	Year 10	Year 10	Year 10
FSA-A	2.7 – insufficient to justify selection (require 3) as SoP is 1 in 100 yrs.	1.8 – sufficient to justify selection as SoP has reduced to 1 in 75 (required threshold reduced to 1)	1.8 – insufficient to justify selection (require 3) as SoP is greater than 1 in 75 yrs for first half of the appraisal
FSA-B	3.3 – sufficient to justify selection as >3	4.7 – sufficient to justify selection as >3	4.0 – sufficient to justify selection as >3

- 6.1.27 Option 3 Shonks Mill FSA-A has been ignored when applying the decision rule as it has a marginal iBCR in the base case and, when climate change impacts are included, it becomes less viable. It also fails to lift the SoS downstream from the Moderate to Low risk band and to mitigate the SoS reductions caused by increased fluvial flows: it is therefore not considered future proof. Whereas the larger FSA-B mitigates for fluvial flow increases, whilst providing a strong case of construction without any climate change increased flows.
- 6.1.28 It is therefore recommended that Shonks Mill FSA-B is taken forward as the preferred option.
- 6.1.29 The optimum timing for the construction of Shonks Mill FSA-B has also been tested. Based on the 2011 climate change guidance, the business case is stronger if construction is delayed to year 30. This shows that the higher the fluvial flows become, the stronger the business case for earlier construction of the FSA. However this is also a 'no regrets' option as it has a strong business case without the inclusion of estimated climate change impacts. It is therefore recommended that the Shonks Mill FSA-B is constructed by year 30 (2040). This is demonstrated in Appendix M, Tables 1.35 and 1.36.
- 6.1.30 With Shonks Mill FSA in place the number of properties at potential increased risk reduces to less than 15 in the upper catchment. This estimate is based on the current modelled flood levels. Climate change predictions published by DEFRA in Autumn 2011 show that climate change could result in decreased as well as increased fluvial flows. If flows were to decrease worse off property numbers would reduce significantly. Alternatively if fluvial flows increase, the upper catchment would see an increase in properties at risk. Whilst we know that this won't change the preferred option, future increase may see us working to address the flood risk at additional properties with IPP. A view can be taken on this as fluvial flow patterns are better understood in coming years.

Strategy Option Summary

- 6.1.31 The resulting sustain standard of protection (SoP) and benefiting properties are outlined in Appendix M. Shonks Mill FSA mitigates for a significant number of properties at increased risk due to the loss of defence structures recommended in the Flood Cell preferred option scenario.

6.2 Sensitivity testing

- 6.2.1 Sensitivity testing included analysis of the following variables;

a) Climate change using both the 2006 and 2011. 2006 guidance has a greater percentage increase in fluvial flows and has the affect of testing the Flood Cell sensitivity to increased flows and increased damages. It allows us to see if the decision we make on the current damages would stand up to scrutiny if flows increased in the future. 2011 guidance is more moderate in comparison, with lower increased for the early period of the strategy study. This has also been tested. The flood cell climate change results are shown in Appendix M. The results of the strategic option assessment can be seen above in Table 64.

b) Timing of investment is important. Testing three different investment periods along with climate change scenarios has allowed us to gauge the strategy preferred option sensitivity to the timings of increased flows and the most appropriate time for investment to mitigate their affects.

- i) Using the 2006 climate change guidance we tested implementation in year 10 and delayed to year 25 (Year 25 (2035) was chosen as it is a quarter of appraisal period).

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The same timing test has been carried out using the new 2011 climate change guidance. The threshold between 10% and 15% increased flows is 2040, around year 30 of the Strategy. This has therefore been compared with year 10 as construction year.

ii) 2006 climate change analysis shows that the earlier implementation is preferred as it has an iBCR in excess of 3 compared to the delayed construction option. This is because earlier construction mitigates the increased 20% flows due in 2025, which would reduce the SoP of Woodford significantly. The new climate guidance analysis shows that a delayed construction date is preferred. Both dates mitigate the step up to 15% increased fluvial flows and the associated damages. Beyond this point climate change would decrease the standard of protection in Woodford to a significant level. Despite this, we have already proven that the option is viable with no increase in flows if constructed in year 10 as adequate benefits exist.

iii) What this tells us is that the optimum timing of implementation is dependent upon the level of change in fluvial flows as a result of climate change; however, a shorter timeframe of 10 years is viable. This delay allows us to take a more informed view of the need for intervention before committing to the expenditure, providing an adaptive solution to climate change.

c) Traffic disruption costs and other infrastructure damages can be difficult to value. Within the study we have included traffic disruption costs in three flood cells (FC1,8 and 9) where evidence suggested that significant disruption was caused in the recent 2000 flood event. As traffic disruption can be significant and distort an appraisal the three flood cells have been tested without the traffic damages.

d) A preferred option model was produced which modelled all the elements recommended above and assessed the water levels throughout the catchment to get an accurate picture of what would happen once implemented (rather than using data on a cell by cell basis as adopted for the economic appraisal). This informed the information included in some of the tables to reflect what would actually benefit / be worse off in different flood events. Please see Appendix G for more information.

6.3 Details of the preferred option

Technical aspects

6.3.1 The preferred Strategy contains some elements of maintenance including both channel and conveyance maintenance and also some structural and non-structural elements in combination with withdrawal of maintenance at other locations. These will, in the main, reduce the fluvial flood risk to properties within *the Roding catchment* (upstream of the tidal limit). The preferred option will also reduce the pluvial flood risk to properties within Woodford. However, 12 properties in the upper Roding will be at increased risk of flooding. The preferred option is summarised in Figure 4 in Appendix C.

Maintenance of River Channel and Flood Defence Assets

6.3.2 The Strategy proposes to continue maintenance of the channel and repairing and replacing of existing flood defence assets as required in Woodford, Redbridge and on the Cripsey Brook and Loughton Brook (FC3, FC8 and Loughton Brook). Asset inspections and all ongoing maintenance works will be undertaken to keep structures safe for users and the public. This option will continue to provide the existing SoP for the assets in these areas over the 100 year strategy period (without accounting for climate change).

6.3.3 Channel maintenance including grass cutting, weed and debris clearance (light maintenance) and, where appropriate, silt removal (heavy maintenance) would be continued in other areas of Woodford and Redbridge (FC7, 9, 10, 11 and 12). Flood defences in these areas would not be maintained, as the costs of continued maintenance outweigh the protection provided, although works will be undertaken to keep structures safe for users and the public as the assets deteriorate.

6.3.4 Asset replacement and channel maintenance will both continue to be funded through the existing annual maintenance budget. However these investments will vary in approach:

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channel maintenance would be subject to local prioritisation of available funds whereas asset replacement could also be subject to partnership funding.

