



ENVIRONMENT
AGENCY

Project Appraisal Report

Authority Scheme
Reference

IMSO 000532

Defra / WAG LDW
Number

40436

Promoting
Authority

Environment Agency Southern Region

Scheme Name

The Middle Medway Strategy Study for Flood Risk
Management



Date

August 2005

Volume 1

Project Appraisal Report

Volume 2

Figures

Volume 3

Options Report

Volume 4

Hydrology & Hydraulics

Volume 5

Strategic Environmental Assessment

Volume 6

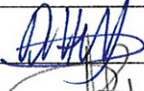

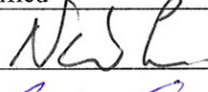

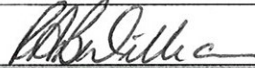


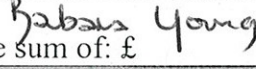
Economics

Revision History

Middle Medway Strategy for Flood Risk Management. Version 1.0 (April 2005)	Submitted to NRG April 2005
Middle Medway Strategy for Flood Risk Management. Version 1.1 (August 2005)	Submitted to NRG Chair in August 2005 for sign off following minor amendments
Middle Medway Strategy for Flood Risk Management. Version 1.2 (August 2005)	Changes made to approval amounts and recommendations

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ENVIRONMENT AGENCY			
FOR ACTION			
22 APR 2005			

FOR INFO			
EA APPROVAL HISTORY SHEET			
Project Title: The Middle-Medway Strategy for Flood Risk Management		Agency Project Code: IMHK40164	
Agency Project Manager: Richard Hull		Date of PAR: March 2005	
Consultant Project Manager: Marcus Francis		Consultant: Babbie, Brown and Root	
AGENCY STAFF INVOLVEMENT			
Position	Name	Signature	Date
"I have reviewed this document and confirm the project meets EA and Defra/WAG investment appraisal criteria and recommend approval"			
Originator (PM)	Richard Hull		18-4-05
Reviewer (Project Executive)	Chris Harding		18 April 05
"I confirm I am content for the project as described in this document to proceed to design and construction, that funding is available and that strategic/project level risks have been identified"			
Client Representative	Neil Gunn		
NEAS Team Leader	Phil Griffiths		18 April 05
"I have reviewed this document and confirm that it complies with the current PAR guidelines"			
PAR Reviewer	Richard Williams		18/4/05
"I confirm the project is ready for submission to PAB/NRG"			
Operations Manager	Tim Kersley		18/4/05.
PAB – Project Assessment Board (Projects less than £1.5 million)		NRG – National Review Group (Projects greater than £1.5 million)	
(Delete as appropriate)			
Date of Meeting: April 2005	Chairman: DAVID COTTERELL	PAR Amendment No: See Query Response form returned on 18th August	
Project Presenter(s): Richard Hull, Chris Harding and John Gosden			
Detailed record of any comments/actions required/additional information provided, to be appended to the PAR for onward transmission			
Recommended for approval:  (NEA Chair)		Date: 18/8/05.	
In the sum of £:			
PROJECT APPROVAL			
AGENCY	Officers in accordance with the Agency's SoD: Specified Officer; Regional Director; Director of Operations; Chief Executive or Director of Finance: Agency Board		
PAR Submitted			Date:
Project Approval	By:  In the sum of: £	Date: 30/10/05	
Defra or WAG APPROVAL (Delete as appropriate)			
Submitted to Defra / WAG or Not Applicable (as appropriate)			Date:

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SoD COVERSHEET

REGION	Southern		Project Executive	Chris Harding	
Function	Flood Defence		Project Manager	Richard Hull	
Start year	2000				
Project Title	Middle Medway Strategy Study		Code		

FORM A AUTHORISATION

Reg.Sod Ref	A1/2000/35 & 9/2001/54		H.O.Sod Ref		
Date	2/5/2001 & 26/4/2002		SoD Category	A9	
	Agency Staff Costs (£K)	External Costs (£K)	Total (£K)		
Form A	A1/2000/35 Date: 2/5/2001	46	110	156	
PAR	9/2001/54 Date: 26/4/2002	10	166	176	

PID RECOMMENDATION AND AUTHORISATION (LARGE PROJECTS)

	Agency Staff Costs (£K)	External Costs (£K)	Total (£K)
Actual Cost of PID Preparation	112	548	660
Total Project Cost (inc PID prep'n cost)	3,090	58,713	61,803

PAB/NRG Recommendation

D. Gough
(NRG Chair)

Date: 18/8/05.

We are assured that this project fully complies with the Agency's Environmental Policy

Reg.Sod Ref 9/2005/25 **H.O.Sod** P177-26/8/05

Authorisation:

Signed *K. Davidson* *Babara Young* *30/10/05*
Job Title *Regional Director* *Pauline* *22nd Aug 2005*
Director of Operations

Consultation Miles Jordan *6.9.05*

BOARD APPROVED 6/12/05

Authorised Project Cost (£K)							
Form G No.	Date	Region Sod Ref	HO Sod Ref	Agency Staff Costs	External Costs	Total	Re-app.? Y/N
1	21/8/02	G/2002/8		70	438	508 (c6)	N
2	12/5/2004	G/2004/7		84	529	613 (c7)	N
3	28/6/2005	G/2005/4		109	554	663(c7)	N

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SoD COVERSHEET

REGION	Southern		Project Executive	Chris Harding	
Function	Flood Defence		Project Manager	Richard Hull —	
Start year	2000				
Project Title	Middle Medway 5 Year Capital Work Programme (Yalding and Leigh)			Code	

FORM A AUTHORISATION

Reg.SuD Ref	A1/2000/35 & 9/2001/54		H.O.SuD Ref		
Date	2/5/2001 & 26/4/2002		SoD Category	A2	
	Agency Staff Costs (£K)	External Costs (£K)	Total (£K)		
Form A	A1/2000/35 Date: 2/5/2001	46	110	156	
PAR	9/2001/54 Date: 26/4/2002	10	166	176	

PID RECOMMENDATION AND AUTHORISATION (LARGE PROJECTS)

	Agency Staff Costs (£K)	External Costs (£K)	Total (£K)
Actual Cost of PID Preparation	112	548	660
Total Project Cost (inc PID prep'n cost)	558	10,602	11,160

PAB/NRG Recommendation

D. P. [Signature]
(NRG Chair)

Date: 18/8/05.

