Strategy Appraisal Report

Authority Scheme Reference	IMTH000616
Defra / WAG LDW Number	
Promoting Authority	Environment Agency
Scheme Name	Oxford Flood Risk Management Strategy

Low level flooding in West Oxford, July 2007

Date	June 2010
Version	V7

StAR for Oxford Flood Risk Management Strategy

Version	Status	Signed off by:	Date signed	Date issued
0	Internal Draft	Lise Taylor Richard Young	Mar 2009	Feb 2009
1	External Draft	As per Approvals Sheet	Apr 2009	Mar 2009
2	Final	As per approvals sheet	May 2009	Apr 2009
3	1st Revision NRG		Jul 2009	Jul 2009
4	2nd Revision NRG		Dec 2009	Dec 2009
5	3rd Revision NRG (responding to NRG questions)	As per approvals sheet	Feb 2010	Feb 2010
6	4th Revision NRG (responding to NRG questions)	As per approvals sheet	Apr 2010	Apr 2010
7	5th Revision NRG (update on whole life costs in response to Head of Asset Management query)	As per approvals sheet	June 2010	June 2010

CONTENTS

Environment Agency approval history sheet			
Strategy title: Oxford FRM Strategy		**Environment Agency project code: IMTH000616**	
Environment Agency project manager: William Chan		**Date of StAR: April 2010**	
Consultant project manager: David Wilson		**Consultant: Black & Veatch**	
Environment Agency staff involvement			
Position	**Name**	**Signature**	**Date**
'I have reviewed this document and confirm the project meets Environment Agency and Defra/WAG criteria and recommend approval'			
Originator (PM)	William Chan		
Reviewer (ncpms project executive)	Angelin Hallaways		
'I confirm I am content for the strategy as described in this document to proceed for approval and that strategic level risks have been identified.'			
Client representative	Simon Hughes		
NEAS Unit Manager	Phil Griffiths		
'I have reviewed this document and confirm that it complies with the current StAR guidelines.'			
StAR Reviewer	Nigel Widgery		
'I confirm I am content that the strategy as described in this document contributes to the delivery of our FRM Policy objectives as defined in the relevant CFMPs/SMPs, and that the strategy can proceed for approval.'			
Regional FRM Strategic and Development Planning Team Leader	Dave Bedlington		
'I confirm the project is ready for submission to PAB/NRG.'			
Regional Operations Manager	Rob Hall		
NRG – National Review Group			
Date of meeting:	**Chairman:**	**StAR amendment no:**	
Presenter(s):			
Detailed record of any comments/actions required/additional information provided, to be appended to the StAR for onward transmission.			
Recommended for approval: In the sum of £:	**Date:**		
Strategy approval			
Environment Agency	Head of ncpms and officers in accordance with the Environment Agency's SoD: Specified Officer; Regional Director; Director of Operations; Chief Executive or Director of Finance: Environment Agency Board		
StAR Submitted	**Date:**		
Strategy Approval	**By:** In the sum of: £	**Date:**	
Defra or WAG Approval (Delete as appropriate)			
Submitted to Defra/WAG or not applicable (as appropriate)	**Date:**		
StAR amendment no. (if different):			
Defra/ WAG Approval: or not applicable (as appropriate)	**Date:**		

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FINANCIAL SCHEME OF DELEGATION (SoD) COVERSHEET

1.

Project name	Oxford Flood Risk Management Strategy			Start date	2002
				End date	2010
Business unit	Thames Region, FRM		Programme	FDGiA	
Project ref.	IMTH000616	Regional FSoD ref.		Head Office FSoD ref.	

2.

Role	Name	Post Title
Project Sponsor	Howard Davidson	Regional Director
Project Executive	Simon Hughes	West Thames Area Manager
Project Manager	William Chan	ncpms Project Manager

3.

Outline Risk Assessment (ORA) Category	Low	☐	Medium	☐	High	☒

4.

FSoD schedule		Description	Delegation	
			Regional – up to	Environment Agency – up to
A1	☐	Non FRM project	£5m	£5m
A2	☐	FRM project within approved strategy	£5m capital	£50m WLC Defra/£5m capital NAW
A3	☐	FRM project outside of approved strategy	£5m capital	£50m WLC Defra/£5m capital NAW
A5	☐	Consultancy project	£300k	£500k
A9	☒	FRM Strategy	£500k	£50m WLC Defra/£5m capital NAW
O1	☐	IS/IT project	--	£5m
T2	☐	Purchase or lease of land and buildings	£40k purchase/£10k pa lease	£5m

5.

FSoD value	
Preparation costs for Form A/Business Case/PAR/FRM Strategy	-
Project costs	-
Whole Life Costs (WLC) of FRM Project or Strategy	£63M

6.

Required level of Strategic Environmental Assessment (SEA)			Medium ☐	High ☒

7.

FSoD approver name	Post title				Signature	Date
Paul Leinster	Chief Executive					
FSoD consultee name	Post title				Signature	Date
Richard Williams	NRG Chair	RED ☐	AMBER ☐	GREEN ☐		
Miles Jordan	ncpms Manager					
Simon Hughes	West Thames Area Manager					

8.

Form G	Form G value (£k)	Regional FSoD ref.	Head Office FSoD ref.	Latest FSoD authorised cost (£k)
1	141	1256	N/A	364
2	1,762	1256	S014-25/04/07	2,126

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Submission to obtain strategy approval

Thames Region: Oxford Flood Risk Management Strategy ***£63M***

Sponsoring Director: David Jordan - Director of Operations

Approval route

FCERM Strategies /Complex Change Projects, following recommendation for approval from the National Review Group, is Regional Director and Director of Operations. A new NFSoD coversheet for sign off is currently being produced and should be available very soon.

EXECUTIVE SUMMARY

1.0 Introduction and background

1.1 This Strategy Appraisal Report (StAR) describes the Environment Agency's Flood Risk Management Strategy for the 100 year period to 2109 for the city of Oxford and its surrounding villages. The key objectives of the Oxford Strategy are to: identify sustainable solutions to reduce flood risk to people and property; reduce the disruption and financial loss associated with road and railway flooding; improve the human and natural environment for the quality of life of people and benefit of wildlife; and to be adaptable to future climate change.

1.2 This StAR implements the Thames Catchment Flood Management Plan's (CFMP) Upper Thames unit policies UT1 and UT6, which promote increasing conveyance in urban locations and improved use of floodplains in rural locations, respectively. This Strategy will also contribute to the Water Framework Directive (WFD) targets for maintaining and improving good ecological status or achieving good ecological potential in watercourses and the key aims of the Defra-led programme 'Making Space for Water', as well as contribute to the Environment Agency's corporate strategy 'Creating a Better Place'.

1.3 The Study Area is bounded by Sandford Lock on the River Thames (south of Oxford), Kings Lock on the River Thames (north west of Oxford) and the floodplain boundaries of the River Thames and River Cherwell as defined on the Environment Agency's flood map. The Indicative Strategy Boundary (known in the Strategic Environmental Assessment Environmental Report (Appendix A) as the 'Study Area'), where the impacts of options have been considered, extends from the villages of Cote in the north west and Charlton-on-Otmoor in the north east to Abingdon in the south. The Study Area and Indicative Strategy Boundary are shown in Key Plan 2.1.

1.4 The catchment draining to Sandford Lock is 3,086km^2, with its source in the Cotswold Hills to the north west. The lengths of the River Thames and River Cherwell in the Study Area are approximately 15km and 6km respectively. Complex networks of secondary watercourses (which are mostly located in the floodplain to the west) contribute towards flow conveyance through and around Oxford (see Key Plan 2.2).

1.5 There are no formal raised flood defences in Oxford and therefore the onset of flooding and standard of protection (SoP) to properties and infrastructure varies throughout the Study Area. The complex river network (which interconnects throughout the Study Area) means that flooding in the key residential areas is interdependent, i.e. solving the problem in one area could lead to a greater risk of flooding in others. Therefore the system is considered as a single flood cell.

1.6 Periodic routine (and occasional reactive) maintenance is currently carried out on the river system. An effective flood warning service is available to properties within the flood risk area. This service has been improved in recent years with the extended direct warning project, resulting in a public take up of 87%.

1.7 Works will be carried out under the Water Resources Act 1991 for capital schemes. Non-structural measures will be undertaken by either the Environment Agency or third parties supported by the Environment Agency.

2.0 Problem

2.1 The Oxford area has a long history of flooding. Severe flooding occurred in 1894 and 1947, and more recently in 2000, 2003 and 2007. The key areas affected are Botley, Osney, Grandpont and New Hinksey. There is also flood risk associated with outlying areas such as Wolvercote, South Hinksey and Kennington.

2.2 Floods in the study area are lengthy, typically 7 to 9 days. The onset of flooding to property occurs in a 1 in 5 year (20% annual exceedance probability (AEP)) flood event when approximately 1,059 properties are at risk. There are 3,348 properties at risk in the 1 in 100 year (1% AEP) flood extent. With predicted climate change impacts the number of properties at risk in this event will increase to >4,800 by 2109.

2.3 The presence of a gravel aquifer, and the high surface water and groundwater connectivity, leads to a risk of groundwater flooding, particularly in the areas of Osney, Grandpont and New Hinksey.

2.4 Traffic disruption is a significant problem during flood events, especially on two of the main arterial routes into the city centre and the railway line which forms a key part of the freight network. The city of Oxford is an important employment centre, internationally renowned seat of learning and a popular tourist destination. Disruption to major infrastructure severely impacts Oxford's ability to function during flooding, with significant effects on the local economy.

3.0 Options

3.1 The Strategy was divided into two stages. In Stage 1 a long list of over 100 options was appraised, and it was concluded that the structural measures of improving flow conveyance and upstream storage should be further considered.

3.2 In Stage 2 these structural measures were optimised and a suite of Additional Measures included (see Table 1.1) to form the short list of Do Something Options (see Table 1.1). Option 1 - Do Nothing, Option 2 - Do Minimum and Option 3 - Do Minimum Sustain were also considered.

Table 1.1 Short List of Do Something Options

Option	Key Component(s)
1	Do Nothing No new flood alleviation schemes would be promoted and no maintenance works carried out to channels or existing flow control structures.
2	Do Minimum Maintenance of existing flood defence assets until failure.
3	Do Minimum Sustain Maintenance of existing flood defence assets until failure, then replacement of structures.
3b	Do Minimum Sustain & Additional Measures As Option 3, with Additional Measures which comprise: • Short Term Measures Phases 1 and 2. • Raised defences at the village of Wolvercote.

Option	Key Component(s)
	• Development and implementation of a Multi-Agency Flood Plan (MAFP) for Oxford. • Improved watercourse maintenance regime. Provision of flood resilience measures to individual residential properties.
4	Enhanced Maintenance & Additional Measures [A] Enhance maintenance on all secondary watercourses in the Study Area.
5, 6, 7	Western Conveyance Channel & Additional Measures [A] Increase flow conveyance to the west and south west of Oxford by constructing new sections of channel and/or enlarging existing channels to convey an estimated maximum in-bank flow of 18 m^3/s (small channel, option 5); 38 m^3/s (medium channel, option 6); or 57 m^3/s (large channel, option 7). Includes creation of priority BAP habitat
8, 9	Western Conveyance Channel, Upstream Storage & Additional Measures [A] Options 8 and 9 have a small and medium conveyance channel respectively (as options 5 and 6 above) and a temporary flood storage area. Includes creation of priority BAP habitat.
[A] Options 4 to 9 include all elements of Option 3b (Do Minimum Sustain and Additional Measures)	

4.0 Recommended strategy

4.1 The preferred strategy considers reduction of the flood risk in Oxford over the long term. Not only does it consist of the best value options in the shorter term but it also considers the effects of climate change in the medium to longer term.

4.2 The PAG decision rule preferred option based on current fluvial flows is Do Minimum Sustain with Additional Measures (Option 3b). This will reduce the risks of fluvial flooding to 1,642 properties and associated critical infrastructure for a 1:75 (1.33% AEP) flood event when all elements are implemented.

4.3 Do Minimum Sustain will allow us to maintain our flood defence assets until failure and then replace them over the life of the strategy.

4.4 The Additional Measures are mainly focussed on higher frequency flood events and will comprise:

(a) Short Term Measures Phases 1 and 2.
(b) Raised defences at the village of Wolvercote.
(c) Development and implementation of a Multi -Agency Flood Plan (MAFP) for Oxford.
(d) Improved watercourse maintenance regime.
(e) Provision of flood resilience measures to individual residential properties.

4.5 The improvements that will be achieved with Option 3b are:

(a) Short Term Measures Phase 1 is already benefiting 96 properties that will no longer be at risk of flooding in a 1 in 20 year event. Phase 2 will build on the work completed during Phase 1 and continue to address and improve the Standard of Protection to the remaining 580 properties that flood in a 1 in 20 year event (5% AEP).
(b) At Wolvercote, 83 properties will benefit from an increased Standard of Protection of 1 in 75 (1.33% AEP).
(c) The Multi-Agency Flood Plan will reduce the consequence of flooding to all residents and businesses within the study area.
(d) Improved watercourse maintenance regime will help maintain the increased flow capacity achieved through the de-silting and vegetation obstruction clearance undertaken as part of Short Term Measures Phase 1 and 2 thereby prolonging the initial benefits that these achieve.
(e) 112 properties will have flood resilient measures installed which will provide an estimated reduction (of 62%) in flood damages.

4.6 At this stage of the Strategy cycle a western conveyance channel is not an economically justified option under the PAG (or FCERM) decision rule. This option does have a healthy Benefit Cost Ratio of between 7 -10 when taken in isolation but when considered in addition to option 3b the benefits do not sufficiently outweigh the additional costs. Please see section 2.7 Choice of Preferred Option for further detail.

4.7 However, over the 100 year appraisal period peak fluvial flows may increase depending on the impacts of climate change. The future impacts of climate change on flows will be monitored; evidence collated and reassessed for each periodic review of the StAR. If flows increase at the rates included in the current Defra guidance on climate change it may in the future be economically justified to implement the following elements in addition to Option 3b:

(a) Western Conveyance channel (based on Defra guidance, it might be implemented in the medium term – 2039 to 2079)
(b) Upstream Storage (based on Defra guidance, it might be implemented in the long term – 2079 to 2109)

4.8 As there is some uncertainty about when and if these elements would be constructed during the strategy timeframe the construction costs have not been included in this approval.

4.9 The Western Conveyance channel would extend from Botley Road to Sandford Lock, and will convey a maximum in-bank capacity of 38 m^3/s (see Key Plan 2.1). For comparison, the Thames carries approximately 55 m^3/s of in-bank flow at Botley Road and the secondary watercourses convey a further 25-35m^3/s at the same location. This intervention will increase the SoP of approximately 2,353 properties from as low as 1 in 5 (20% AEP) in 2008 to 1 in 75 (1.33% AEP), and for road traffic and the main railway line from 20% and 10% AEP respectively to 2%. A further 83 properties will benefit from a SoP that is better than is currently afforded as result of raised defences at Wolvercote. Property numbers refer to improvements from the Do Nothing scenario.

4.10 Implementation of Upstream Storage would provide a SoP of 1 in 75 (1.33% AEP) for about 2,707 properties in conjunction with the Western Conveyance channel.

4.11 If the Western Conveyance channel was implemented environmental enhancement would include the creation of 115 hectares of Biodiversity Action Plan (BAP) habitat. The BAP habitat will comprise floodplain grazing marsh, lowland meadows and ponds. The habitat will be located within the wider Indicative Strategy Boundary (see Key Plan 2.1) where areas have been identified using the Oxford Nature Conservation Forum's Conservation Target Areas. Economic benefits associated with BAP habitat creation are included in the appraisal.

5.0 Economic case and Outcome Measures

5.1 The Strategy has been developed in line with the Flood and Coastal Defence Project Appraisal Guidance (FCDPAG3). The period of economic appraisal is 100 years. Table 1.2 summarises the economic case for the Preferred Strategic Option (Option 3b). Outcome Measures are provided for the Additional Measures projects, as they will be delivered in the short term.

Table 1.2 Economic Case and Outcome Measures Score

Present value costs	Present value benefits	Net present value	Benefit cost ratio	Cost per residential property
£24.6m	£1,086m	£1,061m	44.2	£15k
Project				**OM Score**
Wolvercote defences				3.68
Multi Agency Flood Plan				37.77
Short term Measures 1				5.99
Short term Measures 2				6.00
Flood Resilience Measures				0.50

6.0 Environmental and social considerations

6.1 A non-statutory Strategic Environmental Assessment (SEA) was carried out as part of the Strategy (Appendix A). The area contains rich ecology and archaeology, supports recreational activities and provides unique views towards Oxford. These factors have been considered in the option development and appraisal.

6.2 Oxford Meadows Special Area of Conservation (SAC) requires particular flooding regimes. Under the Habitats Regulations Assessment (HRA), an Appendix 11 assessment has been completed which concludes no significant impact (alone or in combination with other plans or programmes) on the site through implementation of the Strategy. Natural England has provided a letter of support (Appendix E), which confirms that the Strategy does not require an Appropriate Assessment under the Habitats Regulations (an Appendix 12).

6.3 Extensive consultation has been undertaken with key stakeholders and the general public throughout the last 7 years since the 2003 floods. These have been in line with the 'Building Trust with Communities' approach (further information is provided in Appendix F).

6.4 Five early engagement meetings (in the Upstream Storage area, downstream in Abingdon and in Oxford) were also held with elected representatives and landowners prior to publication of the Public Consultation Document and SEA Environmental Report in February 2009.

6.5 Consultation on the SEA Environmental Report has taken place with Environment Agency internal functions, statutory consultees, wider external stakeholders and the public. The 12 week period of external consultation ended on 12th May 2009. Eight public meetings and exhibitions were held during this period across the Study Area to gather comments and hold discussions.

6.6 Public consultation has identified only a limited concern regarding the impact of conveyance schemes on downstream communities. Direct, continued engagement with councillors by the Area team is aimed at managing these concerns.

7.0 Risks

7.1 The delivery risks of the Strategy and their proposed mitigations are listed in Table 1.3.

Table 1.3 Delivery Risks

Risk	Mitigation
Climate Change does not occur in accordance with current Defra supplementary guidance.	Periodic reviews of the Strategy will consider the latest climate change guidance and reassess when it might be economically justifiable to implement Western Conveyance and, later, Upstream Storage.
Further monitoring identifies significant impacts that cannot be mitigated on Oxford Meadows SAC or the SSSIs within the	*(NB: This only affects the Upstream Storage element of the Strategy)* Work closely with local partners to understand the risks. Prepare environmental monitoring plan (see Section 8 on the SEA Environmental Report, Appendix A).

Risk	Mitigation
upstream storage area as a result of Upstream Storage	Periodically review climate change predictions and guidance.
Affordability	Seek third party contributions and continue to explore other funding mechanisms.
Scheme does not achieve planning permission	Close liaison with statutory consultees and the general public. High quality submission environmentally.

8.0 Implementation

8.1 The Additional Measures will be implemented in the first 9 years of the Strategy.

8.2 It may be justifiable for the Western Conveyance channel to be implemented in the medium term if river flows increase due to climate change, which would lead to an appropriate incremental benefit cost ratio. If an incremental benefit cost ratio of ~1.5 is used as the decision point, then the estimated implementation date is between 2039 and 2079. It may be appropriate to implement downstream reaches of Western Conveyance channel earlier, i.e. before the remainder of the channel.

8.3 To further mitigate the effects of climate change, implementation of 10Mm^3 of Upstream Storage on the Thames might be possible in the long term (currently estimated as 2079-2109).

8.4 The recommendations of this Strategy are based on the current Defra Supplementary Note on Climate Change Impacts. Proactive reviews of the Strategy are recommended to accommodate revisions to climate change guidance which are likely to impact the implementation dates of both the Western Conveyance channel and Upstream Storage.

8.5 Short Term Measures 1 (an 'Additional Measures' element) was developed under a framework for action in accordance with PAG2 guidance. These works were brought forward to provide an interim reduction in flood risk to key areas in Oxford. The project is supported by Project Appraisal Report IMTH001301 Version 3.2 approved in June 2008 by the Thames Region Project Approval Board. This project was completed in November 2009.

8.6 A Form A promoting the implementation of Short Term Measures 2 was approved by the Thames Region Project Approval Board in November 2009.

8.7 Form As for the other Additional Measures will be submitted for approval in 2010/11.

8.8 The cost of the Strategy over the 100 year appraisal period is shown in Table 1.4

Table 1.4 Summary of Whole Life Cash Costs for Preferred Strategic Option (£k)

Item	Shot Term Measures 1	Short Term Measures 2	Multi Agency Flood Plan	Defences at Wolvercote	Flood Resilience	Total £k
Costs pre StAR						2,800
Capital costs for first 5 years						
Gen Items (EA, consultants, surveys)	716	200	110	334	0	1,360
Construction costs	851	855	0	1,112	2,395	5,212
Environmental enhancement costs	19	0	0	0	0	19
Land Purchase / Compensation	110	0	0	31	0	141
Optimism Bias [A]	0	445	0	733	958	2,136
Inflation @ 2.5% per annum	0	76	10	353	258	
Total capital cost for first 5 years (£k)	1,696	1,576	120	2,563	3,611	
Future costs (years 6 – 100)						
Future costs Multi Agency Flood Plan						650
Future costs flood resilience						2,395
Maintenance costs (100 yrs)						50,973
Whole life cash cost (inc. maintenance, but not inflation)						62,887
Rounded to £63M for approval, including £2M Optimism Bias (3% of Strategy cost)						

[A] 40% of Short Term Measures 2, 55% of Defences at Wolvercote, 40% of Flood Resilience

9.0 Contributions and Funding

9.1 Consideration will be given to seeking contributions from Oxford City Council regarding the West End Area Action Plan.

9.2 Contributions to the creation of BAP habitat in the medium term, amenity and/or access and recreational use of landscape will be sought via external funding, for example the Heritage Lottery Fund. This will be applied for in partnership with other organisations such as wildlife trusts.

10.0 Status

10.1 A series of small scale flood risk management measures will reduce flooding in the short term. Implementation of major flow conveyance improvements in the medium term, and provision of an upstream storage area in the long term, will mitigate the impacts of increases in fluvial flows attributed to climate change. The medium and long term measures will need to be considered in future local plans, working with Oxford City Council, to safeguard these areas of land.