Improve Surface Water Management in Woodford

- 6.3.5 It is proposed to create a new FSA in Woodford (FC8) at Dartnell's Field (Broadmead), Chigwell Road in order to provide storage for surface water flooding until the flood water levels in the River Roding have subsided. This will reduce the risk of surface water flooding to properties in Woodford and downstream. The works required to implement this FSA include creation of a storage volume of 3600m³ of material and installation of overflow and outfall pipes. The FSA will be designed and constructed in accordance with the Reservoir Act 1975 and any other associated guidance and legislation.
- 6.3.6 Two pumping stations with associated pipework will be constructed, one at the Winn Brook and the other at Charlie Brown's roundabout. The estimated duty of each pump will be 0.5 m³/s. Kiosks housing the controls will be set above the flood storage level. Suitable vehicular access for maintenance will be required. The improvements would increase the SoP against surface water flooding in Woodford to 1.33% AEP (1 in 75 years), allowing for climate change and a further contingency of 25% due to the outline nature of the design at this stage.
- 6.3.7 Agreement on discharge consent conditions will be required to determine if the water may be discharged back into the river directly without treatment or will need treatment. The implementation of the works will also be subject to the granting of other consents such as planning permission.
- 6.3.8 The proposed works to reduce surface water flood risk in Woodford will be implemented in partnership with Thames Water and the London Borough of Redbridge by 2013. London Borough of Redbridge proposes to lead on this project following the approval of the Strategy.
- 6.3.9 These improvements to the management of surface water flood risk would need to be undertaken in parallel with the continued maintenance of existing assets and the channel itself as per Option 3 above (undertaken by ourselves and funded from the annual maintenance budget).

Flood Storage Upstream from Shonks Mill Bridge

- 6.3.10 It is proposed to create a new FSA upstream of the M25 at Shonks Mill Bridge. This FSA would hold back flood waters in extreme events (above 2% AEP (1 in 50 year) events) and thereby provide an increased SoP for 996 properties downstream FSA (FC5 - 17). The proposed FSA will provide storage up to a 0.5% AEP (1 in 200 year) event, allowing only a 2% AEP (1 in 50 years) volume to pass downstream. An earth embankment approximately 700m long with a maximum height of 3.75m above ground level will be constructed across the floodplain adjacent to Shonks Mill Road. The embankment will incorporate a flow control structure, which is likely to be a passive control structure such as a double baffle orifice between abutments. The FSA will be designed and constructed in accordance with the Reservoir Act 1975 and any other associated guidance and legislation. The implementation of the works will be subject to the granting of consents such as planning permission.
- 6.3.11 It is proposed that this FSA is implemented by 2040. Prior to this, we will continue to work with our partner organisations to secure funding. At present it is difficult to obtain firm funding commitments for this FSA as it is not proposed to be implemented in the immediate future. However, London Borough of Redbridge have committed to support the scheme (letter of support included as Appendix K) and the Thames region RFCC are also supportive. Over the next few years we must ensure we make best use of this time available to explore funding options outside of FDGiA. This element of the Strategy is therefore subject to funding availability.

Withdrawal of Maintenance (No Active Intervention)

- 6.3.12 It is not possible to improve or continue with existing flood risk management activities in some areas as there is insufficient economic justification to do so. This is the case for the Roding from its source in Molehill Green to just above Woodford and in the lower part of the catchment (FC1, 2, 4, 5, 6, 13, 14, 15, 16 and 17). Withdrawal of maintenance of the channel and the existing defences (where present) is therefore the

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only option available to us. We will also be withdrawing from the existing flood risk management assets in some parts of Woodford and Redbridge (FC7, 9, 10, 11 and 12), although we will continue with channel maintenance and address public safety issues due to failing structures. It will need to be made clear to the riparian owners that they are responsible for maintaining the integrity of the flood plain, i.e. to maintain the passage of flood water. This is described in more detail on Appendix E. Where the Environment Agency has developed an expectation to continue to sustain a certain standard of service (SoS) to residents and riparian owners, the 2 year period will enable us to inform those affected of their responsibilities, allow them to adapt and change their expectations. A summary of the defences affected is included in the implementation plan Appendix E.

- 6.3.13 Not all defences structures and channel can be left and walked away from. A summary of key assets found in Withdrawal of maintenance areas is shown Table 65 below. Withdrawal is not an option in some cases as the assets performs a flood warning role or would need to be decommissioned, for health and safety reasons, which would result in making flooding worse for 3rd parties.

Table 65 List of key assets where simple withdrawal is not an option

Key Asset	Recommendations	Maintenance	Time scale	Cost implications
Alders Brook Barrage	Hand over the management to the Golf Club or Decommission	Pen Stock and barrage structure require inspection and maintenance	Hand over within 2 years	Cost may materialises during negotiations with the riparian owners and advising on O&M
Passingford Weir	Not owned by EA; however bridge over it is	Brushing off debris and structural monitoring	Hand over within 2 years	n/a
Cranbrook – FSA, defences and channel assets	Maintain – not included within the study but falls within the system studied	Channel and asset	Until further study makes an alternative recommendation	As now
Golf Club Flood defences	Hand over to the riparian owner and tenant (Redbridge / Golf Club)	General maintenance and structural replacement when necessary	Failure expected within 10 to 15 years	1.5 Million replacement costs of maintainer

- 6.3.14 The "Protocol for the maintenance of flood and coastal risk management assets" published in November 2011, outlines the principles and approach to withdrawing maintenance of uneconomical defences. The document recommends a 3 stage approach. These three stages have been set out in the Strategy 'Implementation Plan, Appendix E. In line with this we anticipate implementing a notice period of 2 years for all of these areas affected by withdrawal of maintenance (either from existing assets or existing assets and channel maintenance). Threshold surveys have been undertaken of at key locations predicted to be worse off. These surveys revealed that the threshold of flooding for properties in FC11 will be no worse with Do minimum compared with the loss of defences in the Maintain Option. Royston Gardens was revealed to not be at risk of flooding despite there being a flood wall round the properties. The surveys also helped us to understand the actual number of properties with a potential increase in Flood risk. This resulted in a revised list of 15 down from 22. We will also review funding availability for property level flood resistance / resilience measures.

Other Non-structural Measures

- 6.3.15 Discussions with our Flood Warning team have indicated possible improvements to flood warning such as the incorporation of new telemetry substations along the Roding to improve flood forecasting, particularly in the upper catchment. Flood warning costs have not been included in the strategy.
- 6.3.16 The Strategy also recommends non-structural measures such as sustainable urban drainage systems, resistance/resilience measures such as flood proofing and sustainable catchment management for areas with increasing flood risk. The Strategy also recommends that development of the floodplain continue to be restricted.

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- 6.3.17 In line with national policy, we will continue to work with the local planning authorities to prevent any new development in the floodplain and by influencing planning policy and individual planning applications.
- 6.3.18 Most properties located in a 14 km stretch of the River Roding, between Abridge and Ilford, will benefit from the preferred option. *This means that the majority of properties currently at risk in Woodford, the London Borough of Redbridge and the Loughton area will have an improved standard of protection.* However, in these areas, some open land adjacent to the river and where there are no properties will be permitted to flood more frequently to reduce the risk in places where there are properties.
- 6.3.19 Some properties in the rural parts of the river will see little change in their current flood risk (which may remain relatively high for some properties). These include properties on the Cripsey Brook and the Loughton Brook, as well as the majority of the River Roding upstream of Abridge.
- 6.3.20 A small number of properties, especially in the northern part of the catchment, will either remain at a high risk of flooding or be at increased risk after implementation of the strategy due to the implementation of Withdrawal of Maintenance where it is uneconomic. This approach will allow the river to act more naturally and flow more slowly in some places, holding back flood water. In total 13 properties will be at increased risk in the upper and middle Roding (in areas just upstream of Great Cranfield and close to Leaden Roding, Fyfield and Birds Green (all to the north of Chipping Ongar)). Two additional properties and some areas of farmland near Shonks Mill Bridge, just south of Chipping Ongar will also be at increased risk. We are working with the owners to identify ways of reducing or managing this risk such as improved coverage via the Flood Warning System and flood resistance and resilience measures.
- 6.3.21 A Resistance and resilience or individual property protection project is recommended to be undertaken on approval of the strategy. In total 23 properties remain at Very Significant risk in the catchment post strategy. These qualify for FDGiA funding to carry out individual property protection measures. We propose that the Environment Agency leads a project to study the viability of a project on each of the qualifying properties.