We are assured that this project fully complies with the Agency's Environmental Policy

Reg.SuD Ref 9/2005/25 **H.O.SuD** P178-26/8/05

Authorisation:

Signed *A. Davidson* Date: 22nd Aug 2005
Regional Director

Job Title *Paul [Signature]*
Director of Operations

Consultation Miles Jordan *[Signature]*
Barbara Young CE 14/11/05
Authorised Project Cost (£K)

Form G No.	Date	Region SoD Ref	HO SoD Ref	Agency Staff Costs	External Costs	Total	Re-app.? Y/N
1	21/8/02	G/2002/8		70	438	508 (c6)	N
2	12/5/2004	G/2004/7		84	529	613 (c7)	N
3	28/6/2005	G/2005/4		109	554	663(c7)	N

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FIGURES

Figure 3.6.1 The impact of climate change on the return period of an event

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1. EXECUTIVE SUMMARY

1.1 Introduction

The Middle Medway Strategy has been carried out to investigate flood risk management options for the Middle Medway catchment through modelling, economic and strategic environmental assessment. The strategy is intended to guide those involved in flood defence and planning and presents a business case to justify future works and investment in flood risk management. The strategy follows the recommendations of the recently completed Medway Catchment Flood Management Plan.

The strategy was commissioned by the Environment Agency Kent Area Flood Defence Improvement Team and managed through the National Capital Programme Management Service (NCPMS). NCPMS appointed Consultant Babbie Brown and Root (BBR) under the National Engineering and Environmental Consultancy Agreement to carry out the appraisal work.

1.2 Problem

The main flood risk is posed by the River Medway and in particular at its confluence with the Rivers Beult and Teise. Flooding mechanisms are complex and interdependent due to the backwater effect of these rivers under spate conditions and the flat topography at the confluence. In order to appraise options for flood risk management, taking account of environmental impacts and interconnected benefit areas, a strategic approach has been necessary. Figure B1 at the end of the PAR section shows the catchment along with the locations of preferred structural flood defence measures.

There are 20 discrete flood prone settlements in the Middle Medway catchment (see Figure B2) and around 865 properties at risk of fluvial flooding in a 1% annual probability event. Of these around 382 properties are at risk of flooding in a 4% annual probability event, which is below the indicative standard of protection for much of the catchment.

Flood protection to some properties is currently provided by the Leigh Barrier storage scheme and other local flood defence structures. There is no comprehensive flood defence system for the catchment and there is a history of regular flooding with the most recent event in October 2000 flooding approximately 490 houses across the catchment.

1.3 Preferred Solution

The preferred flood risk management strategy comprises a combination of structural and non-structural options. Structural options are shown in Figure B1.

There are five structural options recommended by this strategy. Two of these are strategic in that they provide catchment-wide benefit, while three are of local benefit only. The strategic options recommended are:

- 3.1 Mm³ additional flood storage above the Leigh Barrier on the River Medway
- 5.6 Mm³ flood storage scheme on the River Eden above Edenbridge

The preferred local options recommended are:

- floodwalls in Yalding (earth embankments) on the River Beult
- floodwalls in East Peckham (earth embankments and structural walls) on the River Medway
- floodwalls and stream diversion at Collier Street

These five structural options are supported by a Strategic Environmental Assessment (SEA) and environmental constraints and objectives have been fully integrated into the option selection process. The preferred options are all indicated as being environmentally preferred in the SEA and are supported by the statutory consultees.

The principal non-structural options are:

- Improved operation of the Leigh Barrier to take advantage of operating experience and developments in telemetry and flood forecasting
- Flood warning improvements, for which a substantial programme is currently being implemented
- Assistance with flood proofing in areas which do not benefit from one of the recommended structural options
- Improved development control to limit the increasing number of properties in the flood plain

1.4 Assets Protected

The strategic flood defence options proposed have been designed on the basis of storage capacity available rather than to provide a particular standard of protection. A single standard of protection cannot be stated for the strategic storage options, as they each provide improvement to more than one flood risk area. Also, the standard of protection differs within each flood risk area protected by a storage option. However by implementing the strategy, the total number of properties removed from flood risk in a 1% annual probability event is 547, including 90 upstream of the study area in and near Edenbridge.

1.5 Economic Justification

The economic justification for the proposed Strategy as a whole is provided in the following table. All costs and benefits have been discounted in accordance with Treasury Guidance and assessed in line with Flood and Coastal Defence Project Appraisal Guidance (FCDPAG).

Table 1.1 Summary of Benefits and Costs

	Do Nothing	Do Minimum	Implement recommended strategy
PV costs PVc (£1000's)	0	17,420	64,424
PV damage PVd (£1000's)	431,369	227,936	115,226
PV damage avoided (£1000's)		203,432	316,142
Total PV benefits PVb (£1000's)		203,432	316,142
Net Present Value NPV (£1000's)		186,013	251,718
Average benefit/cost ratio		11.7	4.9
Incremental benefit/cost ratio			2.4
Properties protected 4%			268
Properties protected 1%			547

Note: All cost estimates and benefits are expressed in mid-2005 prices

All construction and maintenance costs include optimism bias at 60% and 30% respectively.

Benefits are based upon damage avoided to residential and commercial property and emergency call out following implementation of the recommended options. No assessment has been made of damages and benefits arising from agricultural land and livestock, disruption to transport and other utility assets. Inclusion of these damages and benefits will strengthen the business case but are unlikely to affect the choice strategic options.

1.6 Implementation

Table 1.2 shows the implementation of capital works over the next 15 years. Costs for capital construction and renewals are included along with the benefit cost ratio and priority score for each stage of implementation. The benefit cost ratio and priority score reduce as further options are implemented.

The implementation plan is dependent on the score for individual options being above the funding threshold for the year in which construction is planned.

A limited feasibility study is recommended for Stilebridge, even though this is not a preferred option at this stage. The scheme at Stilebridge will mitigate the possible future effects of climate change and consideration needs to be given now to identifying a suitable location and ensuring that future development in this area is controlled.

Table 1.2 Implementation plan

Proposed measure	Expenditure £k				
	Capital Cost	Renewal cost	B/C ratio	Priority Score	Construction start
Sunk costs (Strategy)	660	-	-	-	-
Do Minimum	-	4,635	11.7	21	-
Leigh Barrier (additional flood storage)	6,391	3,462	9.5	18	2008/9
Yalding (flood walls and embankments)	8,242	4,657	7.4	15	2008/9
Stilebridge (storage study)	100	-	-	-	-
Edenbridge (flood storage)	12,773	3,300	5.8	12	2012/3
East Peckham (flood walls and embankments)	8,620	4,881	5.1	10	2017/8
Collier Street (flood walls and embankments)	2,823	1,258	4.9	10	2017/8
Total (A9 Strategy Approval)	39,610	22,193	-	-	-

1.7 Expenditure Profile

The expenditure profile is given in Table 1.3 for the first five years (including sunk expenditure for years 2001-5) and then in Table 1.4 for future periods covering the 100 year appraisal period of the strategy. The construction works at Leigh Barrier are included in the first five years of work but are not included in the current A2 FSoD Approval.