10.2 The Strategy promotes BAP habitat opportunities which are in line with Environment Agency Outcome Measures and Thames Area targets.

10.3 This Strategy requires Defra/WAG and Treasury approval.

11.0 Recommendations

11.1 It is recommended that the Oxford Flood Risk Management Strategy is approved in order to manage the risks of fluvial flooding to 1,642 properties and associated critical infrastructure.

11.2 The Whole Life Cost (excluding inflation) is £63M. This includes a contingency of £2M.

The Executive summary ends here

Directors briefing paper

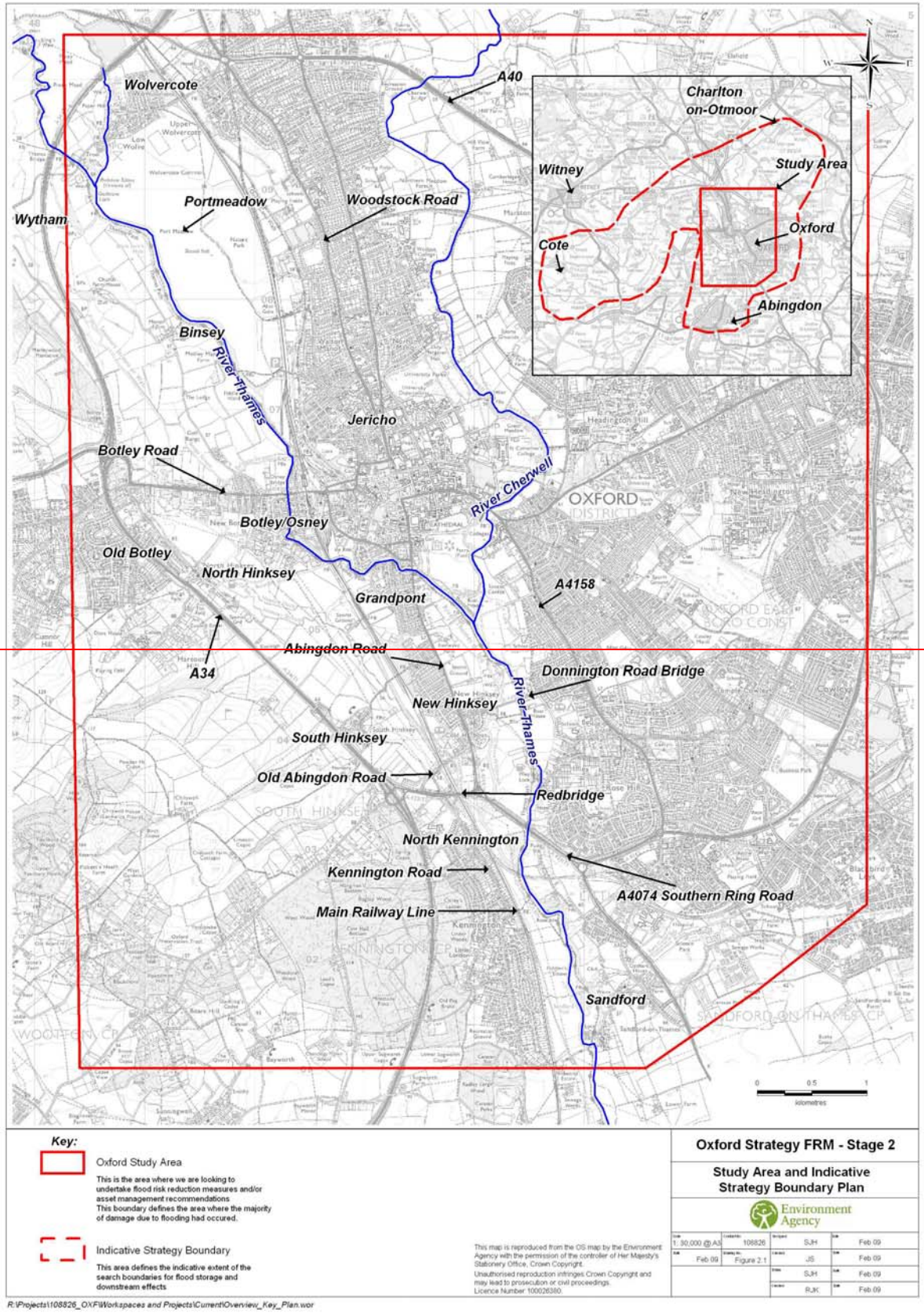
Region:	Thames		**Project executive:**	Simon Hughes	
Function:	Flood Risk Management		**Project manager:**	Angelin Hallaways	
Strategy title:	Oxford Flood Risk Management Strategy		**Code:**	IMTH000616	
NEECA consultant:	Black & Veatch	**NCF contractor:**	Team Van Oord	**Cost consultant:**	EC Harris

The problem:	An intricate network of watercourses with insufficient capacity (and the lack of formal raised flood defences) leads to extensive fluvial flooding. The presence of a gravel aquifer, and the high surface water and groundwater connectivity, leads to a risk of groundwater flooding.
People at risk: Probability of exposure: Consequence of exposure:	Over 3,500 properties are currently at risk in the 1 in 100 year (1% AEP) flood event. Local floods have been lengthy, typically 7 to 9 days. The onset of flooding to property occurs in a 1 in 5 year (20% AEP) flood event, placing 1,059 properties at risk.
Environmental resources at risk: Probability of exposure: Consequence of exposure:	Scheduled Monuments, listed buildings and buried archaeology, recreational resources (including navigation) and existing land uses at risk from repeat flood events. Oxford Meadows SAC, Iffley Meadows SSSI, Chimney Meadows SSSI and Langleys Lane Meadow SSSI can be adversely affected during large and / or prolonged flood events.
Assets at risk from flooding: Probability of exposure: Consequence of exposure:	1 in 5 year (20%) flood event closes two main roads (the A420 and A4144) which service Oxford city centre and the main railway line (passenger and freight) between London, Southampton and the Midlands.
Description of proposed strategy:	A series of small scale flood risk management measures will reduce flooding in the short term. To mitigate against any increases in fluvial flows attributed to climate change periodic reviews will be held. These will be used to collate evidence and justify implementation of major flow conveyance improvements in the medium term, and provision of an upstream storage area in the long term.
Outcome for people at risk:	1,642 properties (assuming no climate change) will be protected to a 1 in 75 year (1.33% AEP) flood event when all elements are implemented; as a result of resilience measures a further 112+ properties will have an improved standard of protection, although not to the 1.33% level.
Outcome for environmental resources at risk:	Reduction in flood risk to some cultural heritage assets, and recreational resources including Public Rights of Way. There is likely to be no significant impact on Oxford Meadows SAC. The scheme will create 115ha of fluvial BAP priority habitat in the medium to long term. Further research is recommended to investigate the potential impacts of Upstream Storage on two SSSIs in the storage area prior to implementation.
Outcome for assets at risk:	A reduction in traffic disruption benefits local businesses, commuters and tourists. Two main roads (A420 and A4144) and main railway line protected up to the 1 in 50 year (2% AEP) flood event in the medium term.

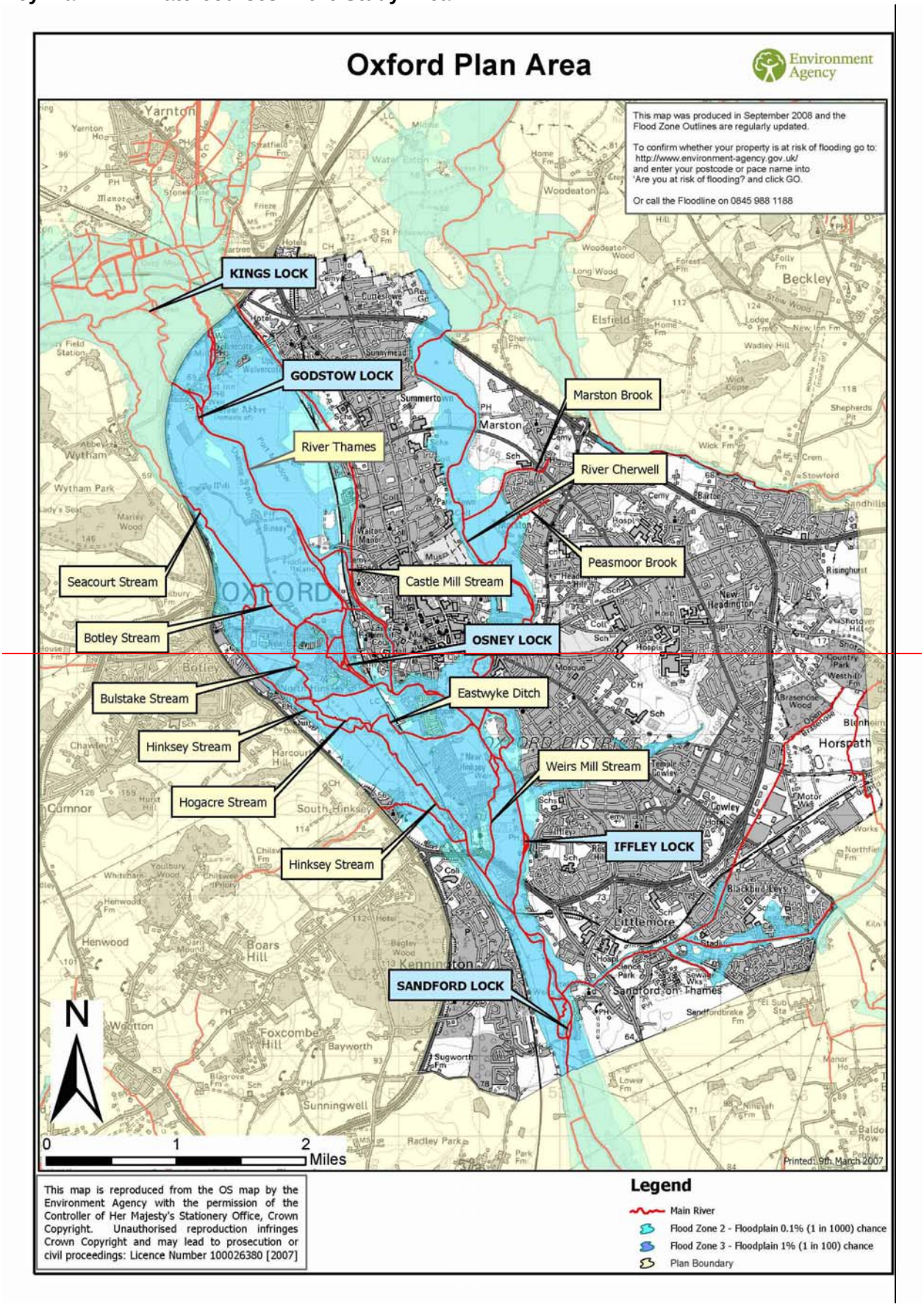
Costs (PVc): (100 year life inc. maintenance)	£24.6M	**Benefits: (PVb)**	£1,086M	**Ave. B: C ratio: (PVb/PVc)**	44
NPV:	£1,061M	**Incremental B:C ratio:**	≥3.4	**Whole life cost (cash value):**	£63M
Choice of preferred option:	Without Climate Change: Option 3b – Do Minimum Sustained & Additional Measures				
Total cost for which approval is sought:	**£ 63M (incl. £2M contingency)**				
Delivery programme:	Year 0 to 9 'Additional Measures' Year 30 to 70 Western Conveyance channel (dependant on review of climate change impact) Year 70 to 90 Upstream storage (dependant on review of climate change impact)				
Are funds available for the delivery of this programme?	Not confirmed				
External approvals:	Natural England – letter of support received April 2009				

Defra approval:	OM Scores: Defences at Wolvercote = 3.68, Oxford Multi Agency Flood Plan = 37.77, Short Term Measures 1 = 5.99, Short Term Measures 2 = 6.00, Flood Resilience Measures = 0.50.

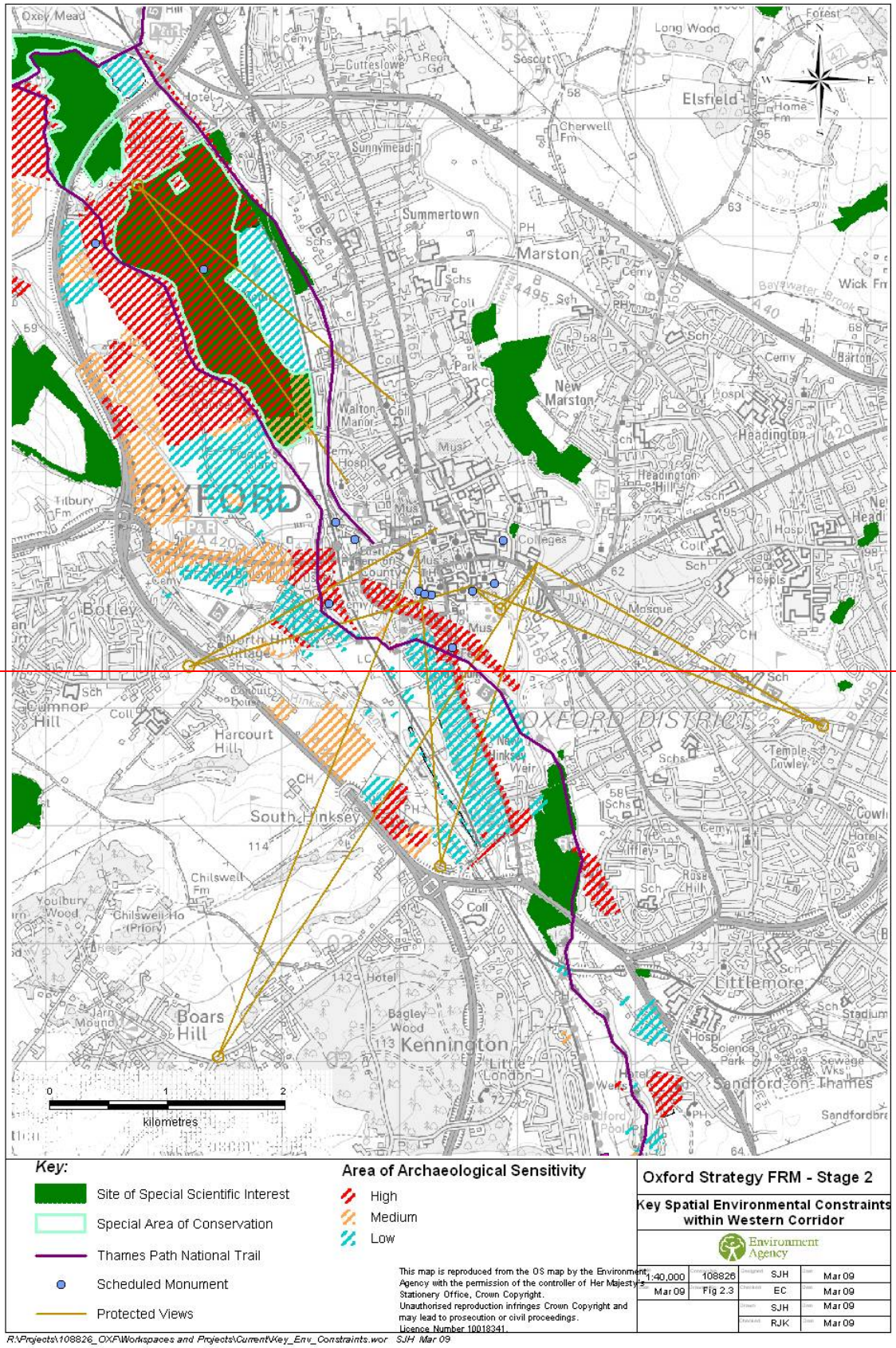
Key Plan 2.1 – Oxford Study Area and Indicative Strategy Boundary



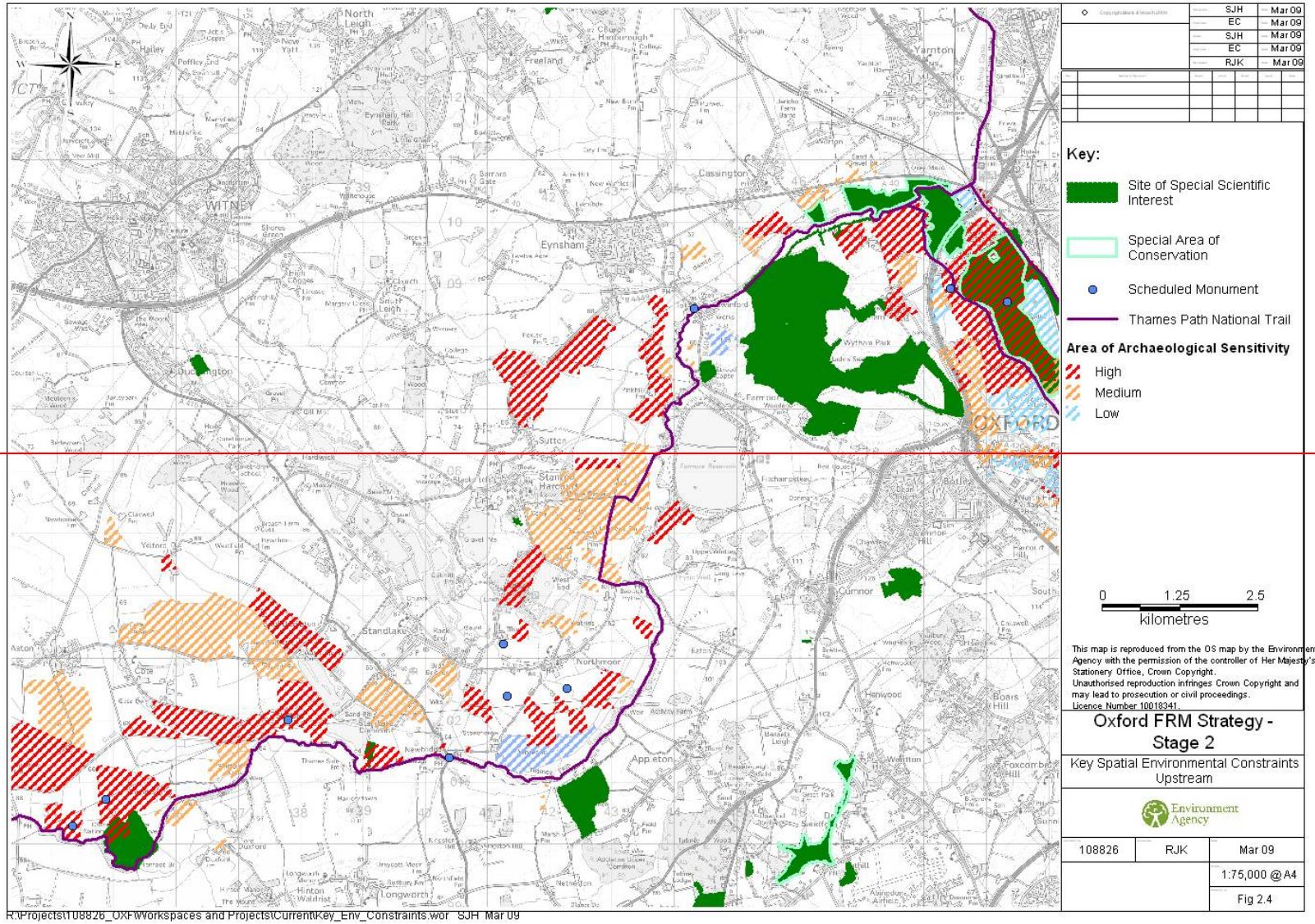
Key Plan 2.2 – Watercourses in the Study Area



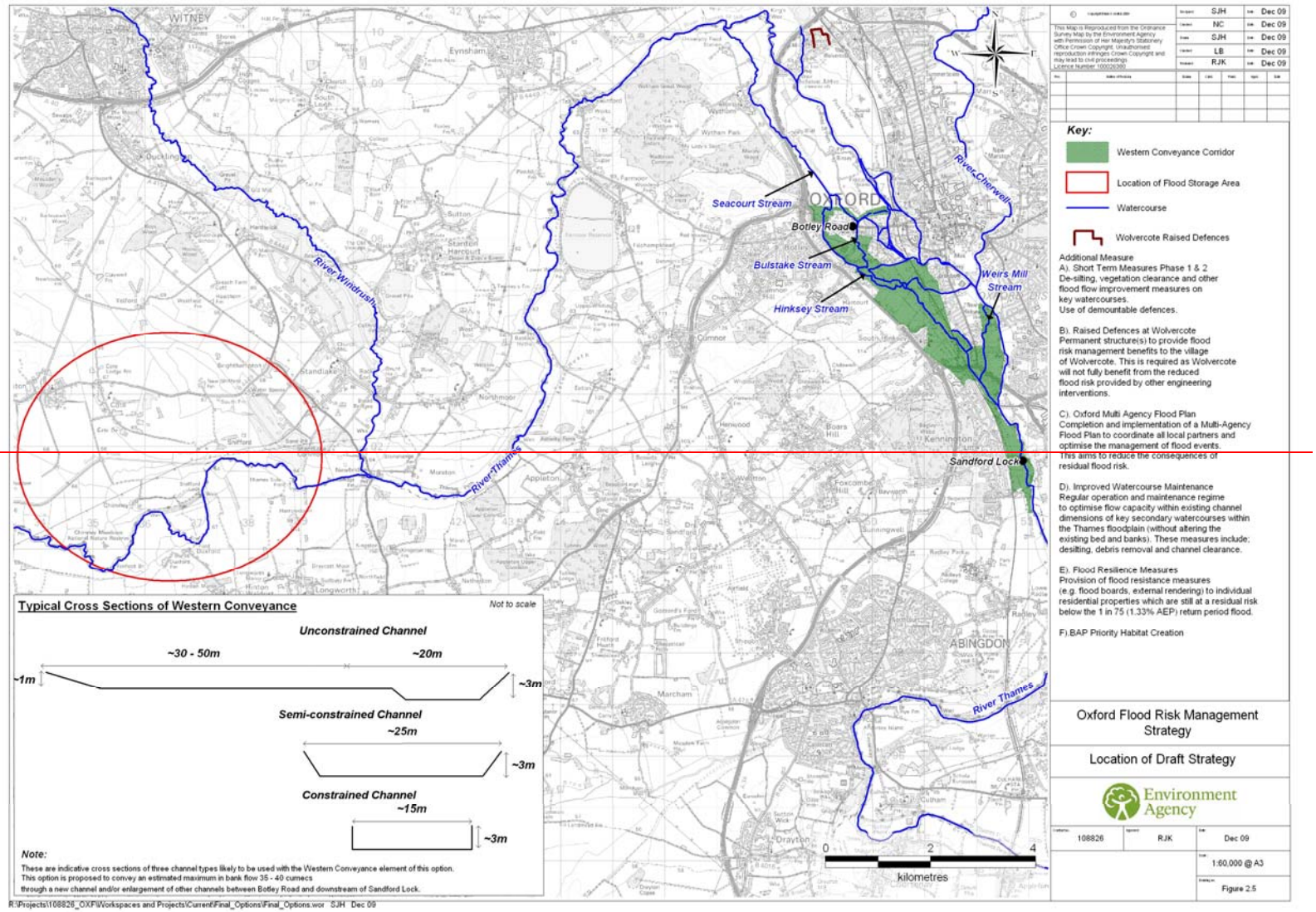
Key Plan 2.3 – Key Spatial Environmental Constraints (1 of 2)



Key Plan 2.4 – Key Spatial Environmental Constraints (2 of 2)



Key Plan 2.5 – Preferred Option Description and Location



2 BUSINESS CASE

2.1 Introduction and Background

Introduction

2.1.1 The Oxford Flood Risk Management Strategy has been carried out to identify sustainable flood risk management (FRM) options for the city of Oxford and the villages of Wolvercote, Wytham, South Hinksey, North Hinksey, Binsey and Kennington (refer to Key Plan 2.1) This Strategy Appraisal Report (StAR) presents the business case for the recommended FRM approach within this area for the next 100 years.