Environmental aspects

Residual environmental risks to be managed at project level

- 6.3.22 *Water quality/Water Framework Directive:* The impacts of preferred Strategy have been considered in respect to the WFD (Appendix J). The preferred option is not predicted to cause deterioration in water body status or prevent the water body from meeting its objectives. At Strategy level there are a number of unknown factors that have led to uncertainty in the WFD assessment as precise elements of design are unknown at this stage. These areas of uncertainty include the width of the bund, the type of flow control structure and how many riparian owners will take up the option to maintain the defences which could be removed. These will be addressed at project level when the design is developed and a full WFD assessment will be undertaken if required.
- 6.3.23 During the strategy and throughout the project development and design stages mitigation measures will be identified and developed to meet the WFD objectives. These will also mitigate for interventions at Shonks Mill and Woodford. Potential mitigation measures for Shonks Mill include:
- Design of culvert to be sufficiently large so that fish can pass through under normal flow conditions;
 - Design of culvert to minimise localised affects, such as scour, that may occur immediately around the culvert;
 - Substrate that matches that of the river bed as closely as possible is to be used, to increase the acceptability of the culvert to fish and invertebrates;
 - Design of culvert to maintain sediment transport from upstream, therefore allowing the replacement of bed materials that are washed out of the culvert during high flows;
 - Incorporation of a mammal ledge or separate otter culvert to avoid otters using the road where possible;

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- f) Planting of bank side vegetation (such as shrubs) at the inlet and outlet points in order to lessen the contrast and make a more acceptable transition;
- g) In agreement with landowners, look to convert arable land to grass pasture within the FSA to keep soil and silt *in situ* and remove the requirement for spraying of pesticides.

- 6.3.24 *Ecological:* Natural England has confirmed its support for the preferred Strategy (letter of Support in Appendix K) and that a Habitat Regulations Assessment is not required. Baseline data collection has identified that protected species including water voles, otters, badgers, great crested newts, stag beetles, kingfishers and bats which have all been recorded within the Roding catchment. Natural England's standing advice for protected species (Natural England, 2011) will be used at project level to decide whether there is a 'reasonable likelihood' of protected species being present in the project area and appropriate surveys and mitigation plans will be implemented.
- 6.3.25 *Recreation:* At project level it will be important to consider the impacts of the design and construction works on recreational activities within the Roding catchment. This is likely to require liaison with PRoW Officers, local angling clubs and canoe clubs which may be affected.
- 6.3.26 *Landscape:* The proposed pumping station by the Winn Brook at Woodford would need to be carefully sited and constructed to minimise potential damage to the mature trees and vegetation that line the brook. The design of both the pumping station kiosks in Woodford and the potential need for screening vegetation would also need to be carefully considered at project level to ensure that the developments would not have a negative visual impact upon the area. The lowering of the public open space at Broadmead, Chigwell Road to create an additional FSA in Woodford will also require a detailed landscape and visual impact assessment at project level to ensure appropriate landscape design. The main impact of the storage area at Shonks Mill will be the embankment, which will also require a detailed landscape and visual impact assessment at project level to ensure that sensitive siting, landform design and planting is incorporated into the final proposal.
- 6.3.27 *Contaminated land:* The baseline data gathering exercise identified that there may be areas of potentially contaminated land within the lower Roding. At project level a targeted Envirocheck should be undertaken to confirm any areas of potentially contaminated land in the vicinity of where proposed structural works are to be undertaken. Site investigations will also need to consider sampling and testing for contaminated land.
- 6.3.28 *Cultural heritage:* There are SMRs within the proposed footprint of Shonks Mill FSA and consultation with English Heritage at project level will identify the need for any specific mitigation. Many of the properties left at an increased risk of flooding are listed: a response from English Heritage is still awaited. However all listed properties qualify for resistance/resilience measures.

Consent Regime and Level of EIA required for the Strategy

- 6.3.29 All of the proposed structural works will require planning permission under the Town and Country planning Act 1990. Works for the Withdrawal of Maintenance or Maintain are likely to be low risk and will not require statutory EIA. Measures to reduce surface water flooding including creation of a FSA at Dartnell's Field (Broadmead), Chigwell Road and installation of pumping stations may require statutory EIA. The proposed works to create Shonks Mill FSA will fall under the Town and Country Planning EIA Regs 1999 (SI 293).
- 6.3.30 Other consents such as Flood Defence Consent, Scheduled Monument Consent, Discharge Consent and PRoW Diversion Consent may also be required to implement the elements of works resulting from the preferred Strategy.

Potential Enhancements as Part of the Strategy

- 6.3.31 Our preferred Strategy, which focuses on managing flood risk, will lead to the natural restoration of the functional floodplain, which will enhance biodiversity in these areas.

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6.3.32 Further improvements to WFD are likely through the following measures:

- a) 'Do nothing' allows natural processes to take place and will lead to less disturbance of the channel bed and margins in some flood cells. As the water moves around debris and vegetation it will create localised flow variability leading to improved morphological diversity within the channel.
- b) At Broadmead FSA it is proposed to include creation of riverside habitat. At Shonks Mill enhancement measures include creation of wet woodland, lowland meadow or grazing marsh BAP habitat.
- c) A number of mitigation measures were discounted on the basis of disproportionate cost which could not be included as part of the Strategy including *flood bunds (earth banks, in place of floodwalls), set-back embankments, remove obsolete structure, operational and structural changes to locks, sluices, weirs, beach control, etc.*

6.3.33 Due to the limited funds available, we have not allowed for any specific enhancements (that are not a natural consequence of our flood risk management approach) in the costs put forward to implement the Strategy. However, where there are opportunities to improve the environment for people and wildlife we will work with and support landowners and others to create recreational and wildlife benefits where possible. Identified potential enhancements that could be incorporated in to the preferred Strategy (subject to funding) are summarised and costed in Table 7.3 of the SEA ER Addendum in Appendix J). Priority enhancements have been rated as priority '1'. These include setting back embankments, marginal shelves, improved marginal zones and wetland habitat creation. WFD funding should be targeted to address relevant opportunities, in partnership with Landowners and Wildlife trusts over the coming years.

Community Engagement

6.3.34 As we implement the preferred Strategy for the fluvial river Roding, we will continue to communicate with the local community, particularly in areas where there will be a change to our flood risk management activities and / or the standard of protection provided.

Costs of the preferred option

6.3.35 No costs are incurred for flood cells 1 and 4, 5, 6 and 13 to 17 as the preferred option in these cells is Option 1 (Do Nothing). The whole life cash cost of implementing the preferred option for flood cells 3, 7 to 12, LB and the Strategic option is set out in Table 6.6.