Table 1.3 5 Year Expenditure Profile

Proposed measure	Expenditure £ million (without inflation)					
	2001-6	2006-7	2007-8	2008-9	2009-10	Total
Strategy costs	0.66					0.66
Feasibility study of additional storage at Leigh Barrier		0.31	0.31			0.62
Design and construction of additional storage at Leigh Barrier				2.06	3.71	5.77
Feasibility study of local defences at Yalding		0.41	0.41			0.82
Design and construction of local defences at Yalding				3.09	4.33	7.42
Stile Bridge pre-feasibility study		0.05	0.05			0.10
Total						15.4

Table 1.4 100 Year Expenditure Profile

Item	Expenditure £ million (without inflation)							Total
	0-4	5-9	10-14	15-24	25-49	50-74	75-99	
Feasibility studies, design & construction	15.4	12.8	11.4	0	0	0	0	39.6
Renewal	0	0	0	0	7.4	7.4	7.4	22.2
Operation & Maintenance	2.8	3.6	4.4	10.1	25.1	25.1	25.1	96.2
Total								158

1.8 Financial Scheme of Delegation Approval

Approval will be sought under the Financial Scheme of Delegation (FSoD) to pursue feasibility studies for improvements at Leigh, Yalding and Stilebridge and construction works at Yalding. The construction stage of the Leigh Barrier improvements will be the subject of a future request for FSoD approval when compensation, construction and timing risks are better understood and quantified.

Table 1.5 Financial Scheme of Delegation Approval Sought

Proposed measure	Expenditure £ million					
	2005-6	2006-07	2007-08	2008-9	2009-10	Total
Strategy preparation costs	0.66*					0.66
Feasibility study of additional storage at Leigh Barrier and		0.31	0.31			0.62
Feasibility study of local defences at Yalding		0.41	0.41			0.82
Design and construction of local defences at Yalding				3.09	4.33	7.42
Stilebridge prefeasibility study		0.05	0.05			0.10
Inflation (5%)						1.54
Total (inc inflation)						11.16

Note: * Represents completed expenditure in years up to and including 2005-2006

1.9 Strategy Implementation Risks

All costs have had an 'Optimism Bias' factor applied. This is 30% for current maintenance and 60% for new capital works and maintenance. A Monte Carlo financial risk assessment has been carried out on the construction works proposed at Yalding and this confirmed that the Optimism Bias applied is a conservative upper bound value. The key risks regarding implementation of the strategy are listed in Table 1.6 with a description of the control measures to be adopted.

Table 1.6 Main Implementation Risks

Major Residual Project Risk	Mitigation
Acts of Parliament or Statutory Instruments required for storage reservoirs under Section 3 of the Transport and Works Act 1992	Plan for minimum five year approval process for new storage embankments
Capital cost estimation	Optimism bias of 60% applied to whole life costs. Specific financial risk assessment for Yalding
Consent from landowners	Early involvement of landowners in the consultation process
Significant consultation required to obtain community buy-in to storage schemes and local defences	Co-ordinated approach to communication plans for individual feasibility studies across the catchment
Strategy needs to be implemented by July 2006 otherwise it will need to be fully revised to comply with the SEA regulations	Efforts undertaken to achieve earliest possible approval programme

1.10 Legal Powers

All works recommended by the strategy will be carried out under Section 165 of the Water Resources Act 1991. Planning permission will be required for most options although some could proceed under the General Permitted Development Order 95/418. Other powers available to the Agency are the River Medway (Flood Relief) Act 1976 and there are duties and powers contained in the Upper Medway Navigation and Conservancy Act 1991.

1.11 Recommendation

NRG recommend Environment Agency Board approval of the strategy for £61,803k capital cost over the 100 year appraisal period. This capital cost is for construction of increased storage at the Leigh Barrier, local defences at Yalding, storage at Edenbridge and local defences at Collier Street and East Peckham, including renewal costs.

NRG recommend Financial Scheme of Delegation approval for £11,160k for feasibility studies investigating increased storage at the Leigh Barrier and Stilebridge and feasibility and construction for local defences at Yalding.

NRG recommend that the strategy be submitted to Defra for approval of the strategy and the £158,000k whole life cost over the 100 year appraisal period.

Table 1.6 Key Information

Defra Priority Score	Economics: 8.8; People: 0.7; Environment: 0.1 Combined total: 9.6 Range 9.6 – 18 FSoD approval only sought on schemes within strategy having a priority of 15 or above. See also Table 1.2
Assets protected:	No. of residential properties: 572 No. of other properties: 245 Infrastructure: Not assessed Areas of habitat protected /enhanced: 92Ha Other: None
Asset condition improved	NA
Efficiencies	NA
Current threshold of flooding	Varies from approximately 1:10 to 1:100
Standard of protection for proposed option:	572 residential properties protected to a 1% standard
Key programme dates:	NRG Recommendation for approval August 2005 External approvals: April 2006 Target cost agreed 2008/9 Works start 2008/9 Works complete 2020
PV Benefits	£316,142k
PV Costs	£64,424k
NPV	£251,718k
Benefit-cost ratio	9.5 (first scheme only) - 4.9 (whole strategy)
Cost per property protected (Only residential properties included that will benefit from a protection of 1% or better)	£81,000 (first scheme only) to £109,000 (whole strategy) using present value whole life costs including maintenance over the 100 year appraisal period.
Base date for costs and benefits:	Mid 2005
Planning costs of the project	Approximately 10%

Table 1.7 Summary of Estimated Costs

Item	Economic appraisal (£k)	Whole Life Cash Cost (£k)	SoD Approval (£k)
Costs pre PAR (outline design)	N/A	660	660
Costs post PAR			
Agency costs, fees, investigations, compensation, contingency and construction	29,079	38,950	8,960
Inflation	NA	NA	1,540
Future costs (maintenance, replacement, etc)	35,345	118,400	N/A
TOTAL	64,424	158,000	11,160

Notes: For a full breakdown of costs see Section 6 and the Cost Appendix

2. INTRODUCTION

2.1 Background

The Middle Medway Strategy Study has been carried out to investigate flood risk management options for the Middle Medway catchment through modelling, economic and strategic environmental assessment. The strategy is intended to guide those involved in flood defence and planning and presents a business case to justify future works and investment in future flood risk management.

The strategy develops the policies of the Medway Catchment Flood Management Plan (CFMP) and justifies further development and implementation of appropriate schemes where the policy is to reduce flood risk.

2.2 Study Area

The Medway is the largest river basin within the Southern Region of the Agency. The catchment is predominantly in Kent, but also includes parts of Surrey and East and West Sussex. The major tributaries of the Medway are the Eden which joins at Penshurst, and the Beult and the Teise, which join at Yalding, upstream of Maidstone (see Figure B1).

This strategy covers approximately two thirds of the Medway catchment and most of the developed area at risk of flooding. The strategy boundary as shown in Figure B1 includes the following river reaches within the indicative floodplain:

- the Medway from the Leigh Barrier to Allington Lock
- the Bourne from Hadlow to its confluence with the Medway;
- the Beult from Smarden to its confluence with the Medway;
- the Teise from Lamberhurst to its confluence with the Beult and Medway.