2.1.2 This strategy study has been carried out in stages as follows:

a) In February 2002 a FRM Strategy for the Oxford area was commenced. A strategic approach was necessary due to the relative size and complexity of the Study Area, the variety of flooding mechanisms, environmental sensitivities and land use issues. This also enabled a wider area to be investigated for the potential of flood storage within an 'indicative study boundary'. The results of this first stage were presented in an Interim Strategy Report, which included a Strategic Environmental Assessment (SEA). In October 2004 the Interim Strategy Report was presented to and agreed by the National Review Group (NRG).

b) Stage 2 commenced in November 2004. This “feasibility” stage was intended to develop the preferred option. However, reconsideration of the risks had the capacity to alter the choice of preferred option. Key members of the Strategy Appraisal Team met with the NRG Chairman in April 2006, to discuss the appropriate way to progress the study to a conclusion in the most efficient way. With the introduction of A9 strategy approval the team decided to resubmit the Strategy to address the key outstanding risks.

2.1.3 The key objectives of this Strategy are to identify a sustainable solution to:

a) Reduce flood risk to people and property. Currently 3,348 residential and commercial properties are at risk in a 1 in 100 year (1% AEP) flood event.
b) Reduce the disruption and financial loss associated with flooding of main roads into the city and a nationally important railway line.
c) Improve the human and natural environment for the quality of life of people and the benefit of wildlife.
d) Be adaptable to the potential effects of future climate change.

2.1.4 In addition, to assist in testing the options, the SEA sets out a range of environmental objectives taking into consideration legislative requirements and guidance recommendations from internal and external consultees. The environmental objectives cover all aspects of the environment and include protection, maintenance and enhancement of environmental assets.

2.1.5 The complex flood mechanism, long history of flooding and the historic built and natural environment unique to Oxford mean that a strategic approach is required to ensure a balanced FRM solution. A full range of FRM measures have been considered, both structural and non-structural, to achieve the Strategy objectives.

2.1.6 The structural works identified in this Strategy will be completed under the Environment Agency’s permissive powers set out in Section 165 of the Water Resources Act (1991). The appraisal of these works has been undertaken in accordance with the Defra Flood and Coastal Defence Project Appraisal Guidance (FCDPAG) series of documents and the ‘Supplementary Notes to Operating Authorities’, taking into account the climate change guidance set out in FCDPAG3 and revised guidance released in October 2006.

2.1.7 The Strategy also includes recommendations concerning non-structural measures to be undertaken by either the Environment Agency or by supporting third parties.

2.1.8 This Strategy is in accordance with the 2008 Thames Catchment Flood Management Plan (CFMP) policies:

a) Making space for water (Action UT1) through various interventions of different scales including engineered flood storage
b) Conveyance in urban locations (Action UT6).

Study Area and Indicative Strategy Boundary

2.1.9 The Study Area (in Key Plan 2.1) is bounded by Sandford Lock on the River Thames (south of Oxford), Kings Lock on the River Thames (north west of Oxford) and the floodplain boundaries of the river as defined on the Environment Agency's flood map. The Study Area also includes the floodplain of the River Cherwell between the A40 Oxford ring road and the confluence with the River Thames south of the city centre. The overall size of this area is approximately 30km², whilst the approximate lengths of the Thames and the Cherwell within the Study Area are 15km and 6km respectively.

2.1.10 A wider area (defined by the Indicative Strategy Boundary on Key Plan 2.1) was considered to identify the impacts of the various strategic FRM measures. This was necessary for consideration of flood storage in the upstream catchment, downstream effects of any conveyance improvements, and overall landscape and visual amenity.

2.1.11 The northern part of this Indicative Strategy Boundary is typified by alluvial flood meadows and hay meadows which include four water-dependent Sites of Special Scientific Interest (SSSI) which form the European designated Oxford Meadows Special Area of Conservation (SAC). Port Meadow with Wolvercote Common and Green SSSI (part of the SAC) falls within the Study Area. The western part of the Indicative Strategy Area includes two water-dependent SSSIs, Chimney Meadows and Langley's Lane Meadow. Other designated sites are shown on Key Plans 2.3 and 2.4.

2.1.12 The low-lying parts of the Study Area at risk of flooding include urbanised areas of Oxford and its surrounding villages. Throughout this area there are Scheduled Monuments dating predominantly from the prehistoric and medieval periods including the ring ditches, barrows and associated enclosures of Port Meadow, numerous Listed Buildings (many centred on the historic core of Oxford) and non-designated areas of archaeological sensitivity within the floodplain. This valuable cultural heritage and the unique and protected landscape and views of Oxford have influenced the development of flood risk management options.

2.1.13 A landscape character assessment has been undertaken to map landscape types within the Indicative Strategy Boundary. The northern section of the western corridor is primarily pastoral floodplain with cattle grazing amongst the silhouettes of mature floodplain trees contrasting with the adjacent busy urban scenes. The southern section of the western corridor and much of the landscape upstream of Oxford is a linear riverine landscape with a flat, well defined alluvial floodplain. It also has pastoral character with meadows, wet and semi-improved pasture. Other prominent landscapes within the Indicative Strategy Boundary include alluvial lowlands adjacent to the main river corridor of the Thames which have a regular pattern of medium sized hedged fields with permanent pasture and arable cropping.

2.1.14 In addition to the designated sites for nature conservation (water dependent SSSIs and SAC) and cultural heritage and the summary of the landscape character assessment outlined above, other valued elements of the environment that have been taken into consideration in the assessment are listed below.

a) A variety of recreational interests are represented in the study area including angling, cycling, walking (the Thames Path National Trail runs through the study area), nature conservation and boating.
b) Navigation is important along the River Thames which provides the main navigational route through the study area.
c) The Thames and its secondary watercourses provide ecologically important aquatic ecosystems and habitats for fish.
d) Riverside, floodplain and mature urban trees are an essential element of the landscape character of Oxford.
e) The historic crossing of Old Abingdon Road is likely to have been an extension of a Norman causeway and this is being further investigated.
f) Much of the study area is agricultural land and open in nature.

2.1.15 There are no formal raised flood defences within the Study Area. However, there is a complex network of small braided watercourses which have been significantly modified to service a variety of uses. These leave and rejoin the River Thames providing additional in-bank flow capacity for water as it makes its way through the city centre and main residential areas.

2.1.16 The Thames carries approximately 55 m^3/s of in-bank flow at Botley Road and the secondary watercourses convey a further 25-35 m^3/s at the same location.

2.1.17 Weir complexes and associated locks on the River Thames maintain the statutory rights of navigation to the Upper Thames.

2.1.18 The main geological features in the Study Area are formed from alluvial silts (typically 1m depth) overlying river terrace gravels (3-6m thickness). Beneath these strata, Oxford Clay is present down to bedrock. The river gravels provide an effective flow path for groundwater which is at a level of 1-2m below ground. There is good hydraulic continuity between groundwater and surface water as many of the watercourses break through the alluvial material into the gravel beneath.

2.1.19 The Study Area lies within the local authority areas of Cherwell District Council, Oxford City Council, South Oxfordshire District Council and Vale of White Horse District Council. The County Council is Oxfordshire. The Indicative Strategy Boundary includes the local authority area of West Oxfordshire District Council and those councils covered by the Study Area.

Social and Political Background

2.1.20 Recent flooding (in 2000, 2003 and 2007) prompted local homeowners and interested residents to form flood action groups to raise the profile of flooding in Oxford and to apply pressure on Local Authorities and the Environment Agency to act to reduce flood risk. The Environment Agency Area Team has been in regular consultation with the Oxford Flood Alliance, Wolvercote Flood Action Group, and Kennington and South Oxford Flood Action Group to ensure that local knowledge could be fed into the Strategy.

2.1.21 The Oxford Preservation Trust is a major land owner and tenant in the western part of the Study Area. This influential party's aims are to retain unique Oxford features and landscapes.

2.1.22 The Berkshire, Buckinghamshire and Oxfordshire Wildlife Trust (BBOWT) promote nature conservation and have spent the last 5 years creating alluvial flood meadows in the Upper Thames catchment. The Trust has over 55,000 members and is also a key landowner within the Indicative Strategy Boundary.

Strategic Context

2.1.23 The Thames Valley Regional Multi-Agency Flood Plan is currently being developed with other project partners. This plan looks strategically at how resources from the different Agencies can be more effectively coordinated to prepare, plan and manage the consequences of flood events. The Strategy Appraisal Team has worked with the Environment Agency team involved in developing this plan in order to understand how it links in with the strategic objectives.

2.1.24 The Environment Agency Area Team was fundamental in forming the Oxford Area Flood Partnership following the 2007 floods. This group consists of the Environment Agency, Oxfordshire County Council, Oxford City Council, Vale of White Horse District Council, Thames Water and Network Rail. The group meets regularly to provide a coordinated approach to flood risk management and has been kept informed of the development of the Strategy. This direct, regular link with utilities and the local Councils also assists in identifying and dealing with localised flooding issues including surface water management and reduces the risks in implementing the overall Strategy through continued engagement.

2.1.25 The Strategy was developed in parallel with the Oxford City Council's Strategic Flood Risk Assessment (SFRA) and supports the draft Thames River Basin Management Plan, currently under consultation, with respect to achieving 'good' ecological status or potential for all water bodies in the region by 2015, in line with the Water Framework Directive. The Strategy also draws on lessons learned from the 2007 floods, the outcomes of the Pitt Review and Defra's Making Space for Water Strategy.

2.1.26 The draft SFRA completed by Oxford City Council outlines how key development areas in Oxford are affected by flood risk. The majority of key development areas lie outside the floodplain to the east of the city centre. The most significant development which requires consideration under PPS25 is that in the West End of the City (see paragraph 2.8.13). The SFRA also recommends safeguarding areas of land to the west of the city centre for the purposes of flood risk management in line with the recommendations of this Strategy.

2.1.27 A range of relevant local authority plans, strategies and policies have been considered and used in developing the Strategy (refer to SEA Environmental Report, Appendix A). It is acknowledged that many of these plans, strategies and their policies will be replaced or updated during the 100 year lifetime of our strategy, but their overall long-term visions provide the best current guide to constraints and opportunities within the Study Area. Periodic reviews of the Strategy will seek to accommodate changes if these strategies or policies are revised or superseded.

2.1.28 In 2003, the Strategy Appraisal Team formed a strategic partnership with the British Geological Survey (BGS). The partnership aimed to pool resources to investigate groundwater flows and flood risk to inform FRM activities, understand geological processes and the impact on important environmental sites.

2.1.29 The Environment Agency and BGS have monitored groundwater levels in the Study Area since 2003. BGS have also developed a 3-D geological model using the borehole logs from site investigations. This information (along with evidence from the 2007 floods) has been used to complete a preliminary assessment of the risk of groundwater flooding.

2.1.30 The economic methodology adopted in this Strategy for assessing the costs and benefits of weir structures on the River Thames aligns with the draft Lower Thames and Thames Weir Strategies.

2.2 Problem

Scope of the Problem

2.2.1 Within Oxford and the surrounding communities there are currently 3,348 properties at risk in the 1 in 100 year (1% AEP) fluvial floodplain (when compared to Do Nothing). This includes 7 schools, 6 colleges and 2 health care centres, indicating that a large number of particularly vulnerable people are likely to be affected.

2.2.2 Initial findings from the BGS / EA groundwater flood assessment has identified that between 80 and 330 properties are potentially at risk from groundwater flooding (at ground level) as well as fluvial flooding. These are mainly located in the Grandpont area of Oxford. There is also potential for groundwater flooding of basements and this occurred during the 2003 and 2007 flood events.

2.2.3 Table 2.1 gives the number of residential and commercial properties in the Study Area that are currently at risk of flooding.

Table 2.1 Residential and commercial properties at risk

Annual chance of flood (% AEP)	Residential property*	Commercial property*	Total*
1 in 5 (20%)	747	312	1,059
1 in 10 (10%)	1,044	397	1,441
1 in 20 (5%)	1,525	467	1,992
1 in 50 (2%)	2,321	574	2,895
1 in 75 (1.33%)	2,533	623	3,156
1 in 100 (1%)	2,695	653	3,348
1 in 200 (0.5%)	3,240	722	3,962

*Figures include properties at risk of flooding above threshold for the Do Nothing option. This approach is in alignment with current guidance.

2.2.4 The distribution of properties (both residential and commercial) and current onset of flooding in each area is shown in Table 2.2 below. Refer to Key Plan 2.1 for the location of these areas.

2.2.5 The 1 in 75 year (1.33%) flood event has been quoted in Table 2.2 as this is the standard used by the Association of British Insurers and the forthcoming updated Defra Flood and Coastal Defence Project Appraisal Guidance. The onset of flooding quoted does not relate to all properties. As there are no formal raised flood defences, the onset of flooding varies from property to property.

Table 2.2 Properties at risk by area in Oxford

Area	Properties in 1 in 75 (1.33%) AEP floodplain*	Onset of flooding Annual Chance (%AEP)
Botley/Osney (inc Binsey)	1,381	1 in 5 – 1 in 10 (10-20%)
New Hinksey	1,027	1 in 5 – 1 in 10 (10-20%)
Grandpont	352	1 in 5 – 1 in 10 (10-20%)
Jericho	124	1 in 20 – 1 in 50 (2-4%)
Wolvercote	108	1 in 20 – 1 in 50 (2-4%)
North Kennington	30	1 in 10 – 1 in 20 (5-10%)
Cherwell catchment	74	1 in 50 – 1 in 75 (1.33-2%)
South Hinksey	19	1 in 20 – 1 in 50 (2-4%)
Wytham	31	1 in 20 - 1 in 50 (2-4%)
Sandford	10	1 in 20 – 1 in 50 (2-4%)
Total	3,156	

*Figures include properties at risk of flooding above threshold for the Do Nothing option. This approach is in alignment with current guidance.

2.2.6 There are four key roads and a main railway line at risk of flooding in the Study Area, as shown in Table 2.3. The location of these assets is shown on Key Plan 2.1.

2.2.7 The flooding of major roads in the area leads to disruption, affecting residents, people travelling to Oxford to work and to businesses located in the heart of the city. The transport network's ability to function is seriously impacted by flooding (road closures commence at 1 in 5 (20% AEP) flood events) as two of the four main routes into the centre city are inundated by flooding for up to approximately 7 days in a 1 in 100 (1% AEP) event.

2.2.8 Flooding severely disrupts mainline railway services and this occurred during both the 2003 and 2007 flood events. The railway is estimated to be closed for approximately 10 days in a 1 in 100 (1% AEP) event.

Table 2.3 Roads and rail at risk

Asset	Description	Annual chance of flooding causing closure (% AEP)
Botley Road (A420)	Main arterial route into city from A34	1 in 10 (10%)
Abingdon Road (A4144)	Main arterial route into city from A423	1 in 10 (10%)
Kennington Road (B-road)	Main route into Kennington from Oxford	1 in 5 (20%)
Donnington Bridge Road (B4495)	Main route from East Oxford to Abingdon Road and the city centre	1 in 10 (10%)
Main railway line	Passenger services to London, the Midlands and beyond Key freight route from Southampton to Birmingham	1 in 10 (10%)

2.2.9 There are three minor electricity substations at risk, although recent flood events have shown that supplies can be maintained by switching to other substations on the local distribution network. There are no major water or sewage treatment assets at risk of flooding.

History of Flooding

2.2.10 The Oxford area has a long history of flooding. The most significant flooding in recent history occurred in 1947 (estimated at 1 in 75 year (1.33% AEP) flood event) when heavy rains combined with rapid snow melt in the Upper Thames catchment. This caused widespread flooding at a number of locations in the catchment downstream. The largest event recorded since detailed records began was in 1894. It is estimated that this was in the region of a 1 in 100 year (1% AEP) flood event.

2.2.11 Other examples of flooding which have occurred in the last 100 years include 1903 (5% AEP), 1910 (10% AEP), 1933 (10% AEP), 1998 (10% AEP), 1979 (20% AEP) and 1960 (20% AEP). There are no records available to indicate the level of property flooding which occurred during these events. The Hydrology Report appended to the Technical Report (Appendix B) provides further details of flood events.

2.2.12 Recent flood events occurred in 2000, 2003 and 2007. Table 2.4 provides a summary of these events including the areas affected and number of properties reported with internal flooding. There are more detailed records for these events compared to previous instances of flooding in the Study Area.

Table 2.4 Summary of major flood events in recent history

Date	Estimated AEP	Areas Affected
2007	1 in 15 - 1 in 20 (7.5 - 5%)	Binsey, Osney, Botley, South Hinksey, North Hinksey, New Hinksey, North Kennington and Wolvercote. Over 200 properties were reported as internally flooded, Botley and Abingdon Roads closed for 7 days.
2000	1 in 10 - 1 in 15 (10 - 7.5%)	Binsey, Osney, Botley, South Hinksey, North Hinksey, New Hinksey, North Kennington and Wolvercote (approx.160 properties were reported as internally flooded). Botley Road closed for 5 days.
2003	1 in 10 - 1 in 15 (10 - 7.5%)	Similar damage to property and infrastructure as the 2000 flood event.

NB: The number of properties reported as flooding internally does not reflect the number of properties which, in accordance with the Multi-Coloured Manual, suffer economic damages during an event of the same magnitude. The onset of economic damage starts at -0.3m below threshold level and hence a higher number of properties are at risk as shown in Table 2.1.

2.2.13 Over 200 properties were reportedly flooded in the most recent event (July 2007). Following intense rainfall concentrated over the upper catchment it took approximately 4 days for the peak flows to reach Oxford. Before the peak arrived, the majority of the rural floodplain was full and river channel capacity through Oxford had been exceeded. The estimated channel capacity is 80 – 90 m^3/s. This equates to a 1 in 2 year (50% AEP) flood event.

2.2.14 At the peak of the 2007 event, the maximum capacity of bridges and culverts at Botley Road was exceeded and the flood waters backed up, eventually overtopping Botley Road and leading to a road closure and internal flooding of properties. Further south, at Redbridge, flood waters inundated the main railway line and Abingdon Road, leading to road and rail closures.

2.2.15 The slow response of the River Thames catchment enables flood warnings to play a key part of the response to potential flooding. Since 2007, flood warning areas have been redefined from two to six areas to provide more focussed alerts. Current flood warnings are provided to 2561 of 4988 properties which fall within the Environment Agency Flood Zone 3, equivalent to a 51% uptake in the Study Area. This is above the national average.

Flooding Mechanisms

2.2.16 The Thames at Oxford is generally slow to respond and flood events are long in duration, typically 7 to 9 days. This is due to heavy rainfall falling on the large catchment area

(3,086km^2) which drains to Sandford Lock. The hydraulic gradient through the system is shallow, which slows down the passage of water to Sandford Lock.

2.2.17 Flood water starts to spill over Botley Road at the 1 in 10 year (10% AEP) flood event. Flows can reach high velocities (in places up to 1.5 m/s) as water tries to reconnect with the floodplain. This can pose a risk of injury to local residents. Flood water subsequently pools on the south side in depths of over 1m. In the Abingdon Road area, although water moves at relatively low velocities, it tends to pond to depths of over 0.7m for several days, posing a further health and safety hazard, until levels recede.

2.2.18 Many of the properties, businesses and infrastructure are at risk of flooding from more than one fluvial source. This scenario is highlighted in Key Plan 2.2 where many houses are surrounded by the braided watercourses. Implementing flood risk measures to one watercourse would still leave assets at risk of flooding from another watercourse.

2.2.19 Implementing flood risk measures in isolation could exacerbate flooding in other 'at risk' areas. For example, isolated measures at Botley would increase the risk of flooding downstream at Grandpont and New Hinksey.

2.2.20 Therefore, due to this high interconnectivity of flows between the complex networks of watercourses throughout the Study Area, a single flood cell approach for the Strategy has been used.

2.2.21 Flood peaks on the Thames at Oxford are long and flat which indicates that flood storage (on the floodplain) in the Study Area is already fully utilised during the rising part of the flood. This becomes more pronounced as the flood magnitude increases.

2.2.22 Over the last 150 years, residential, commercial and transport infrastructure developments have gradually encroached onto the natural floodplain.

2.2.23 The natural floodplain narrows to approximately 500m between Redbridge and Sandford Lock. In high magnitude flood events this restriction can cause water to back up through the river system and limits flow conveyance. This restriction has been further exacerbated by:

a) Four former landfill sites which have raised the level of the floodplain by up to 3m.
b) Transport infrastructure of Old Abingdon Road (a Norman Causeway), the Oxford southern bypass and the main railway line to London and Southampton.

2.2.24 Development in the floodplain has existed since Roman times as shown by the Botley Road, which is a causeway across the floodplain (see Key Plan 2.1). Botley Road impedes flood flows and is the only route into the city from the west. It connects to the A34 and therefore provides access to the north and the south.