6.3.36 Maintenance saving compared to current expenditure and forecasts are significant. This amounts to a whole life cost saving of £37 million pounds.

Table 66 Summary of preferred options present value (PV) costs (£k)

Flood Cell	Option	Total Scheme Cost (£k)	Whole Life Cost (£k)	PV Cost (£k)
FC 1/2	Do Nothing	-	-	-
FC3	Maintain – Maintain assets and channel	-	8,658	2,628
FC4	Do Nothing	-	-	-
FC5	Do Nothing	-	-	-
FC6	Do Nothing	-	-	-
FC7	Do Minimum (Channel Maintenance Only)	-	722	215
FC8	Maintain + Reduce Surface Water Flood Risk in Woodford	3,160	18,258	7,553
FC9	Do Minimum (Channel Maintenance Only)	-	212	63
FC10	Do Minimum (Channel Maintenance Only)	-	232	69
FC11	Do Minimum (Channel Maintenance Only)	-	235	72
FC12	Do Minimum (Channel Maintenance Only)	-	473	140
FC13	Do Nothing	-	-	-
FC14	Do Nothing	-	-	-

Flood Cell	Option	Total Scheme Cost (£k)	Whole Life Cost (£k)	PV Cost (£k)
FC15	Do Nothing	-	-	-
FC16	Do Nothing	-	-	-
FC17	Do Nothing	-	-	-
LB	Maintain – Maintain assets and channel	-	6,682	3,516
	Shonks Mill FSA 2	4,685	5,159	3,430
	Resistance & Resilience		300	295
	Withdrawal of Maintenance		461	454
Total	Study Area	7,845	41,392	18,435

Contributions and funding

- 6.3.37 Completion of individual measures will depend on a number of factors, including funding, planning permission, partnership working and public support. Contributions will not be required to change the river management activities, such as channel vegetation and silt clearance, which are routine day-to-day management activities. The level of routine maintenance activities has been determined by analysis of the potential return on investment and best use of public money. However, while some funding has been allocated to option development and preparing the business case, contributions would still be required from private, public and voluntary organisations and communities who will benefit most from future capital works..
- 6.3.38 The whole strategy will only provide the maximum possible benefit by eventually combining the flood storage area at Shonks Mill, the measures for combating surface water flooding at Woodford, and the changes to river management activities. However these recommendations do not depend on one another and each have been economically and technically justified independently of one another. Each element provides a significant proportion of the overall strategy benefits.
- 6.3.39 Although options to alleviate fluvial flooding will be delivered by the Environment Agency, partnership opportunities are being pursued with other organisations, most significantly, the London Borough of Redbridge (LBR). LBR have agreed to support the project as partners with us and, in the case of the Woodford scheme, have the aspiration of taking on the scheme in a lead role, starting with detailed design. A detailed plan will develop as part of the project.
- 6.3.40 The projects have received support from within LBR, including from the Chief Executive and heads of departments. As well as contributing the land on which the schemes are to be located and future maintenance of the flood storage area next to Chigwell Road, the authority is currently seeking and bidding for money from the Greater London Authority and Mayor of London's Outer London Fund to contribute to the Woodford scheme. This bid currently stands at £500k. This bid aims to boost the regeneration of the local area by way of improving confidence in establishing businesses along Chigwell Road with an increased standard of protection. Further effort is to be made to include the scheme in their capital programme and to allocate resources over the coming years. Future bidding opportunities are being investigated, should the current one fail. Both the Woodford scheme and the Shonks Mill Flood Storage Area are being added to the Community Infrastructure Levy (CIL) register, with the focus being on contributing to the latter project. A letter of support from LB Redbridge can be found in Appendix K.
- 6.3.41 Other potential contributors including Transport for London, Thames Water and Drain London. Refer Table 6.7.
- 6.3.42 The Woodford scheme has already secured £200k of local levy funding from RFCC sources. The current local authority contributions are valued at around £30k.
- 6.3.43 Based on these secured contributions, FDGiA calculations for the scheme, (without climate change) show that the Woodford scheme achieves 101% and would require £600k to reach a 120% funding target. If LBR are successful with their Outer London Fund bid, then the 120% target is almost met.

- 6.3.44 With 2011 Climate Change guidance accounted for, the Woodford scheme achieves a funding contribution of 110% from FDGiA and already committed contributions. This would require less than £300k to achieve a 120% adjusted score.
- 6.3.45 Shonks Mill FSA (without climate change) achieves a funding contribution of 26% from FDGiA and requires £3.5 million contribution to reach a 100% score. With 2011 climate change guidance this could improve to 50% FDGiA funding. This could be partly met by Local levy and also London Borough of Redbridge CIL funds.
- 6.3.46 The Shonks Mill FSA project has been presented to RFCC and they are bearing it in mind as a possible candidate for funding. Thames Water may contribute to providing the defence bund around the Little End Sewage Treatment Works. Following discussions, Epping Forest District Council recognise the need for a FSA in the upper catchment and would not object provided all the landowners are satisfied. London Borough of Redbridge are keen to support the project and the two property owners affected and other key landowners are happy to work with us to develop the scheme. Bearing in mind the timing delay to construction it is realistic to generate and implement a strategy for securing funding for the project before the timing becomes critical for the catchment SoP.
- 6.3.47 Funding the scheme from a wider group of contributors, including neighbouring local authorities such as Epping Forest District Council and any significant commercial activities has been investigated. However, the major beneficiary from the Shonks Mill scheme is LB Redbridge. Neighbouring areas do not benefit from the strategy which means contributions from them are unlikely.
- 6.3.48 LB Redbridge have contributed and supported the production of the strategy document, including the attendance and co-presentation of the strategy to the Large Project Review Group (LPRG). Within the draft "Principles for implementing flood and coastal resilience funding partnerships" which is currently out for consultation from DEFRA, it states that strategies require "high level partnerships" and support for the promotion of project. We believe this Strategy achieves both of these objectives. It is currently agreed between LB Redbridge and the Environment Agency that we will continue in the lead role with support from Redbridge. It is the team's ambition that at detailed design stage, the lead role will move to LB Redbridge for project implementation, subject to resource availability. Both parties will continue to identify and seek further internal resources and external contributions to ensure the recommended schemes are successfully implemented.
- 6.3.49 In summary, a potential risk of a funding shortfall exists for both the Woodford scheme and the Shonks Mill Flood Storage Area. However, a plan of actions is in place to find this funding, particularly within the local authority, during the PAR stage. With regards the longer term upstream storage option at Shonks Mill, time is available to further develop commitments and funding opportunities.