A significant feature of the Medway is that it is maintained for navigation from its mouth to Leigh, a distance of 31km. To provide sufficient draft for vessels a cascade of 10 control structures controls the river levels. These affect the river hydraulics and natural processes.

At Leigh, the Medway is also regulated by the Leigh Barrier flood storage scheme which was commissioned to protect the town of Tonbridge from flooding. The Leigh Barrier separates the upper and middle catchments and forms the upstream boundary of this study. Downstream of Maidstone, the Medway becomes tidally dominated and the tidal sluice at Allington forms the downstream boundary.

The River Eden is excluded from the scope of the strategy as it is in the upper catchment above the Leigh Barrier and flooding mechanisms here are different to those affecting the middle catchment. However, during option appraisal, works were considered at Edenbridge that could have a catchment wide impact and this has been included as an option in the Strategy.

The precise study boundary was the subject of discussion and agreement with the Agency. From the perspective of hydraulic modelling, the Bourne, Beult and Teise cover those reaches designated as Main River that include significant communities within their floodplain. The Leigh Barrier was accepted as the upstream boundary on the Medway as it is a significant break in the hydraulic system and upstream flooding is not perceived as a major issue.

The downstream boundary was taken to be the Medway at Allington where Allington sluice separates the purely tidal reaches of the river downstream to Sheerness from the reaches upstream. Upstream of Allington, the Medway is controlled for the purposes of navigation by a series of locks and associated hydraulic structures providing tightly controlled water levels under normal conditions. Despite the presence of the sluice gates at Allington, tidal effects can influence water levels upstream during extreme events as described in Appendix H.

The study boundary has not been rigidly adhered to. As indicated previously, it proved necessary to extend hydraulic study beyond the defined boundary to Edenbridge on the Eden when it became clear that flood storage at this location was a sensible option for consideration.

For modelling purposes, the whole catchment was taken into account to provide meaningful flood flows to the modelling process for the establishment of flood risk and damages.

For economic assessment, the study boundary remained as defined except in the case of the proposed option at Edenbridge where benefits outside the study area were taken into account.

2.3 Properties at Risk of Flooding

The Medway catchment includes both agricultural and urban land uses, with the urban proportion typically around 6%. The strategy study area includes the urban areas of Tonbridge, Hadlow, Smarden, East Peckham, Collier Street, Headcorn, Lamberhurst, Yalding and Maidstone.

In the Middle Medway catchment there are approximately 9,150 properties in the indicative floodplain and 865 of these are currently at risk of fluvial flooding in a 1% annual probability event. The main flood prone areas in the study area are shown in Figure B2 and include:

- Tonbridge, East Peckham and Maidstone on the Medway
- Lamberhurst, Collier Street and Laddingford on the Teise
- Smarden, Headcorn and Yalding on the Beult

While much of the catchment is rural, the urban areas generally fall into Land Use Band A or B (FCDPAG 3, Defra, 2001b) with indicative standards of protection in the range 2% to 0.5% and 4% to 1% respectively.

2.4 Designated Sites

The catchment contains a number of environmental and archaeological features, some of which would potentially be affected by flood defence improvement works. These have been assessed in detail in the supporting Strategic Environmental Assessment.

There are 30 Sites of Special Scientific Interest (SSSI) within the catchment, as designated under the Wildlife and Countryside Act, 1981. Of these, 21 have a strong water related aspect. In particular, a 25km length of the River Beult from Smarden to the Medway confluence is classified as a SSSI. It is one of the few clay rivers in England that retain a characteristic flora and fauna. The River Beult is the only inland site within the catchment for which a Water Level Management Plan has been prepared.

There are a number of Local Nature Reserves (LNRs), Sites of Nature Conservation Interest (SNCIs) and Scheduled Ancient Monuments (SAMs) within the catchment, many of which are within the Indicative Flood Plain.

Nearly three quarters of the Medway catchment is protected by classification as Areas of Outstanding Natural Beauty with associated regulations: the Kent Downs AONB and the High Weald AONB.

2.5 Other Environmental Features

The catchment contains a number of other environmental features, the main ones are summarised below:

- There is a right of navigation on the Medway upstream to Leigh. Sailing, canoeing and windsurfing take place along much of this reach.
- There are numerous riverside Public Houses and picnic spots along the main river reaches and an extensive public footpath network.
- An ancient woodland is present along the banks of the Lesser Teise
- The Teise is designated a Cyprinid fishery from Bartley Mill to Yalding
- The Medway Beult and Teise contain non-migratory brown trout and Bewl Water on the Teise is designated a Salmonid fishery
- The River Bourne catchment lies within the Green Belt and a notable Alder Carr habitat is present
- There are several hundred heritage and archaeological sites in the catchment, some of which could be adversely affected by changes in water levels

2.6 Previous Catchment Studies

There are a number of previous studies that have been carried out relating to the Medway catchment and a full listing is presented in Volume 3, Appendix D. The most significant of these is the Medway CFMP, completed in 2004, with which this strategy has been fully integrated.

2.7 Benefits of a Strategic Approach

The Medway catchment is a hydrologically complex and inter-linked system. The confluence of three rivers in an area which is exceptionally flat, results in a complex and frequent flooding problem. A strategic approach to flood risk management in the Middle Medway is required and justified in accordance with FCDPAG 2 because:

- The flooding problem in the Middle Medway consists of numerous smaller problems over a large area;
- The problems, solutions and benefit areas are interconnected;
- The problems are likely to be exacerbated in the future due to climate change and increased development in the floodplain.

2.8 Statement of Objectives

The objectives of the Strategy were agreed by the Agency and are in line with both Agency and Defra targets. The Strategy objectives are:

- To develop a flood risk management strategy for the Middle Medway River system for the next 100 years, taking account of flood risk and increased risks associated with climate change.
- To further identify and appraise flood mitigation options for implementation.
- To scope and investigate, significant environmental impacts of these options and related opportunities for environmental enhancement.
- To identify flood risk management options that could be carried out in advance of implementation of the main strategy

2.9 Legislative Framework

The Environment Agency has permissive powers for flood defence works under Section 165 of the Water Resources Act 1991. This is the main legislation governing the focus of this study. Further powers and duties are granted by the Upper Medway Navigation and Conservancy Act 1911, Southern Water Authority (Transfer of Lower Medway Navigation Functions) Order 1979 and various bylaws. The 1911 Act gives the Agency powers to maintain and improve existing locks and sluices over the study area (referred to as Upper Catchment in the Act), and the remaining legislation covers the section from Maidstone to Allington Sluice.

The Leigh Barrier was commissioned under the River Medway (Flood Relief) Act 1976. Changes to this scheme would require an amendment of the 1976 Act or creation of a statutory instrument under section 3 of the Transport and Works Act 1992 (relating to construction or operation of an inland waterway).