2.2.25 In addition to fluvial flooding, heavy rainfall can lead to pluvial flooding in low lying areas especially where high fluvial levels reduce the ability of surface water to discharge through the existing drainage systems.

2.2.26 Consistently high groundwater levels are prevalent in the Study Area and pose a threat of groundwater flooding, particularly in the areas of Osney, Grandpont and New Hinksey. Groundwater flooding is affected by a number of factors:

a) The gravel aquifer has limited additional capacity which becomes rapidly filled during flood events.
b) The high response of groundwater to rainfall due to the high permeability of the floodplain gravels which connect groundwater to surface water.
c) Antecedent groundwater and soil conditions (higher groundwater levels are expected in winter prior to flooding leading to greater risk).

d) The role of alluvium in controlling groundwater. Where gravels are not overlain by alluvium, there is a higher probability of groundwater flooding.
e) Sub-surface pipework can provide a flow route for groundwater.

2.2.27 The complex nature of flooding means it is difficult to differentiate between fluvial, pluvial and groundwater flooding during lower order events. In high order events, fluvial flooding dominates, although due to the nature of the underlying geology there is always a risk of groundwater seeping through the thin alluvial layer.

Condition of the existing defences and structures

2.2.28 There are no formal raised flood defences within the Study Area. The key sluice and weir structures which control flows are located on the River Thames adjacent to navigation locks. The sites are King's Lock, Godstow Lock, Osney Lock, Iffley Lock and Sandford Lock and are shown on Key Plan 2.2. However, only Osney, Iffley and Sandford affect water levels at the properties within the Study Area. Some of these structures are in good condition with an estimated residual life of up to 60 years. Others, however, are currently expected to require major works during the next 10 years. Maintenance dredging is no longer carried out on the River Thames. However, periodic de-silting at structures and removal of shoaling is undertaken for navigation purposes.

2.2.29 A variety of smaller sluices and weirs throughout the river system (with varying residual life spans) control the division of flow between the Thames and its braided watercourses, to balance water needs during dry periods and maximise flood risk reduction during heavy rainfall. These structures are repaired and maintained on a reactive basis. Immediately prior to high flows, the Operations team remove obstructions and debris from key bridges, culverts, sluices and weirs. Reactive de-silting and vegetation clearance is carried out as required. These braided watercourses are historically prone to water quality problems during low flow conditions.

Impacts on Heritage, Recreation, Biodiversity and Conservation

2.2.30 Oxford has a wealth of history and is renowned worldwide for its cultural heritage characterised by the historic colleges, punting on the Thames and views of the dreaming spires from Boars Hill. Tourism is an important industry all year round, and visitors are attracted from all over the world. Although flooding only directly affects a small number of the historical college buildings, they are all affected by the transport problems and perception of flooding. Many of the benefits (tourism, business, learning and research) that these internationally recognised institutions deliver to the local and national economy are intangible and therefore they are difficult to quantify in monetary terms (refer to the Economics Report, Appendix C).

2.2.31 Both the River Thames and the River Cherwell are used extensively for river recreation such as rowing, canoeing and punting. A statutory right of navigation exists on the Thames and the small braided watercourses within the floodplain.

2.2.32 The Study Area supports a diversity of flora and fauna, and a number of statutory sites are designated for their nature conservation value within the Indicative Strategy Boundary. Many of these sites and other, non-designated, sites are dependent on a certain groundwater and surface water regime. Implementation of FRM measures needs to fully consider the impacts on these sites. The Study Area also has a substantial number of important archaeological and heritage sites as well as areas of high potential for undiscovered archaeology. These aspects have been considered in the technical, environmental and economic appraisal undertaken during the development of the Strategy.

Impact of climate change

2.2.33 The number of properties at risk of flooding in the 1 in 100 year (1% AEP) will increase from 3,348 to > 4,800 as the effects of climate change are realised (the latter figure is related to 20% increase in flow). Therefore the predicted change has been considered in the option selection process. The economic appraisal considers options both with, and without, future climate change. The impact of climate change has also been considered in the SEA.

2.2.34 Current Defra guidance recommends applying an increase to existing fluvial flow of 10% up to 2025, and 20% from 2025 to 2115. With a 20% increase, the design flow for a 1 in 2 yr (50% AEP) would increase from 142 to 170m^3/s (at Sandford Lock). Similarly, a design flow for a 1 in 100 yr (1% AEP) would increase from 278 to 333m^3/s. The current 1 in 100 year (1% AEP) flood event will increase in frequency with climate change and will become a 1 in 25 year (4% AEP) flood event (using current projections).

2.2.35 There is a level of uncertainty related to future climate change predictions, especially for larger catchments such as the River Thames (as noted in the Defra guidance). Considering the magnitude of the flow increases included in the current Defra Supplementary Note on Climate Change Impacts (2006) the approach to managing climate change effects should be flexible to allow for uncertainties in the current predictions and for future revisions to the guidance. The United Kingdom Climate Projections published in 2009 (UKCP09) considers predictions for future rainfall. Based on this update, the Environment Agency may issue revised guidance to supersede the Defra guidance.

2.3 Options Considered

Overall Approach

2.3.1 A two stage approach was adopted to identify the preferred strategy for Oxford. Stage 1 of the strategy commenced in 2002 when high level investigations and some detailed investigations were carried out to identify the preferred strategy from over 100 potential options. As a result, a strategy to improve urban conveyance with the potential for some upstream storage was recommended.

2.3.2 Improving conveyance has the ability to reduce water levels to approximately 90% of properties and to key infrastructure (roads and rail) in the Study Area. The remaining 10% lie in hydraulically independent areas. Reducing the levels in the river system in turn reduces the recharge of the gravel aquifer and therefore the risk of groundwater flooding.

2.3.3 Upstream Storage can benefit all property and infrastructure downstream, and the majority of the floodplain upstream of Oxford is agricultural land which already floods periodically. Therefore, an opportunity to hold water back in these areas exists.

2.3.4 An SEA was also completed (including extensive consultation) and the production of an Interim Strategy Report finalised in Stage 1. This was submitted to and agreed by NRG in 2004.

2.3.5 Originally, Stage 2 of the Strategy was intended to develop the feasibility study for the Western Conveyance scheme. However, during 2006 the risks to Strategy implementation were reconsidered (by the Strategy Appraisal Team and NRG chairman) and this showed the potential for changing the choice of the preferred option.

2.3.6 With the introduction of A9 strategy approval the Strategy Appraisal Team decided (with agreement from NRG through the submission of a Form G) to resubmit the Strategy. This route was chosen to mitigate the key outstanding risks and provide greater certainty in the delivery of the Strategy.

2.3.7 Therefore, Stage 2 of the Strategy comprised detailed investigations aimed at mitigating any outstanding risks to implementation. The findings of these investigations are presented in this Strategy Appraisal Report (StAR) and accompanying SEA.

Stage 1 High Level Investigations and Appraisal

2.3.8 The full range of 21 FRM measures defined in the Foresight Future Flooding report (also referred to as responses) was appraised. These responses ranged from non-structural measures e.g. flood warning, to full engineering interventions such as raised flood defences.

2.3.9 Over 100 specific measures to manage flood risk in Oxford were identified through consultation with internal specialists, consultants, flood action groups and local residents.

2.3.10 A summary of the appraisal of FRM measures in Stage 1 is shown in Table 2.5.

Table 2.5 Flood Risk Management measures considered during the appraisal

Description	Basis for Considered	Taken Forward as a strategic single stand-alone option	Taken Forward in-combination with other options
Widening of the Thames (conveyance)	The River Thames would need to be widened significantly, e.g. to an estimated 40m at Botley Rd (currently 18m). Widening would require the purchase of approximately 80 properties. A widened Thames channel is unlikely to gain planning permission due to impact on landscape and amenity value.	✘	✘
Western Floodplain (conveyance)	Maximising flows through the existing floodplain to the west of Oxford by widening existing sections of channel and interconnecting these with new sections of river channel. Some major constrictions to flow exist although technical solutions can be implemented to overcome these. Lowering surface water levels would lower groundwater levels reducing the risk of groundwater flooding.	✓	✓
Raised flood defences	Widespread use as a stand-alone solution is not appropriate due to the high level of surface water–groundwater connectivity, leading to a high risk of flooding behind defences. The complex river system would require long lengths of defence (at high cost) to eliminate flooding from several rivers which dissect the key benefit areas of Botley, Osney, Grandpont and New Hinksey (see Key Plan 2.2).	✘	✓
Water transfer	The large size of the catchment would lead to increased flood risk in the neighbouring catchment if flood water was transferred. Size and length of pipeline required would be cost prohibitive. Not environmentally acceptable and high uncertainty in achieving implementation.	✘	✘
Upstream Storage	Potential to significantly reduce flood risk if a large enough storage area can be identified in close enough proximity to Oxford.	✘	✓
Flood Proofing	Measures would not reduce the probability of flooding (especially risk to life) or disruption to transport infrastructure which seriously impacts Oxford. Resilience measures provide partial reduction in damage to properties as they normally require remodelling of residential houses (e.g. moving kitchens upstairs, raising electrics etc). Risk of groundwater flooding could make resistance measures technically non-viable unless fluvial levels can be lowered initially.	✘	✓
Non-structural Measures	Making improvements to non-structural measures (e.g. pre-planning, flood warning, development control) will not reduce the probability of flooding and is unlikely to significantly reduce the consequences without implementing structural measures initially.	✘	✓

2.3.11 This initial option selection process confirmed that in order to significantly reduce flood risk in Oxford, structural measures would be required. Of the four main engineering interventions (conveyance, defences, transfer and storage); defences and transfer were discounted on technical grounds (see Table 2.5). The other options, substantially increasing conveyance (aligning with CFMP, policy UT6) and upstream storage (aligning with CFMP, policy UT1), were taken forward to form the 'core engineering elements' of Do Something Options.

2.3.12 It was also concluded that raised defences and non-structural measures provided a small amount of benefit, especially in geographically distinct areas (e.g. the village of Wolvercote). They could also reduce residual risk in key benefit areas, if they were

implemented in conjunction with the structural measures of increasing conveyance and upstream storage.

2.3.13 It was identified that conveyance improvements in the western and south western floodplain of the Thames required further investigation. The Thames floodplain does not extend to the east of the main river and therefore no technically viable eastern conveyance options exist (widening of the Thames itself was discounted as discussed in Table 2.5).

2.3.14 Maximising the use of the existing river system (Enhanced Maintenance) was also considered as this could provide a reduction in flood risk. This approach would provide a lower SoP than enlarging watercourses but this would be at a significantly lower cost. This option remained in the appraisal process.

2.3.15 Enhanced Maintenance (Option 4) costs comprise silt removal, vegetation clearance and vegetation removal on all secondary watercourses within the Study Area; a total length of approximately 30km. The removal of silt from the river bed and vegetation from the banks aims to achieve the largest river cross section (without disturbing the 'hard bed' profiles of watercourses) and to reduce the friction.

2.3.16 Several 'Western Conveyance' channel lengths were considered (with three different size channel cross sections), running from just north of the A34 ring road to immediately south of Sandford Lock. These options were tested using a complex 1-D ISIS model to estimate their impact on water levels for a range of flood events. Environmental and economic appraisal found that those options extending north of the Botley Road would have a significant impact on the Oxford Meadows SAC and would return lower benefit cost ratios. Therefore, any options extending north of Botley Road were discounted.

2.3.17 All Western Conveyance options also incorporated widening 'pinch points' along the Weirs Mill Stream (see Key Plan 2.2). These changes reduced water levels in the residential areas of New Hinksey and Grandpont, providing additional benefits.

2.3.18 Investigation into opportunities to store water upstream of Oxford was also carried out. It was concluded that there were two technically feasible sites; to the west of Farmoor Reservoir on the Thames, and north of the A40 on the River Cherwell. From these sites, five options (four on the Thames and one on the Cherwell) were developed, as detailed in the appendix of the Technical Report (Appendix B).

2.3.19 To significantly reduce flood risk, it was estimated that a storage area with a volume in the order of 50+M.m^3 would be required, due to the large flood volumes generated by the Thames catchment. None of the five options identified could physically store this volume, so it was concluded that upstream storage as a standalone option was not technically feasible, and that any further consideration of this option should be in combination with conveyance improvements through Oxford.

Stage 2 Detailed Investigations

2.3.20 In Stage 2, detailed investigations were carried out to achieve A9 approval. These investigations included:

a) Identifying the optimal combinations of structural FRM measures (optimisation),
b) Quantify the risks in implementing these measures through further assessment, and
c) Recommending a preferred strategy which considered all areas at risk of flooding within the Study Area.

2.3.21 Details of the option development and appraisal process are described in the Technical Report (Appendix B) and the SEA Environmental Report (Appendix A).

2.3.22 The two 'core engineering elements' (now termed Western Conveyance and Upstream Storage) were considered and whether these options in combination could provide an optimal FRM solution.

2.3.23 Detailed assessment commenced by updating the hydrology and hydraulics to incorporate the new data obtained from the 2007 flood event. This also included adding on sections of 2-D Tuflow modelling to aid calibration and to improve our understanding of river channel and floodplain interaction. The updated hydrology included revised rating curves for Pinkhill and Eynsham Locks, developed in 2008 for the Environment Agency's Flood Forecast Model project. Compared with the flood hydrographs used in Stage 1, the revised hydrology has resulted in higher flows in more frequent events (1 in 2 to 1 in 10 years) and lower flows in more extreme events (1 in 100 to 1 in 200 years).

2.3.24 Ecological surveys, archaeological and contaminated land desk studies, ground penetration radar (GPR) surveys, landscape assessments and ground investigations were undertaken to improve understanding of the constraints in the western floodplain corridor. These assessments aimed to identify if there were any 'show stoppers' and to quantify risks for the remaining constraints.

2.3.25 Three channel sizes (based on channel sizes appraised during Stage 1 and the benefits that they provided) were selected to be tested as part of the Stage 2 appraisal. The selection was intended to refine the size, allowing a range of benefits to be considered and hence varying standards of service.

2.3.26 Channel sizes which would convey 18 ('small'), 38 ('medium') and 57 ('large') m^3/s respectively were chosen. These were based on achieving the optimal hydraulic gradient through the system from the downstream boundary with the Thames.

2.3.27 These three options were taken forward to be appraised in combination with Upstream Storage options. Where space permits, two-stage channels have been adopted. Typical cross-sections are indicated on Key Plan 2.5.

2.3.28 The corridor in which the Western Conveyance would be implemented is shown in Key Plan 2.5. Strategy level investigations into technical and environmental risks have determined that this corridor avoids high risk areas. There is no preferential route within this corridor.

2.3.29 To consider the five Upstream Storage options more fully, additional detailed assessments of storage volumes using LiDAR and OS Profile data, and GIS software were completed.

2.3.30 It was found that the initial investigations in Stage 1 had significantly overestimated the storage volumes available for the smallest site on the Thames and the site on the Cherwell. The revised volumes did not provide a significant reduction in flood risk and hence these sites were discounted.

2.3.31 Further high level environment appraisal led to the largest Upstream Storage option being discounted as this had a significant negative impact on both the built and natural environmental.

2.3.32 The remaining two storage sites (both on the Thames) were developed into three options; a lower and upper storage area and the two areas combined (illustrated on maps within the Technical Report, Appendix B). These options were taken forward to be appraised in combination with conveyance options.

Optimisation

2.3.33 As part of Stage 2 an optimisation process was used to rationalise the number of combinations of Western Conveyance and Upstream Storage to be taken forward to be assessed as part of the SEA.

2.3.34 This resulted in three standalone Western Conveyance options (Options 5, 6 & 7) and the small and medium Western Conveyance elements both combined with Upstream Storage (Options 8 & 9) remaining in the appraisal process. The general area of the storage sites is indicated on Key Plan 2.5. This process is detailed in Section 6 of the Technical Report (Appendix B).

2.3.35 In addition, the channels were also split into several reaches which were appraised individually and in various combinations. The aim of this appraisal was to identify whether it was economically justified to construct the lower reaches of the channel prior to the upstream reaches. This appraisal was not considered in the SEA it does not change the environmental impacts of the option. Further details are in Section 4 of the Technical Report (Appendix B).

Additional Measures

2.3.36 Although discounted as strategic standalone solutions, it was recognised that raised defences, flood proofing and non-structural measures are appropriate to implement, especially at a local level (see Table 2.5).

2.3.37 Therefore, these FRM measures were assessed both as a stand alone option and in addition to the do something options in the geographically separate areas of Wytham, Wolvercote, Binsey, South Hinksey, Kennington and areas along the Cherwell. They were also considered as measures which could target residual risk remaining in the key benefit areas of Botley, Osney, Grandpont and New Hinksey.

2.3.38 As a response to the 2007 flooding which occurred in Oxford, a programme of Short Term Measures (STMs) was developed. These are measures that can be implemented within a short timescale and would complement the medium to long term strategic solution. Phase 1 of the STM work (STM1) was successfully completed in November 2009.

2.3.39 These works also form part of the Additional Measures (of the Strategy) and include de-silting and improved maintenance on some of the key small braided watercourses in the Study Area, as well as the provision of demountable defences to provide interim protection to some properties. STM phase 2 (STM2) will address further de-silting and vegetation obstruction clearance on remaining reaches of key watercourses where not included in STM1, as well as local flow constraints.

2.3.40 The STMs are primarily justified over a shortened appraisal period of 8 years. The works undertaken mostly comprise short term or temporary solutions to reduce flood risk. Some of the other Additional Measures have long term benefits which have not been double counted with other options.

2.3.41 The appraisal of the Additional Measures is described in Section 4 of the Technical Report (Appendix B). The preferred measures to be considered in conjunction with the core engineering element(s) are set out in Table 2.6. Further description of the Additional Measures is provided in Section 2.7 and Table 3.1.

Short-listed Options

2.3.42 The short-list of options from the Stage 1 high level appraisal and the Stage 2 detailed appraisal and optimisation process is shown in Table 2.6.

Table 2.6 Short-listed options

Option	Key Component(s)
1	Do Nothing The baseline against which all other options involving intervention have been compared. No new flood alleviation schemes would be promoted and no maintenance works carried out to channels or existing flow control structures. Includes cessation of all flood management activities with respect to operation, flood warning, maintenance and improvement activities within the Study Area. Increasing blockage of channels through debris accumulation as a result of this regime has been modelled.
2	Do Minimum Maintenance of existing flood defence assets until failure. Includes making repairs to any assets that are still serviceable. As with Do Nothing, there is an increasing probability of failure. All structures are assumed to have failed by year 60 of the appraisal period.
3	Do Minimum Sustain Maintenance of existing flood defence assets until failure, then replacement of structures. Replacement is completed from now until year 60 to maintain the current standard of service throughout the 100 year appraisal period. This option forms the environmental baseline.
3b	Do Minimum Sustain & Additional Measures *Option 3b has been included to demonstrate the decision rule analysis used to develop the phased implementation plan (refer to 2.7). It is not a stand alone option.* As Option 3, with Additional Measures which comprise: • Short Term Measures Phases 1 and 2. • Raised defences at the village of Wolvercote. • Development and implementation of a Multi-Agency Flood Plan (MAFP) for Oxford. • Improved watercourse maintenance regime. • Provision of flood resilience measures to individual residential properties.
4*	Enhanced Maintenance & Additional Measures Enhanced maintenance of all secondary watercourses within the Study Area to a level which is over and above the current standard of service. The aim is to maximise flow capacity by removing silt, vegetation and other debris to reinstate the river cross section and reduce roughness (without altering the existing bed and banks).
5*, 6*, 7*	Western Conveyance Channel & Additional Measures Increase in flow conveyance to the west and south west of Oxford by constructing new sections of channel and/or enlarging existing channels between Botley Road and just downstream of Sandford Lock. The channels would convey an estimated maximum in-bank flow of 18 m^3/s (small channel, option 5); 38 m^3/s (medium channel, option 6); or 57 m^3/s (large channel, option 7). Includes delivery of priority BAP habitat.
8*, 9*	Western Conveyance Channel, Upstream Storage & Additional Measures Options 8 and 9 have a small and medium conveyance channel respectively (as options 5 and 6 above) together with a temporary flood storage area (with permanent downstream embankment and control structure) as the core engineering elements. Includes delivery of priority BAP habitat.
*These options include all elements of Option 3b.	

2.3.43 Enhanced Maintenance (Option 4) has not been used as the underlying maintenance regime for options 4-9. This is because the Western Conveyance options deliver benefits in the same geographical areas as the enhanced maintenance when considering the same flood frequencies. Therefore, implementing both elements would increase costs but not increase benefits. The advantage of Western Conveyance options is that they have the ability to deliver further benefits at higher flood flows where enhanced maintenance becomes ineffective.

2.4 Costs of Options

Overall Approach

2.4.1 The period of economic appraisal is 100 years. The 100 year whole life costs (WLC) have been discounted to present value (PV) using the HM Treasury variable discount rate as described in the FCDPAG3 supplementary guidance of September 2004. Costs have been updated to December 2008 using the public non-roads output index provisional values.

2.4.2 For the purposes of the economic appraisal it was assumed that all elements of each option were implemented in the first 9 years of the Strategy (starting in 2008 with STM1). This allowed for direct economic comparison between options. Once the preferred option was identified the 100 year implementation plan was developed (see Section 2.7).

2.4.3 Optimism bias (to represent an allowance for risk) of 42% has been applied to the PV cost (PVc) of the Western Conveyance elements. This figure was reduced from the standard 60% to reflect the extent of risk quantification work carried out at strategy level for this element. The optimism bias for other elements is set at 56%. Appendix J provides a derivation of the optimism bias in each case.

2.4.4 Where capital costs have been derived, costs include provision of an appropriate freeboard allowance. For more details see Appendix B - Technical Report.

2.4.5 PV costs (construction and maintenance) for all options are shown in Table 2.7.

Maintenance Costs for the existing river system (all options)

2.4.6 In the case of Options 2 – 9, the maintenance costs for all existing watercourses have been derived and agreed with Environment Agency operational staff. The maintenance, repair and replacement costs for the major weir and sluice structures have been derived from the draft Thames Weirs Strategy (Environment Agency 2004). Although there are 5 weir structures within the Study Area, only 3 (associated with the locks at Sandford, Iffley and Osney) affect water levels at properties within the Study Area. Therefore only the costs and benefits associated with these 3 weirs are included. Costs for the staged replacement of the smaller weirs and sluices which control the distribution of water in the braided network of watercourses have also been included.