Table 67 Summary of potential contributors and actions to seek funding

Potential Contributor	Investment Need	Reason for contribution	Proposed Action
Rural Flood Coastal Committee (RFCC)	Support with schemes needing local levy funding such as Shonks Mill FSR	To attract FDGiA funding / implement affordable schemes that do not attract full FDGiA funding	Regularly brief RFCC with potential schemes within strategy on a regular basis
London Borough of Redbridge (LBR) (Drain London)	Reducing SW flood risk in LBR and particularly in Woodford Maintenance of raised banks within constituency Shonks Mill FSR	Landowner of sites for preferred option Public pressure to alleviate flooding since flood event in 2000	Support LBR with funding applications Involve LBR on scheme appraisal as part of Project Board Handover design and construction commissioning to LBR Investigate possibility of including flood risk schemes on Community Infrastructure (CI) register and contributions from CIL (CI Levy)

Essex County Council	Reducing flood risk to properties at risk in Essex. Support Shonks Mill FSR	Public pressure to alleviate flooding since flood event in 2000	Brief Essex CC with potential local community resistance/resilience schemes eg Hiilmans Cottages Investigate possibility of including flood risk schemes on Community Infrastructure (CI) register and contributions from CIL (CI Levy)
Epping Forest LA	Reducing flood risk to properties at risk in Epping Forest	Public pressure to alleviate flooding since flood event in 2000	Investigate possibility of including flood risk schemes on Community Infrastructure (CI) register and contributions from CIL (CI Levy) but as only minor beneficiary this is highly unlikely
Thames Water	Reducing surface water flood risk	Public pressure to alleviate flooding since flood event in 2000	Working with Thames Water to implement effective improvements to SW flood risk management
Highways Agency / TfL	Reducing flood risk to roads and highways	Protect assets, avoid traffic disruption	Maintain dialogue through scheme appraisal phase
Local residents	Implementing resistance and resilience measures / Individual property protection	Managing own flood risk	Maintain dialogue with residents on possible means of protecting homes
Local businesses	Implementing resistance and resilience measures / Individual property protection Shonks Mill FSR	Managing own flood risk. Corporate Social Responsibility targets	Identify commercial properties at most risk and demonstrate how flood risk measures would manage their risk

6.4 Summary of preferred strategy

6.4.1 The preferred Strategy is summarised in Table 6.8 below.

Table 68 Summary of preferred strategy

Item	Cell 3 Cripsey	Cell 7	Cell 8 Woodford	Cell 9	Cell 10	Cell 11	Cell 12	Loughton Brook	Shonks Mill FSR	Resist & Resil	WoM and H&S	Total
Preferred Option	Maintain	Do Min	Improve	Do Mn	Do Min	Do Min	Do Min	Maintain	Improve	N/A	N/A	
Standard of Protection	1 in 50	1 in 20	1 in 200	1 in 200	1 in 200	1 in 200	1 in 200	1 in 20	1 in 200	N/A	N/A	
PV Costs (£k)												
Capital	175	0	6,213	0	0	0	0	2,619	3,335	0	0	12,342
Non-capital	2,453	215	1,340	63	69	72	140	897	94	295	454	6,092
Total PV Costs	2,628	215	7,553	63	69	72	140	3,516	3,429	295	454	18,434
PV Benefits (£k)	34,007	N/A	101,798	452	121	577	638	25,437	11,464	N/A	N/A	174,494
Average B/C Ratio	12.94	N/A	13.5	7.16	1.8	8	4.5	7.2	3.3	N/A	N/A	
Cash Costs (£k)												
Capital	408	0	13,667	0	0	0	0	3,674	4,785	0	0	22,533
Non-capital	8,250	722	4,592	212	232	235	473	3,008	374	300	461	18,859
Total Cash Costs	8,658	722	18,258	212	232	235	473	6,682	5,159	300	461	41,392

7 Implementation

7.1 Project planning

7.1.1 The preferred option for which funding is being sought includes the works at:

- Woodford Flood Storage Area and Pumping Stations
- Shonks Mill Flood Storage Area
- Household Resistance/ Resilience Works
- Maintenance Regime change, including withdrawal of maintenance and associated costs

Phasing and approach

7.1.2 The delivery of the various measures in the preferred option will be developed in four main work packages. These will include the capital works to create the Woodford Flood Storage Area (FSA) and pumping stations, the Shonks Mill FSA, and to provide Household Resistance/ Resilience Measures, all of which will be driven forward as Capital projects, and the revised Maintenance Regime, which will be driven forward as a Non-Capital project.

7.1.3 The proposed implementation programme for the works recommended by the Strategy is shown below in Table 71, which shows the works carried out in three phases: Immediate/ Design Stage; Short Term Measures; and Long Term Measures.

Table 71 Proposed Strategy Implementation Plan

Measure	Details
2012 - 2013 Immediate/ Design Stage	
Surface Water Storage (developed in partnership with Thames Water and LB Redbridge)	Undertake an appraisal study for surface water storage at Broadmead, Chigwell Road (FC8).
Surface Water Pumping (developed in partnership with Thames Water and LB Redbridge)	Undertake an appraisal study for surface water pumping at Charlie Brown's Roundabout (FC8).
Surface Water Pumping (Environment Agency)	Undertake an appraisal study for surface water pumping on the Winn Brook (FC8).
Maintain standard of protection (Option 3: Maintain)	Maintain all existing defences to their current standard in FC3, FC8 and FC18 (Loughton Brook) and continue with current channel maintenance regime in these cells.
Maintain channel conveyance work (Option 2: Do Minimum)	Maintain channel conveyance through light maintenance such as grass cutting, de-vegetating and debris clearance, and heavy maintenance such as de-silting, in FC7, FC9, FC10, FC11 and FC12. Flood defence assets will not be maintained and will deteriorate over time in these cells, but works will be undertaken to manage public safety.
Do Nothing (No Active Intervention) (Option 1)	Manage the withdrawal of maintenance of flood defences (FC1, FC2, FC4, FC5, FC6, FC13, FC14, FC15, FC16 and FC17) by undertaking works to keep structures safe for users and the public as the assets deteriorate.
Non Structural Measures	Increase the number of at risk properties offered a flood warning service, particularly in middle and upper Roding. Raise awareness of flood risk/ promote flood alleviation measures. Influence regional, sub-regional and local spatial planning early in the process.
Short Term Measures (Year 1-4)	
Surface Water Storage	Broadmead, Chigwell Road surface water storage construction scheme (FC8)
Surface Water Pumping	Pumping station on the Winn Brook and Charlie Brown's Roundabout (FC8)
Flood Storage	Develop funding for the proposed Shonks Mill Bridge FSA.
Maintain standard of protection (Option 3: Maintain)	As Above
Maintain channel conveyance work (Option 2: Do Minimum)	As above

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Measure	Details
Non Structural Measures	As above
Further Studies	Undertake work to investigate location-specific options for those properties which do not benefit from the structural measures proposed by the Strategy.
Long term measures (Year 5-100)	
Maintain standard of protection (Option 3: Maintain)	Maintain existing defences to their current standard in FC3, FC8 and FC18 (Loughton Brook) and continue with current channel maintenance regime in these cells.
Maintain channel conveyance work (Option 2: Do Minimum)	Maintain channel conveyance in FC7, FC9, FC10, FC11 and FC12 and continue with current channel maintenance regime. Flood defence assets will not be maintained and will deteriorate over time in these cells, but works will be undertaken to manage public safety.
Flood Storage	Develop funding from other parties for the proposed Shonks Mill Bridge FSA and develop and implement scheme.
Do Nothing (No Active Intervention) (Option 1)	Manage the withdrawal of maintenance of flood defences (FC1, FC2, FC4, FC5, FC6, FC13, FC14, FC15, FC16 and FC17) by undertaking works to keep structures safe for users and the public as the assets deteriorate.
Non Structural Measures	<p>Improve guidance on sustainable urban drainage systems based on proven schemes and continue to restrict development of the floodplain in the middle and upper Roding.</p> <p>Continuation of non structural measures detailed above and extension of flood warning system.</p> <p>Promote environmental stewardship schemes which have the potential to decrease flood risk by decreasing water and soil runoff from surrounding land.</p>