Some new works, particularly flood storage schemes, will require either an Act of Parliament or the creation of a Statutory Instrument under Section 3 of the Transport and Works Act 1992 to progress. All of the preferred options would be subject to the

Town and Country Planning (Assessment of environmental effects) regulations and Land Drainage regulations.

The Strategic Environmental Assessment Directive 2001/42/EC and associated national regulations do not apply to this strategy as it was started before the regulations came into force and will be adopted before July 2006. For this reason, the strategy and SEA can not be taken as complying fully with all of the SEA regulations. However, as the regulations and guidance are now current best practice, they have been applied wherever possible to the strategy plan and production of the SEA.

2.10 Project Team

The strategy was commissioned by the Environment Agency (Agency) Kent Area Flood Defence Improvement Team and has been managed through the National Capital Programme Management Service (NCPMS). NCPMS appointed Consultant Babbie Brown and Root (BBR) under the National Engineering and Environmental Consultancy Agreement to carry out the detailed appraisal and reporting. Key individuals are listed in Table 2.1.

Table 2.1 Key Members of the Project Team

Name	Title	Organisation
Chris Harding	Project Executive	Environment Agency (NCPMS)
Neil Gunn	Client Sponsor	Environment Agency (Kent Area)
Richard Hull	Project Manager	Environment Agency (NCPMS)
Marcus Francis	Project Manager & Hydrology Lead	Babbie Brown and Root
John Gosden	Technical Manager	Babbie Brown and Root
Chris Darton	Engineering Lead	Babbie Brown and Root
Carol Peirce	Environmental Lead	Babbie Brown and Root

2.11 Strategy Approval

This Strategy has been prepared in accordance with Defra's Flood and Coastal Defence Project Appraisal Guidelines (FCDPAG) and in particular Volume 2 for Strategic Planning and Appraisal. The strategy complies with current Treasury guidance and economic appraisal has been carried out in accordance with the Middlesex University 'Multi-coloured Manual'. The strategy fulfils Agency and Defra investment requirements and gives a level of cost certainty appropriate for NRG recommendation, DEFRA Approval and Environment Agency FSoD Approval for the first five years of work.

3. PROBLEM IDENTIFICATION

This section describes the flood risk problem that the strategy will address.

3.1 History of Flooding

The Medway has been subjected to many flood events and records of major events go back to the 1700's. From the records assessed, it is clear that the flood of 1968 produced the greatest damage in recent times, when a large area of Tonbridge was inundated. The floods of Autumn 2000 were the largest in recent history.

3.2 Recent Flooding

For England as a whole, Autumn 2000 was the wettest since meteorological records began in 1766. For Kent, September 2000 was the wettest since 1981, October 2000 was the wettest since 1903 and prolonged rainfall led to flooding between 9 and 15 October. This affected much of Kent and was particularly severe over the mid Kent catchments of the rivers Medway, Beult and Teise. During this period, Yalding, in particular, suffered extensive flooding, with some 50 properties affected and road access closed. Flooding also occurred at East Peckham, Collier Street, Lamberhurst and Smarden as well as other locations within the catchment. Flooding in Tonbridge and Maidstone, however, was limited. Approximately 490 houses were affected by flooding in the Medway catchment. Preliminary estimates of return periods for the mid-October event for different locations in the middle Medway ranged from 40 to 100 years (Environment Agency, 2001). Further, but less extensive flood damage occurred in the following months.

The indicative flood area published by the Agency (2000) shows areas of the catchment which may be at risk of flooding (see Figure B1). This map was generated from observations, engineering judgement and limited mathematical modelling and was subsequently updated with the Medway Section 105 flood study.

3.3 Existing Defences

The Middle Medway does not have an extensive system of flood defences. Existing defences are described below.

3.3.1 Leigh Barrier

During a flood the headwaters of the River Medway are controlled by the Leigh Barrier, located 3km upstream of Tonbridge, which was commissioned in 1981. This attenuates floods and hence reduces the frequency and magnitude of flooding, principally in Tonbridge and other areas downstream. It protects Tonbridge from floods up to a 1% annual probability event. The barrier controls flows from 535 km² (38%) of the catchment and is one of the largest fluvial flood alleviation reservoirs in the UK. The current storage capacity is 5.6 Mm³. During the Autumn 2000 event, the Leigh Barrier was operated from 9 to 14 October, preventing flooding similar to that experienced in 1968. The Barrier control systems are currently being updated under a separate project and provision has been made for future changes to the operating level.

3.3.2 Tonbridge Walls

Tonbridge has flood defences in the form of low flood walls along the banks of the Medway. Although these defences held during the October 2000 floods there was serious leakage through the walls. Sections of the wall have now been rebuilt. The standard of protection for Tonbridge town centre is reported (Environment Agency, 2001) to be in excess of a 1.5% annual probability.

3.3.3 Smarden Defences

The village of Smarden on the Beult has some low defences comprising embankments and structural walls, which afford some buildings a reported 2% annual probability standard of protection.

3.3.4 Collier Street Defences

Collier Street on the River Teise has discontinuous low earth embankments, which are reported to protect a few low lying properties, and an automatic radial sluice gate (Moors Sluice). The embankments were refurbished in 1997.

3.3.5 Flood Warning

Within Southern Region and in the context of the Middle Medway Strategy area, development initiatives are proceeding in the areas of detection, forecasting and warning. Floodline Warnings Direct is being introduced to replace the AVM to provide messages via a wider range of media.

3.4 Assessment of Flood Risk

3.4.1 General Approach

In order to assess existing flood risk this study adopted a staged approach based upon the development of a calibrated flood model as follows:

- a) Hydrological analysis of the sub-catchments providing flood inflows to the river system in the study area
- b) Hydraulic modelling of the river system in the study area and the derivation of flood levels for a range of flood events
- c) Flood inundation mapping based upon flood levels and a Digital Terrain Model of the floodplain providing the extent of flooding and flood depth
- d) Identification of residential and commercial properties within the predicted areas of flooding on the basis of the geo-referenced National Property Database

In subsequent economic analysis, step (d) above was followed by the calculation of damage to each flooded property based upon the classification of the property, the flood depth at that location and standard depth-damage curves provided by the Multi-Coloured Manual (Flood Hazard Research Centre, 2003).

Options for flood risk management were evaluated by testing their effectiveness in the model of the river system and their impact on the extent of flooding, the depth of flooding, the numbers of properties flooded and the flood damages avoided.

The hydrological and hydraulic modelling is presented in more detail in Volume 4. The model was constructed using InfoworksRS. The software package, produced by Wallingford Software, provides a GIS-like interface to the standard ISIS hydraulic model together with powerful post-processing capabilities.

The model drew upon previous work carried out under the Section 105 programme for the Medway and Eden. The modelling of the Teise, Beult and Bourne carried out as part of the study provides the basis for future Section 105 modelling on these rivers. The model also has potential value for use in flood warning and has been provided to the team developing models for this purpose.