2.4.7 The maintenance costs derived for existing watercourses include the reactive clearance of vegetation and debris which could cause blockages to key weirs, culverts and other control structures. The costs to cover periodic removal of silt shoaling and build up of silt at control structures were also included. Operational costs associated with the current flood warning system and flood incident management activities were not included.

2.4.8 The costs for Do Nothing (Option 1), Do Minimum (Option 2) and Do Minimum Sustain (Option 3) align with the methodology adopted in both the Lower Thames and Thames Weir Strategies.

2.4.9 Enhanced Maintenance (Option 4) relies upon widespread frequent and continuous maintenance activities being carried out throughout the lifetime of the Strategy on all secondary watercourses. The costs for this option are based on carrying out de-silting and vegetation clearance activities to all the watercourses in the Study Area, approximately 30km total length. The costs are based on the tender costs of similar activities carried out as part of the STM1 project.

2.4.10 A 40% optimism bias has been included in the Enhanced Maintenance cost estimate to cover the uncertainty in the frequency of maintenance activities. This has been reduced from the normal guideline figure of 60% for capital works to reflect the increased understanding of this type of work gained through undertaking the STM1 project.

2.4.11 For Enhanced Maintenance it was estimated that complete de-silting of all watercourses would be completed every 10 years, key reaches and silt shoaling "hot spots" every 5 years and vegetation clearance on a yearly basis (rolling programme).

Table 2.7 PV Costs of Options

	Option	PVc (£M) excl. Optimism Bias	PVc (£M) incl. Optimism Bias
2	Do Minimum	9.9	9.9
3	Do Minimum Sustain	14.1	14.1
3b	Do Minimum Sustain & Additional Measures	22.3	24.6
4	Enhanced Maintenance & Additional Measures	56.1	70.1
5	Western Conveyance Small & Additional Measures	96.9	122.8
6	Western Conveyance Medium & Additional Measures	126.3	162.5
7	Western Conveyance Large & Additional Measures	140.9	181.8
8	Western Conveyance Small, Upstream Storage & Additional Measures	138.8	184.9
9	Western Conveyance Medium, Upstream Storage & Additional Measures	168.3	224.7

Costs – Western Conveyance and Upstream Storage

2.4.12 Capital costs were derived by NCF2 contractor Team Van Oord using high level design and activity schedules developed by Black & Veatch. The estimates were then checked by Black & Veatch and independently reviewed by cost consultant EC Harris.

2.4.13 The land and estates budget for Western Conveyance was developed by Michael Murphy Associates and for Upstream Storage by the Valuation Office Agency. It is assumed that all land will be purchased for the Western Conveyance element. For Upstream Storage, it is assumed that land is purchased where permanent embankments and borrow pits are to be sited, and that all land which is temporarily flooded will require a right to flood agreement.

2.4.14 Western Conveyance costs include major road and rail crossings, control structures, channel excavation and revetment, disposal of material, environmental mitigation and allowances for archaeological and ecological surveys. Pre-construction costs such as planning / public inquiry and Compulsory Purchase Order (CPO) costs are also included.

2.4.15 Gravel re-sale was not considered in the estimate as it was deemed to be offset by the additional purchase cost for land with gravel abstraction potential. However, a sensitivity test has been carried out to investigate the potential financial impact of gravel sale on the implementation date (see Section 2.7.18).

2.4.16 Western Conveyance construction costs have been benchmarked against the Jubilee River construction costs to ensure that a realistic budget has been used for options comparison purposes and to reduce the likelihood of significant cost increases as the scheme develops.

2.4.17 An estimate of costs for the Western Conveyance element has been generated based on the Jubilee River outturn costs. The estimate makes some adjustments to account for the Jubilee River being twice the length and approximately 3 times the cross sectional area of the Western Conveyance channel.

2.4.18 Jubilee River costs are final account figures which have been inflated to the December 2008 price base. Based on these figures, the Western Conveyance element cost estimate generated is a total of £65M. However, the Strategy cost estimate, £89.9M[1], is more detailed and likely to provide a more accurate, yet conservative, overall figure and therefore should continue to be used as the best estimate for the Strategy. A briefing note outlining the benchmarking exercise is contained in Appendix J.

2.4.19 Maintenance costs have also been derived through consultation with Environment Agency staff operating the Jubilee River. This includes vegetation clearance, de-silting, maintenance and repair of structures and the maintenance of river banks.

2.4.20 Upstream Storage capital costs include a downstream embankment and control structure (which maintains navigation), secondary flood banks (and dewatering systems) to reduce flooding to local settlements, raising local roads to maintain access, landscaping (including borrow pits), the provision of a control building and maintenance area as well as environmental mitigation and allowances for archaeological and ecological surveys. Operation and maintenance (O&M) costs for Upstream Storage include maintenance and repair of embankments and control structures (based on Reservoirs Act requirements) and pre-planning activities (e.g. closure of roads) prior to use of the flood storage area (FSA). O&M costs have been compared to those generated for the Banbury FAS and the Leigh Barrier, Tonbridge.

2.4.21 It is assumed that four properties require compulsory purchase to implement Upstream Storage. The cost (including legal costs) of this purchase is included in the appraisal. No properties require compulsory purchase as part of the Western Conveyance element.

2.4.22 An allowance for providing environmental enhancements has been included, which totals 1.7% of the overall Strategy PVc. £1M has been allocated for the delivery of 100 ha of priority BAP habitat in the Indicative Study Boundary. £2M has been allocated to providing environmental enhancements as part of the Western Conveyance element (a breakdown is provided in Appendix G).

Costs – Additional Measures (Included in Options 3b-9)

2.4.23 The capital cost of raised flood defences is based on the Environment Agency Unit Cost Database Estimating Data (2008) with the addition of pre-construction costs for planning, design and approvals. Maintenance was calculated as 0.5% per annum of the construction cost.

2.4.24 STM2 costs are based on those derived for STM1. There are no long term maintenance costs associated with these measures.

2.4.25 There are no capital costs for developing and implementing the Oxford Multi-Agency Flood Plan (MAFP). The Strategy Appraisal Team has consulted with the West Thames Flood Incident Management (FIA) team and derived a cost based on providing a resource to develop the plan in liaison with other partners and to review and update the plan at key milestones (e.g. on completion of schemes).

2.4.26 The costs for implementing flood resilience measures have been based on information from the Association of British Insurers (ABI) and insurance company AVIVA. An initial cost for retrofitting resilience of £30k per property (including 40% optimism bias) has been used and this is similar to that used in the Lower Thames Strategy.

2.4.27 A summary of the costs associated with the preferred option are shown in Table 2.8 (further details relating to the options selection are provided in Section 2.7).

[1] Includes general items, construction costs, land purchase and compensation and excludes the 42% optimism bias as referenced in Table 2.8.

Table 2.8 Summary of Whole Life Costs for Preferred Option (£k)

Item	Shot Term Measures 1	Short Term Measures 2	Multi Agency Flood Plan	Defences at Wolvercote	Flood Resilience	Total £k
Costs pre StAR						2,800
Capital costs for first 5 years						
Gen Items (EA, consultants, surveys)	716	200	110	334	0	1,360
Construction costs	851	855	0	1,112	2,395	5,212
Environmental enhancement costs	19	0	0	0	0	19
Land Purchase / Compensation	110	0	0	31	0	141
Optimism Bias [A]	0	445	0	733	958	2,136
Inflation @ 2.5% per annum	0	76	10	353	258	
Total capital cost for first 5 years (£k)	1,696	1,576	120	2,563	3,611	
Future costs (years 6 – 100)						
Future costs Multi Agency Flood Plan						650
Future costs flood resilience						2,395
Maintenance costs (100 yrs)						50,973
Whole life cash cost (inc. maintenance, but not inflation)						62,887
Rounded to £63M for approval, including £2M Optimism Bias (3% of Strategy cost)						

[A] 40% of Short Term Measures 2, 55% of Defences at Wolvercote, 40% of Flood Resilience

2.4.28 A breakdown of the Western Conveyance and Upstream Storage costs is provided in Appendix J. This includes an indicative route alignment for the Western Conveyance channel as well as flood storage area embankments and flood outlines for the Upstream Storage.

2.5 Benefits of Options

Damages Calculation Methodology

2.5.1 Details of the damage and benefit calculations for this Strategy are in the Economic Appraisal Report (Appendix C). The assessment was carried out in accordance with Defra's FCDPAG.

2.5.2 The Oxford floodplain acts as a single flood cell as over 90% of the properties and infrastructure at risk fall in areas which are hydraulically inter-dependent (as described in Section 2.2) between Botley Road and Sandford Lock.

2.5.3 The remaining 10% of properties (refer to Section 4 of the Technical Report, Appendix B) have been considered independently as they are located in geographically separate areas (outlying villages such as Wolvercote). These areas have been appraised for potential Additional Measures.

2.5.4 The economic values of losses and damages arising from flooding have been calculated based on standard methodology as outlined in the Multi-Coloured Manual (MCM) (Middlesex University Flood Hazard Research Centre, 2005). Property damage values are capped at the write-off value.

2.5.5 All damages have been updated to December 2008 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 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 emergency services following flooding.

2.5.6 Economic losses resulting from traffic have been calculated using traffic flow data collected from Oxfordshire County Council. The traffic flow data has been converted into a traffic flow volume and applied using the methodology set out in Section 6.2 of the MCM. Damages vary depending on the estimated flood durations from the 2D modelling and flood durations observed in recent flood events. Traffic damages account for approximately 2% of total PV damages (PVd). Further information can be found in Section 6 of the Economics Report (Appendix C).

2.5.7 The rail damages have been calculated using the methodology set out in Section 6.3 of the MCM. Actual damages for the 2007 flood event have been sourced from Network Rail and verified against the MCM methodology. Passenger losses associated with delays have also been included. These have been used as the basis from which Do Nothing and Do Minimum damages have been calculated. Rail damage calculations include both delays and disruption and infrastructure losses and vary depending on the estimated flood durations from the 2D modelling flood durations and those observed in recent flood events. Rail damages account for approximately 1% of total PVd.

2.5.8 The risk to life was calculated following the current Defra Guidance, 'Flood Risks to People, Phase 2 FD2321/TR2'. The Supplementary Note to Operating Authorities May 2008 (Social Appraisal: Assessing and Valuing the Risk to Life from Flooding for Use in Appraisal of Risk Management Measures. Defra) was also consulted. These documents provided both methodological guidance and monetary values (representing the value of preventing a fatality or serious injury), which were used in the assessment.

2.5.9 Other significant economic losses which have been calculated in detail are those associated with agriculture.

2.5.10 Intangible benefits for reduced stress associated with a decrease in flood risk have been included in accordance with the Supplementary Note Defra guidance (July 2004).

2.5.11 Damages for loss of income by flood victims have been included based on data obtained in "The Costs of the Summer 2007 Floods in England", Draft Final Report, July 2009.

2.5.12 Enquires were made with the tourism office in Oxford; however, they were unable to provide visitor figures for key attractions (e.g. colleges) or reliable figures for the number of tourists who visit Oxford each year.

2.5.13 The economic loss associated with tourism, recreation and culture was not included (the majority of tourists could visit alternative attractions in the UK leading to no economic loss to the nation). However, it was assumed that applicable economic losses are captured through the damages derived from the flooding of the major roads into the city centre (i.e. loss to the nation as these tourists are already located in Oxford and could not visit alternatives at short notice).

2.5.14 A utilities assessment was carried out to determine assets at risk of flooding. This included consulting utility companies to estimate repair or relocation costs if flooding affected their assets. Using this information, it was concluded that there were only a small number of electrical substations at risk; the damages associated with these installations are likely to be small and hence they have not been assessed separately. No major water or sewage treatment works are at risk of flooding in the Study Area and hence damages related to these assets were not calculated. An allowance of 10% of PV property damages is included for costs associated with repair of utilities. This is considered appropriate considering the findings of "The Costs of the Summer 2007 Floods in England", Draft Final Report, July 2009.

Option benefit assessment

2.5.15 In Option 1 - Do Nothing, it is assumed that all FRM structures (predominantly flow control weirs and sluices) cease to operate and are left open after year 50. In Option 2 - Do Minimum it is assumed that this happens by year 60. All other options (3 – 9) assume that all FRM structures are replaced before they reach their residual design life of 60 years. A detailed explanation of these timings is set out in Appendix C - Economics Report.

2.5.16 The majority of benefits relating to Do Something options are related to avoiding losses associated with property. The Western Conveyance options aim to reduce water levels (and hence losses due to flood damage) between Botley Road and Sandford Lock. Upstream Storage reduces the peak inflows from the Upper Thames catchment ('peak lopping') to again reduce flows and hence water levels throughout the Study Area. Both elements aim to reduce the probability of flooding.

2.5.17 Some of the Additional Measures associated with all the Do Something options are already underway. These have been justified over an 8 year appraisal period to ensure that the benefits of these measures are not double-counted in the benefits associated with providing long term FRM solutions. These measures aim to 'kick start' an improved maintenance regime for key watercourses in the Study Area.

2.5.18 Additional benefits realised by improving Flood Warning take up have been included in the benefit assessment. Currently there is a 50% take-up and it is assumed that this will increase to 75% considering an 'opt out' registry system and the implementation of the Oxford MAFP. This improvement will reduce the consequences of flooding. The Environment Agency are currently using an 'opt out' system based on publicly available data (names, addresses, and telephone numbers). Negotiations with telecommunications companies holding ex-directory data are underway and with this data the Environment Agency is currently changing to a fully 'opt out' system.

2.5.19 The benefits of flood resilience measures have been assessed for the entirety of the study area. A property with flood resilience will still incur damages associated with temporary accommodation (50% of flood duration without resilience) and clearing up after a flood event. The residual property damages in MCM have been reduced following review of data published by the ABI and insurance company AVIVA. Residual damages with resilience measures in place are between 50-60% of damages without resilience. Further information is provided in the Technical Report.

2.5.20 As part of the environmental enhancement options, the potential to create priority BAP habitat in the wider Study Area which will provide economic benefits has been assessed. Calculations of benefits were based on 'Flood and Coastal Erosion Risk Management: Economic Valuation of Environmental Effects – Handbook'. Three implementation strategies were considered to provide 115ha of priority BAP habitat (see Economic Appraisal Report - Appendix C). These benefits have been included in the Strategy.

2.5.21 The PV of benefits and damages for each option are shown in Table 2.9.

Table 2.9 PV Damages and Benefits 'without climate change'

	Option	SoP [A]	PVd (£M)	PVb (£M)
1	Do Nothing	-	1,243	
2	Do Minimum	< 10	205	1,038
3	Do Minimum Sustain	< 10	192	1,051
3b	Do Minimum Sustain & Additional Measures	< 10	157	1,086
4	Enhanced Maintenance & Additional Measures	10-20	139	1,104
5	Western Conveyance Small & Additional Measures	20-50	98	1,145
6	Western Conveyance Medium & Additional Measures	20-50	69	1,174
7	Western Conveyance Large & Additional Measures	20-50	61	1,182
8	Western Conveyance Small, Upstream Storage & Additional Measures	50-75	59	1,184
9	Western Conveyance Medium, Upstream Storage & Additional Measures	50-75	41	1,202

[A] The SoP varies between properties. SoP quoted reflects that provided to 90% of the properties in the key benefit areas.

Table 2.9a Properties Protected by Flood Risk Category 'without climate change'

	Option	1 in 20 (5%)	1 in 50 (2%)	1 in 75 (1.33%)	1 in 200 (0.5%)
1	Do Nothing	-	-	-	-
2	Do Minimum	1,202	1,583	1,559	1,354
3	Do Minimum Sustain	1,202	1,583	1,559	1,354
3b	Do Minimum Sustain & Additional Measures	1,277	1,664	1,642	1,437
4	Enhanced Maintenance & Additional Measures	1,395	1,807	1,795	1,759
5	Western Conveyance Small & Additional Measures	1,547	2,100	2,212	2,317
6	Western Conveyance Medium & Additional Measures	1,663	2,284	2,436	2,797
7	Western Conveyance Large & Additional Measures	1,694	2,400	2,517	2,963
8	Western Conveyance Small, Upstream Storage & Additional Measures	1,671	2,479	2,661	3,101
9	Western Conveyance Medium, Upstream Storage & Additional Measures	1,739	2,577	2,776	3,330

Note: The above numbers do not include those properties (~ 112 number) which, as part of Additional Measures, will have flood resilience.

2.5.22 The figures in Table 2.9a are quoted for the period immediately after either Western Conveyance or Western Conveyance and Upstream Storage have been implemented. Figures quoted for Options 2 and 3 are the same until Year 60 of the Strategy. After year 60, the number of properties protected by Option 2 will progressively decrease as water level management assets (weirs and sluices) are not replaced.

2.5.23 A breakdown of the Do Nothing PVd by category is set out in Table 2.10 to demonstrate the contribution of each category to the overall economic assessment.

Table 2.10 Do Nothing PVd, by category (£M) 'without climate change'

Item	PVd (£M) 2008	% of total PVd
Property	1144	92%
Traffic	26	2%
Rail	10	0.8%
Agriculture	9	0.7%
Risk to Life	54	4%
Loss of income	0.4	0.03%
Total	**1,243**	**100%**

Climate Change

2.5.24 The economic losses associated with property and infrastructure flooding will rise if fluvial flows increase through climate change. Table 2.11 shows the revised PVd and PVb for the long term 20% increase in fluvial flows.

Table 2.11 PV Damages and Benefits 'with 20% climate change', by option

	Option	PVd (£M)	PVb (£M)
1	Do Nothing	1,751	-
2	Do Minimum	419	1,332
3	Do Minimum Sustain	406	1,345
3b	Do Minimum Sustain & Additional Measures	362	1,389
4	Enhanced Maintenance & Additional Measures	326	1,425
5	Western Conveyance Small & Additional Measures	233	1,518
6	Western Conveyance Medium & Additional Measures	165	1,586
7	Western Conveyance Large & Additional Measures	143	1,608
8	Western Conveyance Small, Upstream Storage & Additional Measures	120	1,631
9	Western Conveyance Medium, Upstream Storage & Additional Measures	82	1,669

2.5.25 The significant increase in economic losses in the climate change scenario occurs because the onset of flooding is earlier, the number of properties affected is greater and the overall depth of flooding to those properties is greater.

2.6 Environmental and Social Assessment

Introduction

2.6.1 A non-statutory Strategic Environmental Assessment (SEA) has been undertaken in accordance with Environment Agency policy (see Appendix A). A Habitats Regulations Assessment (HRA) of the Strategy (Appendix 11 and supporting document) has also been completed to demonstrate no significant impact on Oxford Meadows SAC.

2.6.2 Natural England has provided a letter of support (see Appendix E) and advice on the HRA. In addition to the letter of support, Natural England has sought confirmation from the Environment Agency that the results of further monitoring will be taken into account in future decision making and an Appropriate Assessment would be undertaken if further investigations and monitoring demonstrate that there is likely to be a significant effect on the SAC.

2.6.3 All future project works will be subject to project level environmental assessment. It is anticipated that both the Western Conveyance and Upstream Storage will require a statutory Environmental Impact Assessment (EIA) under the Town and Country Planning (Environmental Impact Assessment) Regulations 1999, as amended. All works from the strategy will comply with applicable legislation, in particular the Water Framework Directive (WFD) in terms of maintaining good ecological status or achieving good ecological potential in watercourses. A Water Framework Directive Assessment has been undertaken and is

included as Appendix L. The assessment concludes that the Oxford Flood Risk Management Strategy is compliant with the requirements of the WFD. Works at the project level (in particular Western Conveyance and Upstream Storage) will be subject to HRA.

Key environmental constraints

2.6.4 The key environmental constraints and opportunities in the Study Area are set out in Table 2.12 and are shown in Key Plan 2.3 and 2.4.

Table 2.12 Environmental Constraints and Opportunities

Receptor	Constraints and Opportunities
Human Beings	The floodplain is inhabited, worked in and visited. The safety and health of these people is highly important. Recreational activities including angling, cycling, walking, nature conservation and various forms of boating and access to these. The Strategy must take these into consideration. 'A' roads, local roads and a mainline railway line run through the floodplain. The watercourses are navigated including the River Thames and the small braided watercourses within the floodplain. Opportunities for enhancements and improvements to recreation and access to recreation and provision of additional navigational opportunities. This may also contribute to benefits to human health.
Soils and Geology	Areas of contaminated land, landfill sites and other waste sites are present in the floodplain. In particular there are concentrations of historic landfills in Oxford on the Abingdon Road, near Port Meadow and on Fiddlers Island (between Binsey and Osney). Opportunities exist to promote restoration of soil and reduce soil erosion rates.
Water	The floodplain of the River Thames is intersected by numerous secondary watercourses where sediment management is an issue. Groundwater levels are generally one to two metres below ground level and there is high hydraulic continuity between the aquifer and surface watercourses. Design of new or widened channels must consider geomorphology and groundwater drawdown risks, with associated impacts on flora and fauna. Opportunities exist to improve water quality and manage the demands for water and minimise maintenance requirements for FRM.
Flora and Fauna	The Study Area supports a diversity of flora and fauna. A number of statutory sites are designated for their nature conservation value including Oxford Meadows SAC, Iffley Meadows SSSI, Chimney Meadows NNR and SSSI and Langleys Lane Meadow SSSI. All of these sites are dependent on a certain surface water and groundwater regime, as are many BAP habitats. Any FRM measure must consider implications on water dependent conservation sites. Opportunities exist to further enhance SSSIs (such as Iffley Meadows) which are already in favourable condition and create significant additional BAP habitat, helping to meet Environment Agency targets. There is potential to enhance the aquatic environment.
Land use and Natural Resources	Land use is part urban and part agricultural land, with isolated villages and dwellings. Retain the integrity of the existing agricultural land use pattern and ownership as much as possible.
Landscape and Visual Amenity	The city of Oxford and its urban fringe form much of the character of the central section of the Study Area. Upstream of Oxford the landscape is more remote and tranquil. There are some protected views of Oxford city that overlook the Study Area. Any new structures, channel widening or alignment of new channels must consider the existing landscape. Opportunities exist to conserve and enhance the natural beauty of the landscape. There are opportunities to strengthen existing elements, remove detracting features and provide more opportunities for enjoyment of the landscape through improved access.