Programme and spend profile

- 7.1.4 Key dates for the delivery of the capital works programme are shown in Table 72 below, and include the proposed works at Woodford being implemented, in partnership with Thames Water and the London Borough of Redbridge, by 2013 and the works at Shonks Mill implemented by 2022.
- 7.1.5 Prior to the implementation of Shonks Mill, further liaison must be carried out with the London Borough of Redbridge and the Environment Agency's Regional Flood and Coastal Committee (RFCC) for Southeast Region to secure sufficient funding, and the timescale for the Shonks Mill element is there subject to possible amendment. It was identified above that the Shonks Mill work package must be implemented by 2040.
- 7.1.6 Further information relating to the delivery programme can be found in the Implementation Plan in Appendix E.

Activity		Date
Woodford FSA		
Business case approval (Gateway 1)		December 2012
Commence detailed design		January 2013
Approval of design (Gateway 2)		April 2013
Construction start (Gateway 3 – contract award)		June 2013
Construction completion (Gateway 4)		April 2014
Shonks Mill FSA		
Business case approval (Gateway 1)		March 2018
Commence detailed design		May 2020
Approval of design (Gateway 2)		April 2021
Construction start (Gateway 3 – contract award)		September 2022
Construction completion (Gateway 4)		April 2023
Resistance/resilience measures		
Business case approval (Gateway 1)		March 2013
Commence detailed design		May 2013
Approval of design (Gateway 2)		July 2013
Construction start (Gateway 3 – contract award)		October 2013
Construction completion (Gateway 4)		April 2014

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Table 72 Key dates for Capital Works

- 7.1.7 A 5-year annualised spend profile with detailed breakdown has been provided in Table 73, which gives a breakdown of the costs for salaries, fees, compensation, construction and contingency. This includes an optimism bias of between 42% and 60% depending upon the information available on differing elements of the scheme.
- 7.1.8 The spend profile in Table 73 shows gross costs and cash costs for the design and construction of capital and maintenance works in the first 5 years assuming year 0 is 2011.
- 7.1.9 The annual channel maintenance costs for the whole scheme are assumed to reduce from £172K to £133K at the end of this 5 year period as a reduction in upstream channel maintenance should improve the flood storage of the upper Roding.
- 7.1.10 Gross costs have been increased by 2.5% per year for inflation, to give the cash cost. The capital cost of construction of the surface water storage areas is included within the gross capital cost. However, funding for this element of the works has been assumed to be provided by partners (Thames Water and London Borough of Redbridge) so this cost has been excluded from the Environment Agency gross and cash capital costs and the overall cash cost.
- 7.1.11 From year 5 onwards, an annual maintenance cost has been included for works at Shonks Mill Bridge. Likewise, costs are included in the 100 year spend profile for renewal of existing defences.

Table 73 Annualised spend profile and OM priority score

Costs (£k)	2011/12	2012/13	2013/14	2014/15	2015/16	Future Yrs	Total
Woodford Surface Water Reduction Priority Score = 116.53% (see Table 74a)							
CAPITAL		1,616	1,657			36,092	39,365
Salaries		45	46			896	987
Fees		87	89			1,963	2,139
Compensation							0
Construction		877	899			19,699	21,475
Contingency		607	623			13,535	14,765
NON-CAPITAL		18	10	73	20	15,708	15,828
Shonks Mill FSA Priority Score = 25.68% (see Table 7.4b)							
CAPITAL						6,278	6,278
Salaries						263	263
Fees						527	527
Compensation / property purchase						641	641
Construction						3,180	3,180
Contingency						1,667	1,667
NON-CAPITAL						1,747	1,747
Resistance/resilience measures and Withdrawal of Maintenance Priority Score = n/a							
CAPITAL							
NON-CAPITAL		390	400				790

Outcome measures contributions

- 7.1.12 For the works at Woodford, the 'duration of benefits', for which the PV of Whole Life Costs has been assessed, is 52 years, being the period of time before the next major capital investment (i.e. when the assets are due for replacement). The overall numbers of properties/businesses benefiting from the works include 30 households within the 20% most deprived areas; 50 households within the 20-40% most deprived areas and 326 households within the 60% least deprived areas. This scheme results in all these 406 households being reduced from 'Significant Risk' to 'Moderate Risk'. The LB of Redbridge is to carry out long term maintenance of the works.
- 7.1.13 Table 74a below sets out the Outcome Measures (OM) contributions for the Woodford FAS and pumping stations.
- 7.1.14 For the Shonks Mill flood storage area the 'duration of benefits', for which the PV of Whole Life Costs has been assessed, is 60 years, being the period of time before the next major capital investment (i.e. when the assets are due for replacement). The overall numbers of properties/businesses benefiting from the works at Shonks Mill include 66 households within the 20% most deprived areas; 110 households within the 20-40% most deprived areas and 723 households within the 60% least deprived areas. This scheme results in a total of 11 households whose risk is reduced from 'Significant Risk' and 888 houses whose risk is reduced from 'Moderate Risk'. The Environment Agency is to carry out long term maintenance of the works.

Table 74a Medium term Outcome Measures contributions (Woodford)

Outcome Measure	2011/12	2012/13	2013/14	2014/15	2015/16	Future Year	Total
OM1 Economic Benefit							
PV WL Costs (£k)				7553			
PV Benefits (£k)				101,798			
Cash cost of next phase (£k)			1160	1160			
Contributions secured (£k)			730				
OM2 Households better protected against flood risk							
20% most deprived areas				30			
21-40% most deprived areas				50			
60% least deprived areas				326			
OM3 Households better protected against coastal erosion							
	-	-	-	-	-	-	-
OM4: Statutory Environmental Obligations met							
	-	-	-	-	-	-	-
Raw OM Score							93.43%
Adjusted OM Score							116.53%

- 7.1.15 Table 7.4b below sets out the OM contributions for Shonks Mill FSA.

Table 74b Medium term Outcome Measures contributions (Shonks Mill)

Outcome Measure	2011/12	2012/13	2013/14	2014/15	2015/16	Future Year	Total
OM1 Economic Benefit							
PV WL Costs (£k)						3,430	
PV Benefits (£k)						11,505	
Cash cost of next phase (£k)						4,685	
Contributions secured (£k)						0	
OM2 Households better protected against flood risk							
20% most deprived areas						66	

21-40% most deprived areas						110	
60% least deprived areas						723	
OM3 Households better protected against coastal erosion							
	-	-	-	-	-	-	-
OM4: Statutory Environmental Obligations met							
	-	-	-	-	-	-	-
Raw OM Score							25.68%
Adjusted OM Score							25.68%

7.2 Procurement strategy

7.2.1 A procurement strategy review has taken and this outlined the procurement strategy to implement the three identified projects to come out of the Roding Strategy. With the likely earliest start of work on the Shonks Mill upstream flood storage area project in ten years time, it was decided that any strategy would be meaningless and most likely have to change as and when the project starts. Of the other two projects, Woodford Surface Water Solution and the Individual Property Resistance and Resilience projects, will have the following Procurement requirements :-

- Consultancy services to provide appraisal, business case production and in the case of Woodford design services,
- Property surveys assessing individual property protection measures.
- Supply and installation of flood guards.
- Early contractor involvement and works.
- Cost consultancy services.