3.4.2 Properties at risk of flooding

To enable simple catchment wide assessment of damages arising from the Do Nothing case (and other cases), the flood plain in the strategy area has been sub-divided into 20 discrete flood prone settlements or flood risk areas with common mechanisms of flooding (see Figure B2). The flood risk areas have been named based on the key town(s) or districts contained within the zone, but do not necessarily match administrative districts.

For each scenario considered, the flood depth grid for all return periods was analysed using the ArcView GIS package. An extract of the National Property Database covering the Medway floodplain area was superimposed upon the flooded areas as represented by the grid of flooded depth. The National Property Database contains residential and commercial properties located by postcode together with information on the classification and rateable value of commercial properties.

This process allows the identification of properties flooded by each event simulated and the assessment of the depth of flooding at each property. The threshold of flooding is assumed to be the same as the average elevation of the particular cell of the digital terrain model (DTM) within which the property lies. This approach is appropriate at a strategic level and its robustness has been confirmed by sensitivity testing.

3.5 Do Nothing Scenario

3.5.1 General Principles

The Do Nothing scenario has been used as the baseline economic reference case for this Strategy. The baseline for the economic analysis required by Defra is defined in FCDPAG 3 Section 3.1 (Defra, 2001b).

Do Nothing is the situation that would arise if the Environment Agency and other statutory authorities 'walked away' from any flood management of the flood prone area. These authorities would still continue to carry out their other statutory duties. In the context of the Middle Medway Strategy, the Do Nothing option would be to walk

away and abandon all maintenance and repair to existing structures allowing nature to take its course. Because the River Medway is managed for navigation it would be necessary to continue to operate the ten penning structures used to maintain the navigable channel.

The adoption of a Do Nothing case is rarely realistic or appropriate as it is usually justifiable to do something to manage flood risk for assets with some national economic, environmental or cultural value. However, the value of considering a Do Nothing case is that it helps determine the most appropriate level of flood risk management. Because of the need to maintain the navigable channel on the Medway under the Do Nothing scenario, it is assumed that the ten penning structures would be maintained in the closed position and would not be opened in the event of a flood. It is assumed that the Leigh Barrier gates would be removed in the Do Nothing scenario. This assumption has been made to avoid the possible catastrophic effects of overtopping of the embankments, which may result if the gates were left in place and which might ultimately fail in a closed position forcing water levels to rise. Subsequent overtopping of the embankment could undermine the downstream face leading to a breach and widespread flooding downstream threatening Tonbridge.

3.5.2 Do Nothing Damages

The results have been analysed in terms of the numbers of properties flooded and the economic damages resulting for the 20, 10, 4, 1 and 0.5 % annual probability events. Property damages have been calculated to reflect the economic impact of flooding. Agricultural and social damages were analysed in the CFMP, but proved to have a minimal influence. Further detail on the calculation of damages is presented in Section 7 and Volume 6.

There are 192,054 properties in the Middle Medway catchment of which 9,150 are in the defined flood risk areas where properties are potentially at risk. In the Do Nothing case 1,134 properties are predicted to experience flooding in the 1% annual probability event. The Present Value Damages (PvD) incurred would be £431,369,000.

Over 650 properties would be flooded by a 4 % annual probability event, which represents a significant risk.

Areas that would experience significant flooding and economic damages are Tonbridge, East Peckham, Laddingford, Yalding and Maidstone. The results of the Do Nothing case are summarised for the 1 % annual probability event in Table 3.1. The number of properties may appear to be low in some instances as the modelling only takes into account flooding arising from the Main River system. Properties flooded as a result of flood events on Internal Drainage Board (IDB) water courses or Critical Ordinary Watercourses (CoW) are not included as these channels were not modelled. Examples would be the Coult Stream in East Peckham, Hilden Brook in Hildeborough and Tudeley Brook at Paddock Wood. In general, flooding of properties from these streams would be unaffected by conditions on the main river system. Any solutions proposed on the Main River system would not provide great benefit for such properties.

The environmental opportunities, impacts and possible mitigations of the Do Nothing scenario are discussed in Section 5.4 and in more detail in Appendix I.

Table 3.1 Do Nothing - Properties Flooding in the 1 % annual probability Event and Annual Average Damages

Flood Risk Area	River	No. of properties flooded in 1 % annual probability event	Annual Average Damages (£k)
Penshurst	Upper Medway	1	4
Leigh	Upper Medway	3	22
Tonbridge	Upper Medway	201	1,643
Five Oak Green	Upper Medway	11	68
Golden Green/Hadlow	Upper Medway	14	96
Lamberhurst	Teise	15	35
D/S Lamberhurst	Teise	1	1
U/S Collier Street	Teise	12	28
Marden	Teise	0	2
Collier Street	Teise	69	214
Paddock Wood	Teise	4	460
Smarden	Beult	5	4
Headcorn	Beult	15	27
Staplehurst	Beult	43	233
Chainhurst	Beult	14	31
Hunton	Beult	12	28
East Peckham/Little Mill	Middle Medway Area	200	1,952
Laddingford	Middle Medway Area	101	754
Yalding	Middle Medway Area	176	3,972
Teston/East Farleigh	Lower Medway	21	695
Maidstone	Lower Medway	217	2,013
Total		1,134	12,277

Notes: (1) Excludes areas: Edenbridge and Edenbridge/Penshurst as being outside the core study area
(2) Damages updated to mid-2005 consistent with costs

3.6 The Do Minimum Case

The Do Minimum option assumes that proactive and reactive maintenance works continue to prolong the life of existing flood defence assets as long as possible. No improvements would be made to the existing standard of defence to account for climate changes. Control structures would be operated in their normal manner and remain serviceable. However, there would be a long term degradation of the standard of defence resulting from increasing water levels due to climate change.

Operating procedures were developed for the Leigh Barrier at the time of its construction in 1980. Since this time there have been improvements to mechanical and electrical systems at the structure and to telemetry across the catchment. These improvements, coupled with the last 25 years operating experience should be used to review and revise the current operating procedures for the structure and make an

assessment of the potential for future procedures to take account of the effects of climate change. Further details on the operation of the Leigh Barrier are discussed in Volume 3, Appendix G.

Modelling of the Do Minimum (and intervention scenarios) has assumed that optimal forecasting and decision making is applied in the operation of the Leigh Barrier. Such operation is possible within the timeframe of this 100 year Strategy period and within the context of the recommendation to review operating procedures.

In order to achieve this, it is recommended that a study be carried out to identify the scope to which current operating practice of the Leigh Barrier and forecasting can be optimised to achieve the flood mitigation performance indicated by this study.

3.7 Future changes in flood risk

The impact of climate change has been assessed on the basis that there will be an increase in runoff of 20% over the next 50 years, which would then be maintained for a further 50 years (covering the 100 year Strategy study period). This approach follows the guidance provided by the UK government (Defra, 2001). For the purposes of the present study this is assumed to apply over the full range of return period events evaluated. As guidance on the assessment of climate change is developed the estimates of flood levels and damages will need to be reviewed and updated as necessary.