Receptor	Constraints and Opportunities
Cultural Heritage, Archaeology and Material Assets	Oxford and the county are designated a European Centre of Culture, the only such designation in the South East of England. The Study Area is of high historical importance with Scheduled Monuments dating predominantly from the prehistoric and medieval periods, numerous Listed Buildings (many centred on the historic core of Oxford) and non-designated areas of archaeological sensitivity within the floodplain. There remains the potential for undiscovered buried archaeology within the Study Area even though the known high risk areas have been highlighted for avoidance. The Old Abingdon Road bridge is not listed or scheduled but a Norman causeway existed on the 'alignment' which may impose design constraints on conveyance improvements. There are opportunities to expand the existing archaeological and palaeo-environmental knowledge of the floodplain through excavation of the Western Conveyance channel.

2.6.5 Key Plans 2.3 and 2.4 provides an overview of the key spatial environmental constraints in the Study Area.

Environmental Impacts

2.6.6 Do Minimum Sustain (Option 3) has been used as our environmental baseline (maintaining the current standard of service over the 100 year appraisal period). This option will result in continued flooding of assets in the existing floodplain. Over time, such repeat flooding is likely to cause increased stress for residents and associated adverse effects on health and social well-being. It may lead to deterioration of assets such as properties, transport links and the historic environment. It may also mobilise contaminants with adverse impacts for water quality and aquatic ecosystems, and cause soil erosion and leaching.

2.6.7 To test all the options, environmental objectives and assessment criteria were developed. These were included in the SEA Scoping Consultation Document and discussed with key stakeholders and interested parties to confirm that they covered the full range of key issues and environmental risks. These environmental objectives and assessment criteria were refined during the main SEA stage.

2.6.8 A 'Source-Pathway-Receptor' model was used to evaluate the significance of the impact of each strategic option on the environmental receptors over the 100 year appraisal period. In undertaking the assessment of impact significance, it was considered how the adverse impacts of each option might be lessened through mitigation. A summary is provided in Table 2.13. Following the assessment of significance, the environmental objectives were used to compare the strategic options and to assist in the recommendation of the environmentally preferred option(s).

Table 2.13 Key environmental and social impacts directly affecting option selection

Option	Environmental and Social Impacts	Comparison of Strategic Options**
Minimal socio-economic and built environment benefits		
1	Do Nothing Increase in flood risk.	Increase in flood risk.
2	Do Minimum Continued flood risk to assets and people within floodplain (increasing with climate change).	The channel and asset maintenance associated with these options has mainly temporary and minor adverse impacts on existing flora and fauna, landscape and archaeology etc. However, the options also have very limited resultant flood risk reduction and thus limited beneficial impact on the socio-economic and built environment.
3	Do Minimum Sustain Continued flood risk to assets and people within floodplain (increasing with climate change).	
4	Enhanced Maintenance & Additional Measures *	
Residual adverse impacts which outweigh flood risk reduction		
5	Western Conveyance Channel (small) & Additional	Some adverse impact on existing flora

Option	Environmental and Social Impacts	Comparison of Strategic Options**
	Measures* a) Moderate flood risk reduction to assets and people within floodplain. b) Adverse impact on flora and fauna, land use, landscape and buried archaeology. Many of these can be avoided through good channel design. c) No adverse impacts on SSSIs, SAC or Scheduled Monuments. d) Opportunities for environmental enhancements. e) The smallest footprint of Western Conveyance alternatives and thus fewest adverse impacts	and fauna, landscape and archaeology etc.; but of the engineering intervention options, this option has the least adverse impact. However, this option also has limited beneficial impact on socio-economic and built environment in terms of flood risk reduction.
Residual adverse impacts which outweigh flood risk reduction		
7	Western Conveyance Channel (large) & Additional Measures* a) Adverse impact on flora and fauna, land use, landscape and buried archaeology as a result of large footprint of channel. The largest footprint of Western Conveyance alternatives and thus the most adverse impacts b) Flood risk reduction benefits and opportunities for environmental enhancements.	Large channel with the potential to have a high adverse impact on existing flora and fauna, landscape and archaeology etc. Flood risk reduction benefits for socio-economic and built environment are not much greater than Option 6 and thus this cannot outweigh the additional adverse impacts.
Good flood risk reduction which outweighs residual adverse impacts		
6	Western Conveyance Channel (medium) & Additional Measures* As for option 5 but larger channel resulting in greater flood risk reduction and greater opportunities for environmental enhancements but potential for greater adverse impacts on flora and fauna, land use, landscape and buried archaeology.	Some adverse impact on existing flora and fauna, landscape and archaeology etc.; but the majority of these can be mitigated or off-set. High beneficial impact on socio-economic and built environment in terms of flood risk reduction.
8	Western Conveyance Channel (small), Upstream Storage & Additional Measures* a) As for option 5. b) In addition, potential impact of Upstream Storage on designated sites (further research prior to implementation is required). c) High flood risk reduction benefits and opportunities for environmental enhancements.	
9	Western Conveyance Channel (medium), Upstream Storage & Additional Measures* a) As for option 6. b) In addition, potential impacts of Upstream Storage on designated sites. c) High flood risk reduction benefits and opportunities for environmental enhancements.	
*includes all elements of Option 3. **Abstracted from the SEA Environmental Report pages 93-94 (Appendix A). ***Option 3b has been included to demonstrate the decision rule analysis used to develop the phased implementation plan (refer to 2.7). It is not a stand alone option and thus is not included in this appraisal.		

2.6.9 The Do Something options have been developed to avoid significant impacts on Oxford Meadows SAC and Port Meadow Scheduled Monument (ring ditches, barrows and associated enclosures). The northern extent of the Western Conveyance channel is proposed to be downstream of this designated site to avoid direct and indirect impact. Raised defences at Wolvercote will not impede groundwater flows, so the groundwater regime to Port Meadow with Wolvercote Common and Green SSSI will be retained. Adjustable low flow control

structures within widened and existing channels will provide flexibility in management of interactions between surface water and groundwater, and hence reduce risks of groundwater draw-down.

2.6.10 The significant environmental effects of the draft strategy (Option 9) are outlined in Table 7.2 of the SEA (Appendix K). Key Plan 2.6 in Appendix H shows the key environmental constraints in the Western floodplain and how these have influenced the future design and alignment of the Western Conveyance channel to minimise environmental impact.

2.6.11 Archaeology risk mapping has shown that it should be possible to enlarge existing channels and create new channels within the western corridor without adverse impact on areas of high archaeological sensitivity (national designations).

2.6.12 Assessment of geophysical survey work and desk based studies have also indicated areas of low archaeological risk along the Old Abingdon Road indicating the potential to enlarge existing structures or create new structures to pass additional flood flows.

2.6.13 English Heritage, Oxfordshire County Council and Oxford City Council archaeologists have been consulted on the archaeology risk mapping and potential channel widening under the Old Abingdon Road. The outcomes were that, although it will be challenging to reach a consensus between interested parties, an acceptable solution can be found.

2.6.14 The landscape character assessment has assessed the impact of the options upon landscape character within the Indicative Strategy Boundary. The landscape assessment shows that the Western Conveyance and Upstream Storage elements can be incorporated into the existing landscape without significant adverse impact. Routing of new channels will need to be carefully implemented to minimise division of field parcels and retain hedgerows and mature trees where practicable. There are also opportunities for environmental enhancements, such as improvements to the landscape structure through work to hedgerows and watercourses, and improvements to the protected views of Oxford.

2.6.15 There are recreational opportunities through the design of the Western Conveyance channel. Additional footpaths and cycle paths are to be constructed as part of the works and there may be potential for further canoeing, angling and boating opportunities on the new channel.

2.6.16 The Upstream Storage will be online storage on the River Thames. Following operation of the storage area, it is predicted that navigation on the River Thames would be ‘red boarded’ (warning to boaters) between Northmoor Lock and Rushey Lock for a period of approximately 9 to 10 days. In the current situation, it is estimated that the navigation is ‘red boarded’ for 8 days. Therefore, the Upstream Storage will have a temporary adverse impact on navigation in the upstream reaches of the Thames.

2.6.17 Some uncertainties remain regarding potential impacts of flood storage on designated sites in the flood storage area. Temporary inundation during the operation of the storage area may impact upon designated grassland communities. Further botanical monitoring (of Chimney Meadows SSSI and NNR and Langleys Lane SSSI) is planned in the monitoring strategy to better assess potential impacts of this inundation (outlined in Section 8 of the SEA Environmental Report). The results of this research should be considered during the periodical review of the Strategy.

Consideration of the Habitats Regulations and Obligations

2.6.18 The Habitats Regulations Assessment (HRA) (Appendix 11) concludes that there are unlikely to be any significant environmental effects on the interest features of the Oxford Meadows SAC as a result of implementing the Strategy.

2.6.19 There are some uncertainties regarding the Upstream Storage element of the Strategy, in particular the increased duration of flooding during higher order events (through prolonged release of flood waters from the flood storage area) and potential for reduced nutrient supply to Oxford Meadows SAC when storing some floodwaters upstream. It should be noted that the flood storage area would only be implemented if increased flows as a result of climate change are realised. Therefore, future environmental baseline trends will be taken into account when assessing the environmental effects at project level.

2.6.20 Further research is recommended to understand the potential impacts that Upstream Storage may have on the Oxford Meadows SAC and the SSSIs within the Upstream Storage area and how this can be mitigated. In accordance with the request accompanying the letter of support from Natural England, the results of this research should be considered during the periodical review of the strategy. This research will also input into the project level HRA work which will be required for the Upstream Storage. Monitoring costs are included in the Strategy. Consultation with Natural England and key stakeholders (including BBOWT) will take place throughout the above process. It should be noted that if the results of the future monitoring work show the potential for significant environmental effects on the SAC or the SSSIs that cannot be mitigated or offset, this will make the Upstream Storage area environmentally unacceptable to implement.

Environmental Enhancement

2.6.21 The incorporation of footpaths, planting, seating and interpretation panels are part of good engineering design and will be detailed at project level design of the Western Conveyance channel. These will allow improvements to amenity for urban and suburban communities affected by the channel construction. These elements have been included in the construction costs of the Western Conveyance channel (Table 2.8).

2.6.22 In addition to good engineering design, a number of enhancement opportunities within the Indicative Strategy Boundary have been identified such as improvements to access, landscape, recreation and nature conservation. These are shown in Appendix G. A priority rating has been given to each item based upon relevance to the overall Strategy. This considers geographic closeness to the proposed FRM measures in the Strategy, achievability, and the least degree of long term maintenance burden.

2.6.23 An indicative costing has been assigned to each potential enhancement opportunity which has been used in our strategy costings. The Strategy Appraisal Team has liaised with the Jubilee River Project team and the parameters for costing environmental enhancements were determined based on the lessons learned.

2.6.24 For each enhancement opportunity, recommendations for funding partners have been provided. If funded, the Strategy would enable continued investigation into these potential opportunities to further define the scope of the works. It is assumed that the high priority rated environmental enhancements will be delivered as part of the strategy and these are summarised in Table 2.14.

2.6.25 Land to be purchased as part of the Western Conveyance schemes in order to create a second stage (or berm) to the main channel will be used to create priority BAP habitat. It is estimated that priority BAP habitat could be achieved on 80% of this area, totalling approximately 15ha.

Table 2.14 – High Priority Rated Environmental Enhancements

Environmental Enhancement	Indicative Cost (£k)
Upstream of A34	
New pedestrian/cycle crossing over River Thames at Bablock Hythe	175
Improvements to Thames Path at Pinkhill	25
Improvements to slipway, car park and visitor moorings at Bablock Hythe	100
Improvements at Swinford Farm	30
Improvements to general landscape structure - Hedgerows	35
Improvements to general landscape structure – Watercourses	80
Improvements to general landscape structure – Visual impact	110
Contribution towards enhancement or extension of existing wildlife sites	200
Downstream of A34	
Improved pedestrian/cycle access to Western Conveyance area from surrounding urban areas	110
Improvements to general landscape structure – Hedgerows	50
Improvements to general landscape structure – Watercourses	100
Improvements to protected views of Oxford's historic skyline	65
Improvements to general landscape structure – Visual Impact	125
Habitat Improvements to Hinksey Meadow/Seacourt Nature Reserve within Thames and Cherwell Conservation Target Areas	40
Re-introduction of Creeping Marshwort (*Apium Repens*)	20
Creation of a fish pass channel at the head of the Seacourt Stream	250
Total	1,515

2.6.26 Significant additional BAP habitat can be created when Western Conveyance is implemented. In accordance with the FRM Biodiversity Policy, areas for priority BAP habitat creation have been identified, including land within the Oxford Nature Conservation Forum's Conservation Target Areas (CTAs)[2]. These are areas which have already been identified as having good potential (ecologically and also with regards to landowner interest).

2.6.27 100ha of priority of environmental enhancement BAP habitat creation (in the wider Indicative Strategy Boundary) has been included as part of the Strategy. This is an estimate taken from over 600ha of land within the Indicative Strategy Boundary which is in existing agri-environmental agreements and has good potential to be developed into priority BAP habitat. Including the 15ha which can be created as part of the Western Conveyance element, this totals 115ha of BAP habitat creation for the Strategy. Opportunities to add to this figure will be investigated during periodic reviews or as part of investigations outlined in 2.6.20.

2.6.28 The priority BAP habitats identified for creation are floodplain grazing marsh, lowland meadows and ponds. All of these habitats are fluvial habitats and are appropriate for the existing land use and landscape.

2.6.29 The costs in Table 2.8A for the Western Conveyance channel include a sum of £1,923k to deliver 15ha of BAP habitat on the second stage of the channel (estimated at £150k), delivering the high priority environmental enhancements summarised in Table 2.14 and environmental monitoring surveys. This sum also allows the opportunity to further investigate the potential for the medium and low priority environmental enhancements. Table 2.8 also includes costs for the delivery of 100ha of BAP habitat in the wider study area.

Consultation Process

2.6.30 As part of the development of the Strategy and the SEA, consultation was carried out during Stage 1 and Stage 2 with the general public, statutory bodies and external interest groups (e.g. flood action groups). During Stage 1 of the Strategy, a Wildlife Forum was established and used in order to consult with a wide range of environmental stakeholders.

[2] The Oxford Nature Conservation Forum is a partnership of 60 conservation organisations, including Natural England, farming bodies, environmental and recreational interest groups and local authorities.

2.6.31 Periodic newsletters, flood surgeries, questionnaires, newspaper articles and meetings with interest groups have been used (in line with the Environment Agency 'building trust with communities' guidance) to ensure the views of all interested parties were considered in developing the Strategy.

2.6.32 The SEA Scoping Report set out the spatial extent of the Study Area, the environmental baseline and the environmental objectives (which are used to assess the potential impacts of proposed strategic options). It also described the proposed SEA methodology and the next steps of the SEA process. The Scoping Report was sent to statutory consultees and external interested parties for comment.

2.6.33 Extensive direct consultation was carried out with relevant parties (primarily Environment Agency specialists, Oxford County Council, Oxford City Council, Vale of White Horse District Council and Thames Water) to assist us in the development of the strategic options. Consultation with Natural England was also undertaken throughout the development of the Strategy.

2.6.34 Prior to the start of public consultation, five early engagement meetings were undertaken with key stakeholders in the Upstream Storage area, in Oxford and in Abingdon. Attendees included elected representatives and landowners. District and county councillors were involved in the identification of specific landowners. These meetings provided proactive contact with stakeholders prior to publication of the public consultation document and provided a route for further dialogue.

2.6.35 A public consultation document on the Oxford Strategy was published on 18th February 2009 alongside the SEA Environment Report. A 12 week consultation period ran from 18th Feb to 12th May 2009. Press releases were issued at the start of the consultation period. The SEA Environmental Report and the Public Consultation Document have been made available on the Environment Agency website and copies of the public consultation document and SEA Environmental Report made available at Environment Agency offices, public libraries and local councils.

2.6.36 The HRA Appendix 11 and supporting document was issued to Natural England at the same time as the SEA.

2.6.37 Eight public meetings have been held across the Indicative Strategy Boundary throughout the 12 week consultation period to allow interested parties the opportunity to ask questions and comment in person.

2.6.38 The outcome of the consultations to date are summarised in the Consultation Summary Report in Appendix F. Consultation has shown that the vast majority of respondents are in support of the Strategy, and in particular Option 9, although there has also been some support for Options 7 and 8. There has been further positive support of the Short Term Measures works, current and proposed.

2.6.39 Respondents have suggested many opportunities for recreation that could be associated with a new conveyance channel.

2.6.40 Consultation has also illustrated some key areas of concern, including flooding from groundwater and what the Strategy can do to address this problem; potential downstream effects of the Strategy; continuing development within the floodplain; and maintenance of existing watercourses.

2.6.41 Potential downstream effects of the Strategy were raised by 10 out of 296 responses; these were predominantly from downstream residents. The Vale of White Horse, South Oxfordshire District Council and Sutton Courtenay Parish Council have also noted similar concerns about potential downstream effects. However, direct, continued engagement with councillors by the Area team is aimed at managing these concerns.

2.6.42 Responses from NE, RSPB and BBOWT raised concerns regarding the impact that Upstream Storage implementation may have on the interest features of Chimney Meadows and Langley's Lane SSSIs. To address these concerns, paragraph 3.2.5 states that, if significant adverse impacts on the interest features of these sites cannot be mitigated, then Option 6 will be taken forward as the preferred Strategy. A summary of the responses is provided in Appendix F, Addendum A. This also includes how the Strategy team are dealing with the issues raised.

2.6.43 Although the vast majority of consultees support the Strategy, respondents also expressed concern that the lack of funding may delay or prevent Strategy implementation altogether. The majority of consultees are keen to see the Strategy implemented, and in as short a timeframe as possible.

2.6.44 As part of the Environment Agency's recent 'End of Year Update' statement (December 2009) they have communicated to key consultees (MPs, Councillors, NE, BBOWT, Local Councils) that the economic case for constructing the Western Conveyance channel in the short term is not as strong as it needs to be, but that future realisations of climate change impacts may make a stronger case for its construction. The EA also advised that more Additional Measures (following on from STM1) will be implemented in the short term.

2.7 Choice of Preferred Option

Land Use Bands and Indicative SoP

2.7.1 Using the FCDPAG, key benefit areas[3] have been identified where the core engineering elements reduce flood risk. These areas fall within land use band A (typically intensively developed urban areas). Therefore, the indicative SoP is 50-200 years (2% - 0.5% AEP). Since no options achieve a minimum SoP to all properties within the indicative SoP, an Incremental Benefit Cost Ratio (IBCR) robustly greater than 1 must be achieved to economically justify the next option. A detailed explanation of the method used to assess the IBCRs for the range of options is set out in the Economics Report (Appendix C).

2.7.2 If meeting the minimum indicative SoP (1 in 50 year (2% AEP)) for <u>all</u> properties in the key benefit areas is considered, none of the options achieve this goal. More pragmatically, we have taken the view that around 90% of properties should meet the minimum indicative SoP in the key benefit areas (with additional measures considered for the remaining properties at risk). In general, only Options 8 and 9 would meet this criterion.

Legal obligations

2.7.3 The Environment Agency have a legal obligation to maintain navigation on the River Thames and as such the minimum acceptable option is Option 3, Do Minimum Sustain which includes maintenance of the 3 main weir structures which affect properties within the Study Area.

Economic Assessment

2.7.4 The economics of all options were compared to Option 1 (Do Nothing) before being compared against each other. The options have been compared in terms of increasing intervention (for example, small channel to medium channel) and also in terms of implementation (for example, small channel to small channel with upstream storage).

2.7.5 Table 2.15 provides the benefit cost summary for each option, assuming there are no impacts from climate change.

[3] Key benefit areas are those properties which are located in Botley, Osney, Jericho and New Hinksey.

Table 2.15 Benefit cost ratios 'without climate change', by option

	Option	SoP*	PVd (£M)	PVb (£M)	PVc (£M)	BCR	IBCR**	
1	Do Nothing	-	1,243					
2	Do Minimum	<10	205	1,038	9.9	105.0		
3	Do Minimum Sustain	<10	192	1,051	14.1	74.5	3.1	2
3b	Do Minimum Sustain & Additional Measures	<10	157	1,086	24.6	44.2	3.4	3
4	Enhanced Maintenance & Additional Measures	10-20	139	1,104	70.1	15.8	0.4	3b
5	Western Conveyance Small & Additional Measures	20-50	98	1,145	123	9.3	0.6	3b
							0.8	4
6	Western Conveyance Medium & Additional Measures	20-50	69	1,174	163	7.2	0.7	5
7	Western Conveyance Large & Additional Measures	20-50	61	1,182	182	6.5	0.4	6
8	Western Conveyance Small, Upstream Storage & Additional Measures	50-75	59	1,184	185	6.4	0.6	5
9	Western Conveyance Medium, Upstream Storage & Additional Measures [preferred option]	50-75	41	1,202	225	5.4	0.5	6
							0.4	8

* SoP quoted reflects that provided to 90% of the properties in the key benefit areas.
**The right hand column states which option has been referenced to calculate the IBCR.
NB: The preferred option (without consideration of climate change) is shaded.

2.7.6 With no climate change the economically preferred option is Option 3b – Do Minimum Sustain & Additional Measures. This option has a robust IBCR compared with Option 3 (Do Minimum Sustain) of 3.4. Options 4-9 cannot be preferred under this scenario as they have all have IBCRs of less than 1.

2.7.7 Table 2.16 provides the benefit cost summary for each option, assuming there is a 20% increase in fluvial flows due to climate change.

Table 2.16 Benefit cost ratios 'with climate change of 20% increase in flows', by option

	Option	PVd (£M)	PVb (£M)	PVc (£M)	BCR	IBCR**	
1	Do Nothing	1,751					
2	Do Minimum	419	1,332	10	134.0		
3	Do Minimum Sustain	406	1,345	14	95.4	3.1	2
3b	Do Minimum Sustain & Additional Measures	362	1,390	25	56.5	4.3	3
4	Enhanced Maintenance & Additional Measures	326	1,426	70	20.3	0.6	3b
5	Western Conveyance Small & Additional Measures	233	1,519	123	12.4	1.3	3b
						2.3	4
6	Western Conveyance Medium & Additional Measures	165	1,586	163	9.8	1.7	5
7	Western Conveyance Large & Additional Measures	149	1,602	182	8.9	1.1	6
8	Western Conveyance Small, Upstream Storage & Additional Measures	120	1,631	185	8.8	1.8	5
9	Western Conveyance Medium, Upstream Storage & Additional Measures	82	1,669	225	7.4	1.3	6
						1.0	8

**The right hand column states which option has been referenced to calculate the IBCR.
NB: The preferred option (allowing for 20% increase in flows) is shaded.