7.2.2 All the above requirements can currently be met by the Agency's national frameworks that are currently in place. The intention will be to utilise these frameworks when the projects start and a detailed Procurement Strategy will be completed. The procurement strategy that will be used to guide subsequent contract preparation i.e. packaging, design & build etc and the outcomes these should achieve.

7.2.3 The Environment Agency will continue to develop the Woodford Scheme through development of the detailed business case through the project stage. However, the London Borough of Redbridge has expressed a desire to deliver the project with contributions from the Environment Agency, with possible utilisation of the Environment Agency frameworks, at detailed design stage and beyond. This would be supported by the Environment Agency. To date no formal agreement has taken place but the authority are allocating future budgets to enable this to happen. Until confirmation we will deliver the Woodford project with LB Redbridge support. An initial assessment of the project indicates that traditional delivery (consultant design and contractor delivers works), would be suitable for this project with an incentivised PAR.

7.3 Delivery risks

High level risk register

7.3.1 The key risks to delivering this Strategy are set out in Table 75 and a more detailed risk register is presented in Appendix H.

Table 75 Register of High level Risks

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Key Project Risk (and Where)	Category	Risk* Owner	Adopted Mitigation Measure
Risk of funding shortfall for the Woodford Scheme and partnership funding issue	Funding	EA/LBR	Project team have support and commitments from London Borough of Redbridge to exhaustively seek sources of funding, both within their own budgets where possible and from external sources. TFL and Thames Water are both beneficiaries and have been open to further discussions regarding contributions. Further to this the team have presented options to RFCC and received support which may be revisited should further funding be sought.
Key Project Risk (and Where)	Category	Risk* Owner	Adopted Mitigation Measure
Risk of project not being passed on / handed over to the local authority	Funding	EA	We have requested and received future years funding allocations for continued development of the scheme. This will be reduced accordingly if and when the London Borough of Redbridge takes on the project.
Local Authority expectations not managed under funding shortfall	Funding	EA/LBR/ RFCC	As project partners the London Borough of Redbridge are fully aware of the consequences of a funding shortfall and are making efforts to avoid this though seeking contributions
Utilities requiring either temporary or permanent diversion for construction of the works (Woodford FSA)	Design / Construction	EA/LBR	Undertake utility searches of the proposed working areas. Where any utilities are identified within the working area, start dialogue early on and work together to develop the most appropriate design solution. Allow adequate contingency.
Unidentified utilities found during works (Woodford FSA)	Design / Construction	EA/LBR	Undertaken utility searches of the proposed area and trial pits. Allow adequate contingency.
Inaccurate option costs, particularly for sewer connections and disposal for runoff storage and source of materials for FSR upstream of Shonks Mill Bridge (Shonks Mill FSR)	Costing	EA/LBR	O&M costs were based on actuals from SAMPS. Construction costs were compared with known construction costs. Apply appropriate contingency and sensitivity analysis. Further engineering assessment, particularly of runoff storage, is needed at design. Also detailed hydrological and hydraulic modelling of the FSR upstream of Shonks Mill Bridge. Freeboard has been allowed.
Cost increases and optimism in estimates	Costing	EA/LBR	Team analysed potential risks of cost increases based on the data currently available. As a result a range of optimism bias has been applied to the capital costs used in the economic analysis. These have a minimum of 42% and up to 60% increases.
Increased number of properties requiring resistance/resilience measures following an assessment of properties along tributaries (Withdrawal of Maintenance)	Costing	EA/LBR	Ensure adequate risk funding available in FSoD Climate change predictions range from a reduction in flows to significant increases. It is possible that future rainfall patterns will in fact improve the standard of protection provided to the residents in the catchment, reducing the number that require IPP.
Level of compensation payable increases. (Woodford FSA & Shonks Mill FSR)	Costing	EA/LBR	Early liaison with affected parties including use of land agents. Land for Woodford FSA to be provided by London Borough of Redbridge. An Optimism Bias factor has been applied to the costs included
Rejection by local authorities affects planning permissions (Shonks Mill) and progress	WoM	EA/LBR	A well as London Borough of Redbridge, the project team have also held extensive negotiations with Epping District Council, where the upstream storage is located, Essex County Council and several parish councils. Epping DC, the local authority directly up stream of Redbridge, whilst opposing the overall strategy (as some residents will be worse off and it is expecting it will result in increased expenditure) they recognise a need for the flood storage and would not oppose the scheme development if all land and property owners are satisfied / compensated to a mutually agreeable point.
Key Project Risk (and Where)	Category	Risk* Owner	Adopted Mitigation Measure

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Key Project Risk (and Where)	Category	Risk* Owner	Adopted Mitigation Measure
Risk of funding shortfall for the Woodford Scheme and partnership funding issue	Funding	EA/LBR	Project team have support and commitments from London Borough of Redbridge to exhaustively seek sources of funding, both within their own budgets where possible and from external sources. TFL and Thames Water are both beneficiaries and have been open to further discussions regarding contributions. Further to this the team have presented options to RFCC and received support which may be revisited should further funding be sought.
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Local Authority expectations not managed under funding shortfall	Funding	EA/LBR/ RFCC	As project partners the London Borough of Redbridge are fully aware of the consequences of a funding shortfall and are making efforts to avoid this though seeking contributions
Riparian land owners decide to implement channel management of upper catchment, increasing potential downstream river flows.	WoM	EA	Little, and in some areas, no maintenance is currently undertaken in the upper catchment where 'withdrawal of maintenance' is the recommended option. Recommended option will result in minor change to management currently seen on the river. This has been a gradual process over the last 10 years. Despite this reduction riparian owners, the vast majority of which are farmers, have not undertaken any significant maintenance. However, during consultation some local property owners express a desire to maintain the area where they live. The team assessed the risk of the likely intervention by riparian owners and decided that due to the relatively minor changes in floodplain extent and frequency, this would be limited to householders in limited locations and would have no affect on the downstream areas. Hydraulic modelling and economic appraisal has considered what if scenarios of landowners maintaining in areas of Do Nothing
Landowners not maintaining assets that have been transferred back to them including maintaining a free passage for flood water; Network Rail holding riparian owners liable for any flood related damage. (Withdrawal of Maintenance)	WoM	Riparian Owners	Inform riparian owners of liability in accordance with advice from legal; make sure that suitable and sufficient legal agreements are in place. Hydraulic modelling and economic appraisal has considered what if scenarios of landowners maintaining in areas of Do Nothing.