The consequence of an increase in runoff will lead to a corresponding increase in peak flow across the catchment, resulting in an increase in the number of properties flooded and flood damage incurred. The effect of climate change on the Do Minimum case and the Do Nothing case was tested by simulation in the model.

The effect of the increase in runoff can be interpreted as a change in the frequency of an event of particular magnitude as shown in Figure 3.6.1. This figure shows, for example, that a 2 % annual probability event will in future have a higher probability of 5%, as explained in Appendix H.

Estimates of the amount of urbanisation which is likely to take place within the catchment during the next 50 years indicates that the amount of 'greenfield' land which will be built upon will be very small, probably less than 1% of the total area even in the 'worst case' (i.e maximum growth) scenario. Areas identified as having the most potential for further urbanisation, albeit mostly minor, are the outskirts of Maidstone, Staplehurst, Marden, and Paddock Wood. Local plans indicate that up to 400 new properties are likely to be constructed in present floodplain areas.

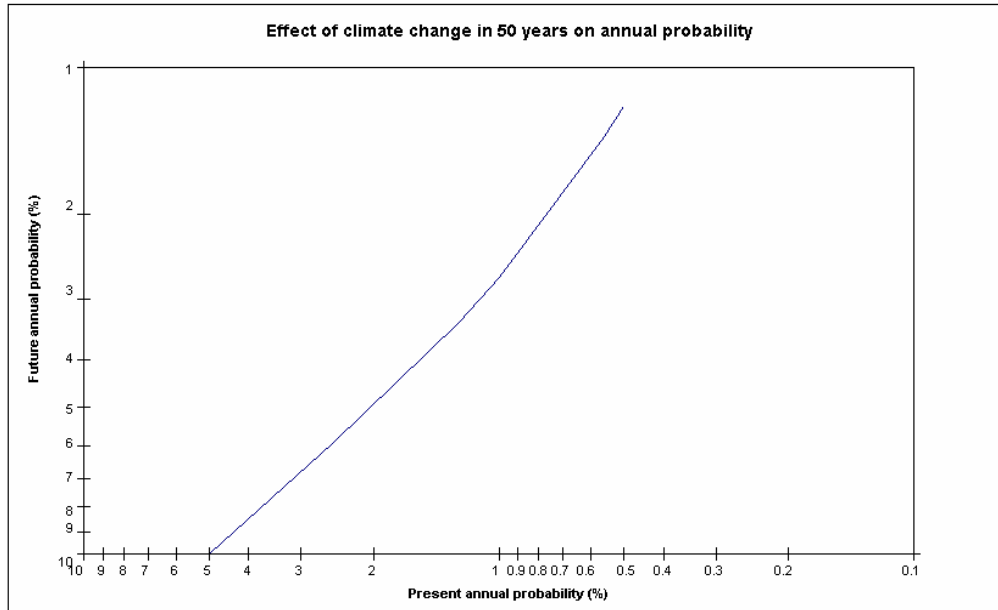


Figure 3.6.1 The impact of climate change on the annual probability of an event

In view of the minor changes that have been identified on a catchment scale, it is unlikely that hydraulic impacts on the catchment will be significant. However, future development may create changes which may have significant effects on the flood hydrology at the local level.

4. OPTIONS SELECTION

4.1 Option Selection Process

A range of measures were considered for flood risk management in the Middle Medway catchment, at different levels of detail. The procedure by which the measures were identified for consideration and selected for detailed evaluation was a two stage process:

- Stage 1: Generation of long list of potential options consistent with policies established and measures considered in the Catchment Flood Management Plan (CFMP). This involved review of CFMP options, identification of further options by inspection and consultation in a stakeholder workshop.
- Stage 2: Generation of short list of options for detailed evaluation on the basis of stakeholder consultation and Multi-Criteria Analysis. This involved scoring and ranking the options, consultation on a wide basis with the Initial Consultees Report, and finalisation in an Options Appraisal Workshop with key stakeholders.

4.1.1 Generation of Long List of Potential Options

The Medway Catchment Flood Management Plan provided the starting point for defining a long list of potential options for consideration in the Strategy. During the process of development of the CFMP, a range of possible approaches to flood risk management measures were considered in consultation with stakeholders. The scoping process encompassed engineering, economic, social and environmental considerations. Options proposed included: improving conveyance at specific locations and along longer reaches; increasing available storage by modifying existing reservoirs; creating new online and offline storage reservoirs and washlands; and the reinstatement of meanders. Individual protection of properties and localised flood defences to towns and villages were also considered. Additional measures evaluated included: river enhancement; river restoration; land use management; social and planning measures; and the improvement of flood warning. The outcome of the CFMP was a range of flood risk management policies for locations across the Medway catchment, and an associated list of potential flood alleviation measures for more detailed consideration in a subsequent Strategy study.

This list of potential flood alleviation measures identified in the CFMP was adopted as a starting point for the Strategy. A review was undertaken of the areas at risk of flooding in the context of the overarching CFMP flood risk management policies. For each location, the options for flood risk alleviation were considered by inspection of the available topographic mapping and digital terrain model taking into account both strategic and local options. These included: flood storage, conveyance improvement, catchment management, flood warning improvements and local structural defences. As a result of this process the initial long list deriving from the CFMP was expanded with the definition of a wide range of options. The expanded long list was reviewed during a joint CFMP/Strategy consultation workshop to ensure that options on the list were consistent with flood risk management policies propounded by the CFMP. The outcome of this workshop was a finalised long list of options for consideration.

4.1.2 Generation of the Short List of Options for Detailed Evaluation

The long list of options was refined in a screening process on the basis of Multi-Criteria Analysis (MCA) in wide consultation with stakeholders by means of the Initial Consultees Report in 2003 and feedback generated to produce a short list for subsequent detailed evaluation. This short list was subsequently finalised during an Options Appraisal Workshop with key stakeholders.

The method of evaluation using the MCA approach was an evolution of the procedure adopted in the CFMP study. Each option on the long list was given a score against the following criteria:

- The reduction in flooding at the location and elsewhere in the catchment (technical effectiveness)
- Opportunities for environmental enhancement (environmental acceptability)
- Sustainability and flexibility for the future (social impacts)
- Adverse flooding impacts (technical effectiveness)
- Environmental constraints and geomorphological impacts (environmental acceptability)
- Scale of impact on the public (social impacts)
- Degree of impact on infrastructure (stakeholder acceptability)
- Magnitude of the intervention measure in relation to cost (economic efficiency)

In an initial screening step of the short listing process, those options which were not considered viable on technical or environmental grounds were discarded.