2.7.8 When incorporating a 20% increase in fluvial flows resulting from climate change Option 4 has an IBCR, when compared with Option 3b, of 0.6. The range of IBCRs for Options 5 to 9 varies between 1.0 and 1.8. In view of the narrow range of IBCRs, it is not possible to make any conclusive recommendations as to which of the full scheme options would be preferred. However, the IBCRs when assessed to each subsequent option (as presented in Table 2.16) demonstrate that there is likely to be economic justification for Option 9 at some point within the Strategic 100 year appraisal period, as it has an IBCR of 1.3 when compared with Option 6.

Additional Measures

2.7.9 Additional Measures have been considered to reduce risk in the short term prior to the implementation of the Western Conveyance channel. Additional Measures also include Targeted Responses which are aimed at those areas that will not fully benefit from the Western Conveyance channel.

2.7.10 These measures were technically, economically and environmentally appraised with all Do Something options, so that benefits were not double-counted. The full appraisal is contained in Appendices A, B & C. The recommended Additional Measures, and their costs and benefits, are presented in Table 2.17 both as stand alone elements and when combined together. A description and the locations of the measures are shown in Key Plan 2.5 with further details in Table 3.1.

Table 2.17 Additional Measures Costs and Benefits

Additional Measure	Additional Props Protected	PVb [A] (£M)	PVc (£M)	BCR	Whole Life Cost (£M)
Short Term Measures Phase 1 [B + I]	96[C]	2.9	1.8	1.63	1.8
Short Term Measures Phase 2 [B + I]	63[D]	2.4	1.35	1.73	1.5
Raised Defences at Wolvercote [I]	83[E]	18.4	1.94	9.46	2.55
Oxford Multi Agency Flood Plan	0[F]	1.7	0.33	5.1	0.76
Improved Watercourse Maintenance [I]	0[G]	5.7	1.55	3.67	5.58
Flood Resilience Measures [I]	112[H]	6.69	3.5	11.91	5.75
Additional Measures (Combined cost and benefits when all elements implemented) [J]	354	35	10.5	3.59	17.94

[A] Benefits for all Additional Measures have been compared to Do Minimum Sustain (Option 3b) to provide realistic benefits and BCRs.
[B] Interim works have an 8 year appraisal period.
[C+D] Numbers quoted are properties with improved SoP to 1 in 20 (5% AEP) in the short term.
[E] Number of properties with improved SoP to 1 in 75 (1.33% AEP). In addition to which there are a further 38 properties with reduced damage.
[F] Multi Agency Flood Plan reduces the consequences of flooding but not the probability.
[G] Improved maintenance further improves the SoP to those properties already benefiting.
[H] Assumes 40% uptake from 279 eligible properties in the 1 in 10 year (10%) floodplain.
[I] Benefits have been included for both properties and social equity.
[J] The total benefits for Additional Measures (taken from Table 2.15) do not include any double counting of benefits from implementing the above elements together. Additional Properties Protected is based on sum of individual elements, refer to notes above.

2.7.11 The benefits of the Short Term Measures works are delivered in first 8 years of the Strategy. The works mainly consist of vegetation clearance and de-silting activities on some reaches of the secondary watercourses, the benefits of which will begin to erode in the short term. The watercourses are estimated to revert to a pre-works condition in the period 2018-2023.

The Preferred Option

2.7.12 The PAG decision rule preferred option is Option 3b (Do Minimum Sustained with Additional Measures. If climate change occurs at the rates assumed in the current Defra guidance Option 9 (Western Conveyance Medium, Upstream Storage & Additional Measures) would be considered for implementation in the medium and long term, respectively. A summary of benefits with and without climate change is shown in Table 2.18. Unlike the previous tables which were developed to allow direct comparison between options, Table 2.18 presents the final strategic option economics which assume a step change in the impact of climate change (10% then 20% increase in flows).

2.7.13 In view of the extended timescales envisaged for implementation of a conveyance channel option (of up to 70 years) and upstream storage (70 - 90 years), the specific requirements of PAG are likely to change. With other uncertainties (e.g. rate of climate change and sale of gravel referred to below in Para 2.7.18), the overall conclusion of the economic appraisal is that it is not possible to make any conclusive recommendations as to which of the full scheme options would be preferred. However, the IBCRs when assessed to each subsequent option (as presented in Table 2.16) demonstrate that there is likely to be economic justification for both a conveyance channel and the upstream storage within the Strategic 100 year appraisal period. This will be kept under periodic review.

Table 2.18 Preferred Strategy costs and benefits

Option		Props Protected (1 in 75yr)	PVb (£M)	PVc (£M)	BCR	WLC (£M)
3b	Without Climate Change (Do Minimum Sustained with Additional Measures)	1,642	1,086	24.6	44.2	62.9

Climate Change Sensitivity Tests

2.7.14 Climate change sensitivities have been undertaken to assess the choice of preferred option and ensure a long term strategic approach is recommended, as described throughout this StAR.

2.7.15 In addition, a further climate change assessment was carried out to consider the economic justification of each option if a 10% increase in fluvial flows were to be realised. This assessment effectively evaluates the interim period between 2009 and 2025. The preferred option under these conditions is the same as without climate change (Option 3b).

2.7.16 Due to the inherent uncertainty surrounding climate change, this StAR therefore recommends an adaptive approach with periodic reviews of the Strategy.

2.7.17 If climate change impacts do not materialise in the medium term, then the preferred option would continue to be Option 3b, Do Minimum Sustain & Additional Measures. In the long term, if Upstream Storage is not justified by a continued rise in water levels due to climate change, then through periodic review; data collation and analyses, the strategy may include Option 6, Western Conveyance Medium & Additional Measures. The economic summary of both of these options is set out in Table 2.15.

Economic Sensitivity Tests

2.7.18 For Western Conveyance Medium, 15% of the initial capital costs are associated with disposal of the excavated channel gravel. If this gravel could be sold then it could bring construction of the channel forward between 20 and 40 years (to the period 2039 – 2079) as it would significantly reduce the cost associated with construction.

2.7.19 An optimism bias sensitivity test has been undertaken on both the Raised Defences at Wolvercote and on Resilience Measures. These options are still justifiable with the sensitivities carried out; further details are included in the Economics Report.

2.7.20 Sensitivities are not required on STM1 as these costs are actual costs. STM2 is based on STM1 costs, but also incorporates an Optimism Bias of 40% which is considered sufficient to cover sensitivities.

2.7.21 The economic sensitivity tests do not change the choice of preferred strategic option.

Implementation Sensitivity Tests

2.7.22 As implementation of the Western Conveyance channel may not be realised until the medium term, a number of staged implementation options were considered. Detailed explanations of these investigations are set out in the Economics Report.

2.7.23 One of these options considered the economic feasibility of constructing the Western Conveyance channel one reach at a time. This sensitivity test demonstrated that there is no economic benefit to constructing the channel in stages. However, it also demonstrated that there is no adverse economic effect, and therefore that the channel could be implemented in stages to align with funding availability in the future.

2.7.24 A second investigation considered whether there is economic justification for the various components of Enhanced Maintenance (Option 4) to be implemented in phases in the interim period before Western Conveyance is constructed. This sensitivity test demonstrated that the IBCR of each component is not greater than that achieved for the Western Conveyance options. Given this, along with the adverse environmental impacts and the inherent uncertainty of the achievable flood risk reduction, this approach has been omitted from the Strategy.

Environmental Summary for the Preferred Option

2.7.25 With the incorporation of mitigation measures and use of good environmental design, the implementation of a Western Conveyance Medium is unlikely to compromise the valued elements of the environment set out in sections 2.1.11 to 2.1.14. Widening of existing sections or the creation of new sections of channel in the Western Corridor will include a berm where feasible and appropriate. This berm will be dry for the majority of the time and can be used for existing land use activities such as grazing. The design and costs for this unconstrained channel includes allowances for 1:20 side slopes on the second stage and a roughness coefficient to allow for vegetation growth to match the existing land use.

2.7.26 Appendix H is a plan of the environmental constraints in the Western Corridor and where constrained, semi-constrained, or unconstrained sections of channel are proposed. In some locations, a constrained channel is recommended, to minimise land-take and avoid impact on features such as existing transport infrastructure and archaeology. In other locations, an unconstrained channel is recommended, to promote continuation of existing land use and conform to the existing landscape character.

2.7.27 The plan in Appendix H also shows further proposed mitigation measures to avoid adverse impact on the existing valued elements of the environment which are listed in paragraph 2.1.14. It should be noted that the indicative route shown within the western corridor has been developed for modelling and costing purposes and has not been consulted upon within the SEA or the public consultation document.

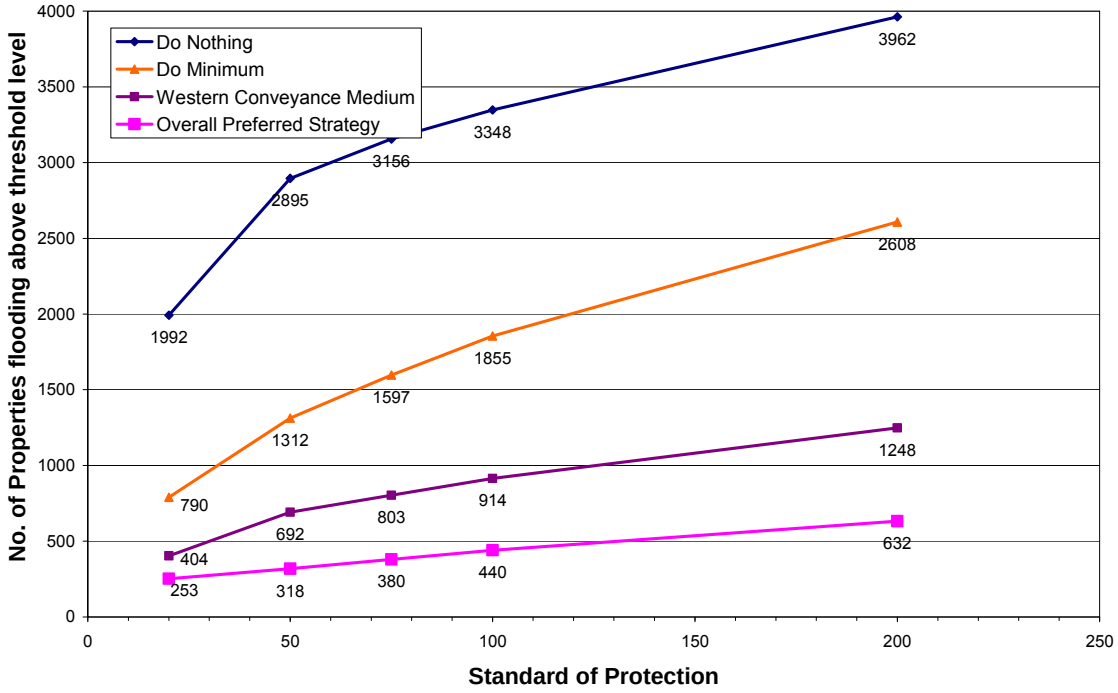
2.7.28 Environmental issues also support the recommended approach to handling climate change. For Upstream Storage, the environmental assessment highlighted potential impacts on two SSSIs and a National Nature Reserve. Although these risks are not considered ‘show stoppers’ for Upstream Storage, further investigations over a number of years will aid

understanding of potential impacts to these environmentally sensitive sites. Implementing Upstream Storage in the long term provides time to investigate and mitigate environmental risks before construction.

Residual Flood Risk and Exceedance

2.7.29 Figure 2.6 shows the reduction in risk and the number of properties which would remain at residual risk of flooding with implementation of the Strategy if all elements were constructed now. Figure 2.6 has been included to demonstrate the incremental reduction in residual flood risk that will be achieved from each element.

Figure 2.6 – Residual Flood Risk (2009)



2.7.30 There will be a reduction in the number of properties protected to the 1 in 75 year (1.33% AEP) flood event over time if the current predicted climate change is realised.

2.7.31 Where the chance of a breach exists (Upstream Storage element) the Reservoir Safety Manual will be used to ensure that appropriate design and safety standards are adhered to.

2.7.32 In the event that a high magnitude event affects Oxford, the recommendations relating to the implementation of a Multi Agency Flood Plan will reduce the consequences of flooding.

Outcome Measure Assessment for the Preferred Strategic Option

2.7.33 The Preferred Strategic Option Outcome Measures (OMs) are set out in Table 2.19. Western Conveyance, BAP creation and Upstream Storage are excluded from the Outcome Measures due to their medium to long term implementation.

Table 2.19 Summary of Preferred Strategic Option Outcome Measures

Measure*	OM1	OM2	OM2b	OM3	OM5	Total	Score
Defences at Wolvercote	0.0038	0.0000	0.0034	0.0000	0.0000	0.0071	3.68
Oxford Multi Agency Flood Plan	0.0126	0.0000	0.0000	0.0000	0.0000	0.0126	37.77
Short Term Measures 1	0.0237	0.0019	0.0029	0.0000	0.0000	0.0285	5.99
Short Term Measures 2	0.0235	0.0013	0.0019	0.0000	0.0000	0.0267	6.00
Flood Resilience Measures	0.0018	0.0000	0.0000	0.0000	0.0000	0.0018	0.50
Total	0.0654	0.0032	0.0082	0.0000	0.0000	0.0768	

Recommendation

2.7.34 The recommended 100 year Strategy incorporates a hybrid of FRM measures which are adaptable to the future climate change in the short, medium and long term.

2.7.35 The following Additional Measures will be implemented, following individual stand-alone scheme level PARs in the short term, over the next 9 years:

- Short Term Measures Phases 1 and 2.
- Raised defences at the village of Wolvercote.
- Development and implementation of a Multi-Agency Flood Plan (MAFP) for Oxford.
- Improved watercourse maintenance regime.
- Provision of flood resilience measures to individual residential properties.

2.7.36 Over the 100 year appraisal period fluvial flows may increase, at the rates included in the current Defra guidance on climate change. To address this potential increase in flood risk the costs for the Western Conveyance and Upstream Storage have been considered. The Western Conveyance Medium channel may be considered for implementation in the medium term (2039 – 2079). Periodic reviews of the Strategy will assess the rate of climate and other changes to determine the timing of intervention. For the reasons of uncertainty of when or if these costs would be realised, they have not been included in this approval. When appropriate, a scheme level PAR will confirm the business case as well as determine both the optimum channel size and optimum channel reaches for phased construction.

2.7.37 Upstream Storage should be considered as a further adaptive approach to climate change. Based on current climate change guidance, it is estimated that possible implementation will be in the long term from around 2079 - 2099. Environmental impacts of Upstream Storage need to be addressed before implementation, and the element needs to remain economically viable.

2.7.38 The Environment Agency will continue close liaison with local authorities, landowners, tenants, infrastructure owners and local interest groups in order to develop the strategic option and the resultant projects.

2.7.39 The creation of priority BAP habitat in the wider Study Area will have benefits for both the natural environment and those using the areas for recreational purposes. It is recommended that the Environment Agency continue to work with Natural England and local project partners such as the Berkshire, Buckinghamshire and Oxfordshire Wildlife Trust (BBOWT), Oxford Rare Plants Group (ORPG) and local landowners to implement appropriate land use management principles.

2.8 Other Considerations

Third Party Contributions

2.8.1 The Strategy Appraisal Team has commissioned the External Relations – External Funding team to undertake a contributions assessment for the OFRMS. The aim of the assessment has been to identify potential sources and extent of financial contributions; strategic partnerships and external funding opportunities.

2.8.2 There are some sites where land values will increase due to decreased flooding resulting from this Strategy. However, these sites are not likely to be uplifted to a 1 in 100 year SoP, thus limiting opportunities for developers. The exception is Wolvercote.

2.8.3 The following are the main conclusions from the assessment. In addition, there are some actions that should be pursued during the Western Conveyance PAR stage of the project:

a) Benefits are widely distributed and deliver a varying SoP due to the nature of the preferred solution (i.e. a channel does not provide a defined SoP as an embankment does). As a result, sustainable housing developments and thus opportunities for developer contributions are likely to be limited.
b) Consideration should be given to seeking contributions from Oxford City Council regarding the West End Area Action Plan via the West Area Planning Liaison Team. However, care will be needed to avoid encouraging inappropriate Flood Zone 3 development.
c) There is the potential for a strategic partnership with Oxford City Council (OCC) regarding Osney Mead Industrial Estate. The estate is of considerable strategic value to OCC especially as parts of it could be uplifted in terms of land use. Conversely, the Environment Agency should work with the Council to change the use of land in other areas of the industrial estate where significant flood risk remains even after the Strategy is implemented.
d) The transport (disruption damage avoidance) benefits included in the OFRMS cost benefit appraisal should be clearly communicated to Network Rail and Oxfordshire County Council via Memorandums of Understanding. We should ensure that we maximise and identify contributions in kind and economies through our own capital investment. Seeking contributions from transport Grant in Aid (GiA) will be explored at the next stage of the project. However, there are opportunities for collaborative working which could also deliver cost savings.
e) In kind contributions to the delivery of the scheme should be sought from other parties through provision of land, services or economies arising from implementation of their own capital investments.
f) Contributions to the creation of BAP habitat, amenity and/or access and recreational use of landscape could be sought via external funding, for example the Heritage Lottery Fund. This could be done in partnership with other organisations such as BBOWT.
g) Both Oxford City Council and Oxfordshire County Council own land along the route of the conveyance channel. The Environment Agency will work with these landowners to minimise the costs of legal agreements and any compensation.
h) The Environment Agency will seek to implement flood resilience measures to individual residential properties in partnership with Oxford City Council and the Vale of White Horse District Council.
i) Based on lessons from the Jubilee River project, the costs for the Western Conveyance options are based on the excavated gravel from the channel being disposed to landfill. An outline assessments suggests that, depending on the quality / quantity of the excavated material and market prices, a indicative cost savings of around £10m for the medium channel might be achievable for the medium channel (refer to the Economics Report). Subject to climate change, this might bring forward construction of the channel. This will be investigated further when the Strategy is next updated.

Hydrologic and Hydraulic Assessment

2.8.4 A high level of input and attention has been paid to the hydrological and hydraulic modelling for the Strategy. Hydrological assessments have drawn on work completed by Halcrow, Edenvale and The Institute of Hydrology. Water level and flow data stretch back over 100 years, providing an unusually good amount of background data. The hydraulic modelling, a combined 1-D ISIS and 2-D Tuflow model, has been developed from previous work carried out over the last 15 years. It is an exceptionally detailed model of a complex river system. The model has been calibrated at key locations such as the downstream water level at Sandford lock to the most recent flood events in 1998, 2000, 2003, 2007 and 2008 to provide confidence. The absolute difference at Sandford Lock between modelled and recorded levels varies from -90 mm to -20 mm for the 5 recent flood events. Both the hydrology and hydraulic modelling have been reviewed by three assessors: the Independent Technical Auditor (Jacobs), HR Wallingford and the West Area Flood and Data Mapping Team.

2.8.5 A conveyance channel will have a minimal effect on flood risk downstream of Oxford. During low-order flood events, the level of the Thames immediately downstream of Sandford Lock will rise by 6mm (for 1 in 2 year (50% AEP) flood event) more than pre-channel implementation. For higher order flood events, the increase in water levels will be less than 6mm.

2.8.6 In Abingdon the corresponding rise in level will be negligible (~1mm higher) for both low and high order flood events. It is not considered necessary that any works are needed to mitigate these minimal impacts.

2.8.7 Raised defences at Wolvercote will result in a small loss of floodplain storage. This will be assessed at project level using detailed hydraulic modelling. A staged flood risk assessment will be completed in consultation with the Development & Flood Risk team. Floodplain compensation will be provided in accordance our relevant operational instruction unless it is unfeasible to do so and it can be demonstrated that the scheme will not have a significant negative impact on surrounding areas. An initial assessment suggests that the impact of the volume (of flood plain storage) that would be lost for a 1% (+cc) flood event, would have negligible impact on water levels across the floodplain. There are areas adjacent to Wolvercote and within the same hydraulic cell that may be appropriate for compensatory storage. These would be subject to EIA during the project appraisal stage.

2.8.8 Freeboard and contingencies have been considered as part of this Strategy, based on the quick calculation method from the Environment Agency Fluvial Freeboard Guidance Note (2000). Allowances for freeboard have been built into the design and cost build-ups of the engineering components of Western Conveyance, Upstream Storage and raised flood defences.

Partnerships with other agencies

2.8.9 Old Abingdon Road forms a significant constriction to flows in the Redbridge Area. As part of Network Rail's W10 project, they need to increase the height of the bridge at Old Abingdon Road to allow for taller freight containers. The bridge is owned by Oxfordshire County Council. An opportunity exists to form a partnership with these two operating authorities, so that the Western Conveyance needs (widening of the bridge or installing a culvert) can be incorporated at the same time as Network Rail's works. This opportunity should be acted upon now, as Network Rail plan to complete their works by 2011. The Environment Agency have already provided comments to Network Rail on their latest proposals.

2.8.10 Although the development of Surface Water Management Plans (SWMPs) for Oxford is not highlighted as a key part of the strategic solution, the Environment Agency needs to work closely with Thames Water and Oxford City Council to fully understand the existing drainage network and develop an integrated approach to future planning.

2.8.11 We will reassess the existing partnership with BGS given the period before Western Conveyance would be implemented. Continuing the partnership would provide the opportunity to develop a ground water model to more accurately identify areas where groundwater flooding remains a threat. Further collaborative work would also support environmental monitoring of the Oxford Meadows SAC and provide invaluable information in the design of low flow control structures which will maintain groundwater levels during normal flows.

Flood warning

2.8.12 Oxford has a good flood warning service. Further measures are being recommended, through the Multi-Agency Flood Plan, to further reduce the consequences and risk to life of flooding. It is also recommend that the West Thames Flood Incident Management team continue to maintain their promotion of the Flood Warning services throughout the communities at risk, especially by pursuing the 'opt out' approach to providing the service.