Safety plan

- 7.3.2 The proposed works arising from the Strategy will be implemented in accordance with the CDM Regulations 2007. The parties under the CDM Regulations will be confirmed following the completion of a procurement process (likely to be different parties for various schemes arising from the Strategy).
- 7.3.3 In accordance with the Reservoirs Act 1975 a Reservoir Supervising Engineer will be appointed to oversee the design of the new flood storage areas.
- 7.3.4 Public safety will be a key consideration in the development of any scheme resulting from this Strategy. For all schemes where we are to own / maintain / operate the new asset post construction, we will undertake a Public Safety Risk Assessment prior to construction to capture any public safety elements in the design.
- 7.3.5 Where we are withdrawing maintenance we would ensure that failing assets would be made safe such as providing warning notices and temporary fencing to avoid injury to the public.

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Appendix A

Entries required in clear boxes, as appropriate.

GENERAL DETAILS

Authority Project Ref. (as in forward plan):

Project Name (60 characters max.):

River Roding Flood Risk Management Strategy

Promoting Authority: Defra ref (if known)

Name

Environment Agency

Emergency Works:

No ☐ Yes/No ☐

Strategy Plan Reference:

N/A

River Basin Management Plan

Thames

System Asset Management Plan

Roding 01, 02, 03, 04, 05, Cripsey Brook, Loughton brook,

Shoreline Management Plan:

N/A

Project Type:

Strategy

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:

20

Contract type*

Framework

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

COSTS

Appraisal:

£893

Costs for Agency approval:

£41,392

Total Whole Life Costs (cash):

£42,285

APPLICATION (£000's)

For breakdown of costs see Table in Section 2.4

CONTRIBUTIONS

Windfall Contributions:

n/a – pending

Deductible Contributions:

n/a – pending

ERDF Grant:

n/a

Other Ineligible Items:

n/a

LOCATION - to be completed for all projects

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

South East / NE Thames

Name of watercourse (fluvial projects only):

River Roding

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District Council Area of project (all projects):	Redbridge
EA Asset Management System Reference:	RF17S090
Grid Reference (all projects):	541791, 191335

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

DESCRIPTION

Specific town/district to benefit:

Redbridge (Woodford) , Epping (Chipping Ongar) and Uttlesford (Great Canfield)

Brief project description including essential elements of proposed project/study
(Maximum 3 lines each of 80 characters)

The recommendations of the River Roding Flood Risk Management Strategy consist of Withdrawal of Maintenance with associated Individual Property Protection, constructing a local Flood Storage Area and Pumping Stations (Woodford) and, in the medium term, a strategic Shonks Mill Flood Storage Area.

DETAILS

Design standard (chance per year):

1.3 to 0.5% AEP yrs

Existing standard of protection (chance per year)

5% to 1.3% AEP yrs

Design life of project:

100 yrs

Fluvial design flow (fluvial projects only):

N/A m³/s

Tidal design level (coastal/tidal projects only):

N/A m

Length of river bank or shoreline improved:

50km naturalised m

Number of groynes (coastal projects only):

N/A

Total length of groynes* (coastal projects only):

N/A m

Beach Management Project?

No Yes/No

Water Level Management (Env) Project?

No Yes/No

Defence type (embankment, walls, storage etc)

Storage

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

ADDITIONAL AGREEMENTS:

Maintenance Agreement(s):

LB Redbridge (pending)

Not Applicable/Received/Awaited

EA Region Consent (LA Projects only):

Not Applicable/Received/Awaited

Non Statutory Objectors:

No Yes/No

Date Objections Cleared:

N/A

Other:

N/A

Not Applicable/Received/Awaited

ENVIRONMENTAL CONSIDERATIONS

Natural England (or equivalent) letter:

Received

Not Applicable/Received/Awaited

Date received

10/08/2011

SITES OF INTERNATIONAL IMPORTANCE

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

Special Protection Area (SPA):

No Yes/No

Special Area of Conservation (SAC):

No Yes/No

Ramsar Site

No Yes/No

World Heritage Site

No Yes/No

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Other (Biosphere Reserve etc)

No

Yes/No

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

Environmentally Sensitive Area (ESA):	No	Yes/No
Site of Special Scientific Interest (SSSI):	Yes	Yes/No
National/Regional Landscape Designation:	No	Yes/No
National Park/The Broads	No	Yes/No
National Nature Reserve	No	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	Awaited	Not Applicable/Received/Awaited
Water Level Management Plan Prepared?	Yes	Yes/No
FEPA licence required?	N/A	Not Applicable/Received/Awaited
Statutory Planning Approval Required	Yes	Yes/No/Not Applicable

COMPATIBILITY WITH OTHER PLANS

Shoreline Management Plan	N/A	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	Yes	Yes/No/Not Applicable
Local Environment Agency Plan	No	Yes/No/Not Applicable

SEA/ENVIRONMENTAL IMPACT ASSESSMENT

SEA	Agency voluntary	Statutory required/Agency voluntary/not applicable
EIA	N/A	Yes (schedule 1); Yes (schedule 2); SI1217; not applicable
SEA/EIA status	Scoping report 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; DEF
FW: improves flood warning; ST: study; OTH: other projects)

LAND AREA	
Total area of land to benefit:	312 Ha

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of which present use is:		FRM	CERM	
	Agricultural:	n/a	n/a	Ha
	Developed:	312	n/a	Ha
	Environmental/Amenity:	n/a	n/a	Ha
	Scheduled for development	n/a	n/a	Ha

PROPERTY & INFRASTRUCTURE PROTECTED

	Number		Value (£'000s)	
	FRM	CERM	FRM	CERM
1Residential	1,122	n/a	397,396	n/a
Commercial/industrial	32	n/a	7,634	n/a
Critical Infrastructure	M11, A113, 4 sub-stations	n/a	n/a	n/a
Key Civic Sites	n/a	n/a	n/a	n/a
Other (description below):	n/a	n/a	n/a	n/a
Description:				

Costs and Benefits

1Present value of total project whole life costs (£'000s):		18,500	
Project to meet statutory requirement?	Y/N	y	
		Value (£'000s)	
		FRM	CERM
Present value of residential benefits:		175,000	
Present value of commercial/industrial benefits:		incl	
Present value of public infrastructure benefits:		incl	
Present value of agricultural benefits:		incl	
Present value of environmental/amenity benefits:		incl	
1Present value of total benefits (FRM & CERM)		incl	
Net present value:		15,000	
Benefit/cost ratio:		9.4	
Base date for estimate:		Dec 2011	
FCERM-AG Decision Rule stage 3 applied		Yes	Yes/No
FCERM-AG Decision Rule stage 4 applied		No	Yes/No

OTHER OUTCOME MEASURE SCORING DETAILS

Super Output Area No*:	E02000759	Indicate if deprived:	Yes	Yes/No				
(*as ranked by Indices of Multiple Deprivation)								
Risk:	H	VH, H or N/A						
Net gain of BAP habitat:	<table><tr><th>Wetland</th><th>Saltmarsh/ Mudflat</th></tr><tr><td>n/a</td><td>n/a</td></tr></table>		Wetland	Saltmarsh/ Mudflat	n/a	n/a	Ha	
	Wetland	Saltmarsh/ Mudflat						
n/a	n/a							
SSSI protected:	0	Ha						
Other Habitat:	0	Ha						
Heritage Sites:	20+	"I or II" , "II or other" or "N/A"						

Exemption Details (if exempt from OM scoring system)

Exempt from Scoring: No Yes/No

Reason (max 100 chars):

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