Development and flood risk

2.8.13 The Environment Agency should continue to work closely with Oxford City Council to ensure that appropriate development in flood risk areas is achieved, adhering to Planning Policy Statement 25. Typical examples where the Environment Agency needs to take a leading role are the proposed West End Development and the University Book Depository in Osney. All potential development sites which lie in the floodplain are identified in the Council's SFRA.

2.8.14 The Strategy has considered where existing development on the floodplain may be considered inappropriate. A small number of units at the south western extent of the Osney Mead Industrial Estate which remain at risk have been identified. It is recommended that, over the medium to long term, the Environment Agency look at ways to promote a change of use of these sites.

2.8.15 The Oxford SFRA states under section 7.2.5 Safeguarding Land that "there is a need to protect land that may be required in the future for flood alleviation.." and references the Environment Agencys FRM. The SFRA is part of the evidence base that will inform the LDF and development decisions. The SFRA is currently being updated and the West Area Development & Flood Risk team will be provided with the latest information to maintain the safeguarding of the western corridor.

Sustainability

2.8.16 To address the need for sustainable construction techniques, several options have been considered especially with respect to disposal of excavated material for construction of new channel cuts. These range from selling aggregate for construction work, spreading onto agricultural land and landscaping material to develop an area with amenity value. Completion of a site waste management plan and carbon calculator at project level will further develop these proposals.

3 STRATEGY PLAN

3.1 Implementation Plan

3.1.1 The 100 year Preferred Strategic Option has been appraised against the strategic objectives: to identify a sustainable solution to reduce flood risk to people and property; reduce the disruption and financial loss associated with road and railway flooding; improve the human and natural environment for the quality of life of people and benefit of wildlife; and to be adaptable to future climate change.

3.1.2 We have developed a strategic approach to managing the flood risk to property and other assets in Oxford and the surrounding villages over 100 years. The recommended solution seeks to comply with all statutory obligations arising from national and international nature conservation designations and related legislation.

3.1.3 The management approach for the Oxford area entails a continuing long term investment in maintenance and non-structural activities such as flood warning and pre-event planning. We recommend initial capital investment for the Additional Measures to reduce flood risk to properties which are currently at risk of frequent flooding in low order events. We also recommend that the Strategy is periodically reviewed and if appropriate further capital invested, should the Western Conveyance need to be constructed to reduce the impacts of climate change. This may be followed by investment in Upstream Storage.

3.1.4 The implementation programme for the Strategy is shown in Table 3.1, outlining activities proposed in the short, medium and long term.

Table 3.1 Strategy Implementation Plan

Strategy Implementation Plan		
Short Term (0 to 9 Years)	**Location**	**Responsible**
Short Term Measures Phase 1 De-silting and removal of vegetation along key reaches. New culverts under Network Rail access track near Old Abingdon Road. Demountable defences at Vicarage Lane and Osney Island. **2008/09: Scheme Implemented.**	Bulstake Stream Hinksey Stream Hinksey Drain Seacourt Stream	Environment Agency
Short Term Measures Phase 2 De-silting and removal of vegetation along remaining key reaches. **2010/11: Scheme Implementation**	Bulstake, Hinksey, Seacourt Streams Hinksey Drain, Osney Ditch	Environment Agency
Raised Flood Defences Raised flood defences to the north and east of Wolvercote **2012: Scheme Implementation**	Wolvercote	Environment Agency
Flood Resilience Measures Provision of flood resilience measures to reduce flood damages at individual residential properties. **2012/16: Scheme Implementation**	Throughout the Study Area	Environment Agency / Oxford City Council / Vale of White Horse
Multi-Agency Flood Plan (MAFP) Complete MAFP to set out the coordinated approach to responding to floods with other key stakeholders. Provision of additional resources to implement recommendations of MAFP over the long term. **2011: Scheme Implementation**	Throughout the Study Area.	Environment Agency and relevant partners

Strategy Implementation Plan		
Improved Watercourse Maintenance Ongoing proactive maintenance through de-silting and vegetation clearance on all watercourses	All watercourses	Environment Agency
Medium Term (10 to 70 years) *	**Location**	**Responsible**
(Dependant on review of climate change impact) *Western Conveyance* Flow conveyance improvements by constructing sections of new channels or enlarging existing channels. It will also include major infrastructure improvements at Botley Rd, Old Abingdon Rd, Southern ring road (A4074) and the main railway line. **By 2079: Scheme Implementation**	Floodplain to the West and South of Oxford. Bulstake, Hinksey, Seacourt Streams River Thames	Environment Agency
Habitat Creation & Environmental Enhancement Provision of environmental enhancements in the wider Study Area to include creation of BAP habitat **By 2079: Scheme Implementation**	Upper Thames floodplain.	Environment Agency / RSPB / NE / DEFRA / BBOWT / ORPG
Long Term (70 to 90 years) *	**Location**	**Responsible**
(Dependant on review of climate change impact) *Upstream Storage* Provision of a Flood Storage Area in the Upper Thames floodplain if future climate change predictions are realised. Construction of a flow control structure, downstream embankments and secondary bunds. **By 2099: Scheme Implementation**	Upper Thames floodplain	Environment Agency

* - These elements will only be implemented in the listed time frame if climate change occurs at rates included in the current Defra Climate Change guidance.

3.2 Western Conveyance and Upstream Storage Implementation

3.2.1 Although implementation of the Western Conveyance and, later, Upstream Storage would be anticipated by 2079 using current climate change predictions, implementation will be kept under review. In preparation for the periodic reviews monitoring would be ongoing and evidence would be collated to justify the business case for construction. Factors that would be considered include:

a) revised climate change guidance / predictions
b) actual climate change impacts on flows
c) changes to the criteria determining economic viability and affordability,
d) impact on environmentally sensitive sites, and associated mitigation strategy, and
e) other appraisal criteria such as, market resale value of gravel, land value etc.

3.2.2 The 2008 hydrological assessment can be taken as a baseline to check if fluvial flows are increasing. Trends can be identified by undertaking periodic reviews of recorded water flows and levels, and comparing them with previous records, which extend back to 1893. If this review indicates that the increases in flows are being realised, then Western Conveyance and Upstream Storage viability and affordability should be revisited. Any changes in appraisal guidance and climate change guidance can be taken into account at that time.

3.2.3 To better understand the impact of Upstream Storage on environmentally sensitive sites, the strategy recommends development of an environmental monitoring programme for the area. The programme should be developed with project partners NE and BBOWT to move towards an appropriate design which delivers mutual benefits.

3.2.4 Environmental monitoring will increase understanding of the existing flooding regime and its impact on existing ecology. This will make it easier to assess the impact of storing more water on these areas for longer periods and to develop a mitigation strategy.

3.2.5 If further research and environmental monitoring after the initial phases determines that Upstream Storage cannot be implemented, then effectively Option 6 will have been implemented as the overall strategy. This would provide benefit to a similar number of properties as Option 9, but to a lower standard of protection under a climate change scenario.

3.3 Strategy Outcomes

3.3.1 The current onset of flooding occurs to property in the range of the 1 in 5 year (20% AEP) flood event. The SoP will be increased to the 1 in 75 year (1.33% AEP) flood event for 1,642 properties (long term, without climate change); a further 112 will benefit from an increased SoP due to resilience measures, although not as high as 1 in 75 year (1.3% AEP). These property figures represent those protected in comparison to the Do Nothing scenario.

3.3.2 A plan to create over 115ha of priority BAP habitat in the wider Study Area is recommended alongside implementation of Western Conveyance.

3.3.3 The scheme also promotes the provision of environmental enhancements (Appendix G). If funded the Strategy would provide funding for a selection of these opportunities. Further consideration at project level is required to prioritise which enhancements are implemented.

3.4 StAR Preparation Team

3.4.1 Those persons involved in this StAR are listed in Table 3.3.

Table 3.2 Key Members of the Oxford Strategy team

Organisation	Name	Role
Environment Agency	Simon Hughes	Project Sponsor
Environment Agency	Geoff Bell	Business User
Environment Agency	Keith Hutchence	Communication Lead
Environment Agency	Angelin Hallaways	ncpms Project Executive
Environment Agency	William Chan	ncpms Project Manager
Environment Agency	Sharon Cornick	NEAS Officer
Black & Veatch	Lise Taylor	NEECA2 Consultant Project Director
Black & Veatch	David Wilson	NEECA2 Consultant Project Manager
Black & Veatch	Lara Ball	NEECA2 Consultant Environmental Lead
Jacobs	John Gosden	NEECA2 Independent Technical Auditor (ITA)
HR Wallingford	David Ramsbottom	Technical Reviewer (hydrology & hydraulics)
Team Van Oord	Gary Page	NCF2 ECI Contractor
EC Harris	Cliff Hall	NCCF Cost Consultant
Valuation Office Agency	John Broughall	Land Agent
Michael Murphy Associates	Michael Thorne	Land Agent
Jacobs	John Scholey	NEECA CDM - Coordinator
Fugro	Ian Judge	NSIF2 Contractor
British Geological Survey (BGS)	David MacDonald	BGS Project Partner

3.5 Current Status and Spend Profile

3.5.1 STM1, which was completed in November 2009, was procured through the Environment Agency NEECA2, NSIF2, NCF2 and NCCF2 frameworks. Approval to commence works was gained through the Thames Region Project Approval Board.

The Form A for STM2 was approved by the Thames Region Project Appraisal Board in November 2009.

3.5.2 The anticipated annualised spend profile is set out in Table 3.3.

Table 3.3 Annualised spend profile for Environment Agency funds (£k)

	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	Future Costs 94 years from 2014/15	Total
Capital Costs [A]								
STM1	1,696							1,696
STM2			1,500					1,500
Multi Agency Flood Plan			50	50	5	5	650	760
Wolvercote Defence					2,210			2,210
Resilience Measures				3,353			2,395	5,748
Maintenance	516	412	412	470	500	470	48,194	50,973
Total	**2,212**	**412**	**1,962**	**3,872**	**2,715**	**475**	**51,239**	**62,887**

[A] Capital costs for 2009-2014 include 2.5% inflation. Capital costs include all costs which are not anticipated as being from annual maintenance budgets.

3.6 Delivery Risks

3.6.1 The key delivery risks are set out in Table 3.4.

Table 3.4 Key Risks to Implementation

Risk	Mitigation
Climate Change does not occur in accordance with current Defra supplementary guidance.	Periodic reviews of the Strategy will consider the latest climate change guidance and reassess when it might be economically justifiable to implement Western Conveyance and, later, Upstream Storage.
Further monitoring identifies significant impacts that cannot be mitigated on Oxford Meadows SAC or the SSSIs within the Upstream Storage area as result of implementing upstream storage	*(NB: This only affects the Upstream Storage element of the Strategy)* Work closely with local partners to understand risks. Prepare environmental monitoring plan (see Section 8 on the SEA Environmental Report, Appendix A). Periodically review climate change predictions and guidance. If further research and environmental monitoring after the initial phases determines that Upstream Storage cannot be implemented, then effectively Option 6 will have been implemented as the overall strategy. This would provide benefit to a similar number of properties as Option 9, but to a lower standard of protection under a climate change scenario.
Affordability	Seek third party contributions and continue to explore other funding mechanisms.
Scheme does not achieve planning permission	Close liaison with statutory consultees and the general public. High quality submission environmentally.

3.6.2 The implementation of Upstream Storage in the future allows for landowner and community engagement over an extended period with a view to local input helping to shape proposals and reduce the risk of land agreements stalling implementation. The importance of

early engagement of landowners and residents was a lesson learned from the Banbury FAS (flood storage).

3.6.3 Lessons Learned from the Jubilee River scheme were also considered (Strategy Appraisal Team members attended a presentation which focussed on key issues). These were particularly useful in developing construction, operation and maintenance costs for the new channel and how to balance the need for good environmental design with maximising the flow capacities of new channels.

3.7 Safety Plan

3.7.1 The current flood mechanisms within Oxford could lead to potential health and safety hazards. Flows over Botley Road have already been noted as a potential hazard. In addition, flooding from more than one fluvial source can take local residents by surprise, leading to increased likelihood of accident or injury. Because of the distributed nature of flooding in Oxford, and the impact on the major arterial routes, there is a high risk of residents becoming isolated and requiring rescue, especially in the areas of New Botley, Osney and New Hinksey.

3.7.2 A preliminary hazard assessment has been carried out as part of the Strategy to ensure that the safety of the general public is fully considered in all aspects of the proposals.

4 STRATEGY APPRAISAL REPORT - DATA SHEET

Entries required in clear boxes, as appropriate, shaded boxes are for Defra use.			
GENERAL DETAILS			
Authority Project Ref. (as in forward plan):	IMTH000616	LDW/CPW	
Project Name (60 characters max.):	Oxford Flood Risk Management Strategy		
Promoting Authority: Defra ref (if known)			
Name	Environment Agency, Thames Region		
	RE Region:		
Emergency Works: *(Y/N)*	N		
Strategy Plan Reference:	N/A	LDW/CPW	
River Basin Management Plan	Thames		
Shoreline Management Plan:	N/A	LDW/CPW	
Project Type:	Strategy Plan		
Shoreline Management Study/ Preliminary Study/ Strategy Plan/Prelim. Works to Strategy/ Project within Strategy/Stand-alone Project 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:	N/A		
Estimated duration in months:	N/A		
Contract type	Framework		
Direct labour, Framework, Non Framework, Design/Construct			

Costs	APPLICATION (£)	Defra ADJUSTMENT (£)
Appraisal:	-	
Costs for Agency approval:	£63M	
Total Whole Life Costs:	£63M	
For breakdown of costs see Table in Section 2.4		

CONTRIBUTIONS:		
Windfall Contributions:	N/A	
Deductible Contributions:	N/A	
ERDF Grant:	N/A	
Other Ineligible Items:	N/A	

Defra use only, below this line on this page			
Application submission date:			
Date application received:		Last papers received:	
Recommendation:		Action Office:	
Formal Approval/Agreement/Agreement to Strategy/Without Prejudice/Refer Back		(HQ/Region)	
Special Conditions required? (Yes, only if conditions required on approval letter): *Y/N*			
Special Conditions:			

	Officer (Surname)	Start (date)	Complete (date)	Days
Progress:				
Senior Engineer:		/ /	/ /	
Regional Engineer:		/ /	/ /	

Entries required in clear boxes, as appropriate, shaded boxes are for Defra use.
LOCATION - to be completed for all projects

EA Region/Area of project site (all projects):	Thames	Ref.
Name of watercourse (fluvial projects only):	River Thames and others local tributaries	
District Council Area of project (all projects):	Oxford City Council Vale of White Horse District Council West Oxfordshire District Council	Ref.
Grid Reference (all projects):	SP515062	
(OS Grid reference of typical mid point of project in form ST064055)		
Specific town/district to benefit:	Oxford	

Description

Brief project description including essential elements of proposed project/study (Maximum 3 lines each of 80 characters)
100 year Strategy to reduce flood risk to Oxford and surrounding communities. Short term measures to address local flood risk. Adaptive management of climate change through improved conveyance to the west of Oxford and then later upstream flood storage areas.
Postcodes of protected property wholly or partially within proposed benefit area OX4 4**, OX4 1**, OX3 0**, OX2 8**, OX2 7**, OX2 6**, OX2 0**, OX1 5**, OX1 3**, OX1 2**, OX1 1**, OX1 4**

details

Design standard (chance per year):	Varies	Yrs
Existing standard of protection (chance per year)	Varies 20-1%	Yrs
Design life of project:	100	Yrs
Fluvial design flow (fluvial projects only):	38	m^3/s
Tidal design level (coastal/tidal projects only):	N/A	m
Length of river bank or shoreline improved:	7km	m
Number of groynes (coastal projects only):	N/A	
Total length of groynes* (coastal projects only):	N/A	m
Beach Management Project? *Y/N*	N	
Water Level Management (Env) Project? *Y/N*	N	
Defence type (embankment, walls, storage etc	Various	

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

ADDITIONAL AGREEMENTS:

Maintenance Agreement(s):	Awaited	Not Applicable/Received/Awaited	
EA Region Consent (LA Projects only):	N/A	Not Applicable/Received/Awaited	
Non Statutory Objectors: Y/N	TBC		
Date Objections Cleared:	TBC		

Entries required in clear boxes, as appropriate, shaded boxes are for Defra use.

ENVIRONMENTAL CONSIDERATIONS

Natural England (or equivalent) letter:	Received	Not Applicable/Received/Awaited	
Date received	April 2009		

Sites of International Importance (*Y/N* for each) Answer Y if project is within, adjacent to or potentially affects the designated site		
Special Protection Area (SPA):	N	
Special Area of Conservation (SAC):	Y	
Ramsar Site	N	
World Heritage Site	N	
Other (Biosphere Reserve etc)	N	

Sites of National Importance (*Y/N* for each) Answer Y if project is within, adjacent to or potentially affects the designated site		
Environmentally Sensitive Area (ESA):	N	
Site of Special Scientific Interest (SSSI):	Y	
National/Regional Landscape Designation:	Y	
National Park/The Broads	N	
National Nature Reserve	Y	
AONB, RSA, RSC, other	N	
Scheduled Ancient Monument	Y	
Other designated heritage sites	Y	

Other Environmental Considerations			
Listed structure consent	N/A	Not Applicable /Received/Awaited	
Water Level Management Plan Prepared? *Y/N*	Y		
FEPA licence required? *NA/R/A*	N/A		

Compatibility with other plans			
Shoreline Management Plan	N/A	Yes/No/Not Applicable	
River Basin Management Plan	Y	Yes/No/Not Applicable	
Catchment Flood Management Plan	Y	Yes/No/Not Applicable	
Water Level Management Plan	Y	Yes/No/Not Applicable	
Local Environment Agency Plan	N/A	Yes/No/Not Applicable	

SEA/Environmental Impact Assessment			
SEA		Environment Agency voluntary	
Statutory required/Agency voluntary/not applicable			
EIA		N/A	
Yes (schedule 1); Yes (schedule 2); SI1217; not applicable			
SEA/EIA status		Final	
Scoping report prepared/draft/draft advertised/final			

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

Entries required in clear boxes, as appropriate, shaded boxes are for Defra use.

Costs, benefits & 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:
FD = Benefits from reduction of asset flooding risk; CE = Benefits from reduction of asset erosion risk

Benefit type (DEF: reduces risk (contributes to Defra SDA 27); CM: capital maintenance; FW: improves flood warning; ST: study; OTH: other projects)	DEF		

LAND AREA

Total area of land to benefit:	180 ha			ha
of which present use is:	FD	CE	FD	CE
Agricultural:	0 ha	0 ha	ha	ha
Developed:	65 ha	0 ha	ha	ha
Environmental/Amenity	115 ha	0 ha	ha	ha
Sched. for development:	0 ha	0 ha	ha	ha

PROPERTY PROTECTED

	Number		Value (£'000s)		Number		Value (£'000s)	
	FD	CE	FD	CE	FD	CE	FD	CE
¹Resid.	1,450	N/A	624,550	N/A				
Comm./ind.	192	N/A	197,315	N/A				
Other: (description		N/A	264,052	N/A				
Description: Infrastructure, agriculture					Description:			

COSTS AND BENEFITS

¹Present value of total project whole life costs (£'000s):	24,580			
Project to meet statutory requirement? *Y/N*	Y			
	£'000s		£'000s	
	FD	CE	FD	CE
Present value of urban benefits:	1,085,049			
Present value of agricultural benefits:	867			
Present value of environmental/amenity benefits:	N/A			
¹Present value of total benefits (FD & CE)	1,085,916			
Net present value:	1,061,336			
Benefit/cost ratio:	44			:1
			Category U/UA/AU/EU etc:	
Base date for estimate:	Dec 08			
Project Appraisal Guidance used: *Y/N*	Y			
PAG Decision rule stages III and IV applied: *Y/N*	Y			

Other Priority Scoring Details¹

Economics		**People**		**Environmental**	
Non-works study, eg coastal process (Y/N)?	N	Risk*:	L	BAP net gain (Ha):	0
		Vuln**:	L	SSSI protected (Ha):	0
				Other habitat (Ha):	0
				Heritage sites***:	I & II

*(VH, H or N/A); **(from ODPM website) *** ("I or II*" , "II or other" or "N/A") See back page for score calculation details

Exemption Details (if exempt from priority scoring system)

Exempt from Scoring (Y/N):	N		
Reason (max 100 chars):			

¹Highlighted fields all used to generate priority score - see Annex for calculation flowchart

5 RECOMMENDATIONS / APPROVAL SIGN OFF

Approval is sought for the Oxford Flood Risk Management Strategy, to reduce the flood risk in Oxford and its surrounding villages over the 100 year period to 2108. The implementation of this Strategy will require capital works to be constructed as set out in Table 3.1 and 3.3. This includes capital investment over the first 9 years. The whole life cash cost of the Strategy over the next 100 years is £63M (not including inflation, but including £2M contingency).

Department for Environment Food and Rural Affairs (only required for projects for submission to Defra)

*Study/Strategy/AIP to first 5 years work/Scheme recommended for:- further study/rejection/approval for:- Fin.Mem. agreement/agreement/approval at a cost of	

Senior Engineer	Name		Signature	
			Date	

*Study/Strategy/AIP to first 5 years work/Scheme accepted/recommended for:-
further study/rejection/approval for:-
Fin.Mem. agreement/agreement/approval at above cost.

Regional Engineer	Name		Signature	
			Date	

*Study/Strategy/AIP to first 5 years work/Scheme accepted/recommended for:-
further study/rejection/approval & submission to DEFRA for:-
Fin.Mem. agreement/agreement/approval at above cost.

Chief Engineer	Name		Signature	
			Date	

* Select as appropriate.

6 APPENDICES

Appendix A Strategic Environmental Assessment: Environmental Report (February 2009)

Appendix B Technical Report (December 2009)

Appendix C Economic Appraisal Report (December 2009)

Appendix D Habitats Regulations Assessment (February 2009)

Appendix E Natural England Letter of Support (April 2009)

Appendix F Consultation Document and Summary Report

Appendix G Potential Environmental Enhancements

Appendix H Plan of Environmental Constraints in the Western Conveyance Corridor

Appendix J Western Conveyance and Upstream Storage Preferred Option cost estimates

Appendix K SEA Table 7.2

Appendix L Water Framework Directive Assessment

Appendix M Procurement Strategy