For the remaining options, a combined score was developed based upon a weighted sum of the values assigned to the individual criteria. In this process, greatest weight was given to technical effectiveness followed by environmental acceptability; the lowest weighting was given to stakeholder acceptability and economic efficiency. A total score for each option was derived from the sum of all criteria taking into account both positive and adverse impacts. The options were then ranked within broad types, for example all flood storage measures, and globally against the Do Minimum Option.

It may be noted that the structural options considered provided a standard of protection within the indicative range described in Section 2.3.

The options identified and the ranking assigned were submitted for consultation with all stakeholders in the Initial Consultees Report. Subsequently, an Options Appraisal Workshop was held with key Environment Agency consultees at which the initial ranking and consultee responses were considered. The outcome of this workshop was a short list of options to take forward for detailed consideration in the Strategy study.

Full details of the consultees and options considered are presented in the Strategic Environmental Assessment in Volume 5.

4.2 Long List of Options

The long list of options generated is shown in Table 4.1. Those options carried forward to the short list for detailed appraisal are shown in bold. The storage volumes presented in the descriptions in Table 4.1 were based on estimates made during the CFMP. For options short listed, these volumes were updated following more detailed modelling.

Table 4.1 Long List of Flood Alleviation Options (with Short Listed Options in Bold)

Option Description	Remarks	Appraised in Strategy
ONLINE STORAGE OPTIONS		
Leigh Barrier, volume increase of 2.8 Mm³	Potential for reduced damages downstream	Yes
Above the Leigh Barrier on the Eden, volume 4.6 Mm³	Potential for reduced damages in Edenbridge and downstream on the Medway	Yes
Above the Leigh Barrier at Penshurst, volume 7.3Mm ³	Potential for reduced damages downstream on the Medway– impact similar to storage at Edenbridge and therefore only one case was modelled. Storage upstream of Edenbridge was selected as it also protects properties in this town	No
Stile Bridge, volume 4.8 Mm³	Potential for reduced damages downstream on the Beult in Yalding	Yes
Stone Bridge, volume 2Mm ³	Similar impact to Stile Bridge – only one case was modelled	No
Hadlow, volume 95,000m³	Potential for reduced damages downstream in Little Mill and East Peckham	Yes
Lamberhurst, volume 450,000 m³	Potential for reduced damages downstream in Lamberhurst	Yes
Tributary at Headcorn, volume 150,000m ³	Limited capacity, unlikely to have significant impact	No
OFFLINE STORAGE OPTIONS		
Smarden, volume 320,000m ³	Limited capacity, unlikely to have significant impact	No
The Shallows, volume 600,000m ³	Limited capacity, unlikely to have significant impact	No
Claygate, volume 1.2Mm ³	Similar impact to Great Cheveney – only one case was modelled	No
Great Cheveney, volume 2.1 Mm³	Potential for reduced damages downstream in Collier Street	Yes
Hildenborough, volume 250,000m ³	Limited capacity, unlikely to have significant impact	No
Hunton, volume 1.6Mm ³	Similar impact to Great Cheveney – only one case was modelled	No
Stilstead, volume 1.5Mm ³	Similar impact to Great Cheveney – only one case was modelled	No
East Peckham, volume 100,000m ³	Limited capacity, unlikely to have significant impact	No
Headcorn, volume 560,000m ³	Limited capacity, unlikely to have significant impact	No
Marden, volume 115,000m ³	Limited capacity, unlikely to have significant impact	No

Option Description	Remarks	Appraised in Strategy
LOCAL DEFENCE OPTIONS		
Marden, length 750m	Likely to have only local impact on damages (based on CFMP modelling), unlikely to achieve sufficiently high benefit cost ratio.	No
East Peckham, length >1km	Potential for economic provision of local defences	Yes
Collier Street, length >1km	Potential for economic provision of local defences	Yes
Tonbridge, length 6km	Likely to have only local impact on damages (based on CFMP modelling), unlikely to achieve sufficiently high benefit cost ratio	No
Yalding, length 1km	Potential for economic provision of local defences	Yes
Smarden, length 700m	Likely to have only local impact on damages (based on CFMP modelling), unlikely to achieve sufficiently high benefit cost ratio	No
Lamberhurst, length 350m	Local defence combined with online storage option to reduce damages in Lamberhurst	Yes
Headcorn on the River Sherway, length 1km	Likely to have only local impact on damages (based on CFMP modelling), unlikely to achieve sufficiently high benefit cost ratio	No
Hadlow, length 600m	Likely to have only local impact on damages (based on CFMP modelling), unlikely to achieve sufficiently high benefit cost ratio	No
Laddingford, length 750m	Likely to have only local impact on damages (based on CFMP modelling), unlikely to achieve sufficiently high benefit cost ratio	No
CONVEYANCE OPTIONS		
Re-profiling on the Beult	Likely to have significant impact on SSSI	No
Flood relief channel at Lamberhurst, length 300m	Likely to have only local impact on damages (based on CFMP modelling)	No
Restriction of flow into the Lesser Teise	Likely to have a significant environmental impact (CFMP, 2004)	No
Removal of bunds on the Bourne	Likely to have only local impact on damages (based on CFMP modelling)	No
Re-profiling on the Medway between Laddingford and Allington	Possibility of reduced damages in Maidstone – recommended for further study	Yes
NON-STRUCTURAL OPTIONS		
Improvements to flood warning	Compatible with sustainability considerations Important element of flood risk management for areas where structural measures do not deliver reduced flood risk	Yes
Improved catchment (land) management		Yes
Assistance with individual property protection		Yes

4.3 Developing the Short List

In finalising the short list for detailed consideration during the Options Appraisal Workshop a number of issues were taken into account relating to options requiring detailed modelling with assessment of benefits and costs and further non-structural options that cannot be model tested.

4.3.1 Options for Model Testing

Conveyance options were modelled during the preparation of the CFMP with the following conclusion: conveyance changes may assist in reducing flood risk, but they are not sufficient to reduce flood risks and damages significantly, especially in major events. Increasing or decreasing conveyance through the management of channel friction has only minor effects on catchment wide economic damages. The impacts of widespread channel enlargement would also cause significant environmental damage and was not favoured as a sustainable solution. On this basis it was decided not to include options for conveyance modification in the short list of options for detailed evaluation.

In principle, however, the design and capacity of hydraulic structures on the various rivers in the project area can have an impact on river levels during flood conditions. It is anticipated that local defence schemes in locations such as Yalding, Collier Street or East Peckham would consider the option of modifying such structures where relevant during subsequent feasibility studies.

The short list includes a number of strategic online and offline storage options selected for appraisal. In addition to modelling these as individual options, combinations of options were selected for evaluation to identify those with the most beneficial catchment-wide impacts.

For those locations where strategic flood management options offered little improvement in flood defence standard, a number of local stand alone defence options were considered. In addition, where the implementation of a storage scheme increased the frequency of flooding locally upstream, local defences were provided in combination with the storage to mitigate the impact e.g. local defences at Leigh and Staplehurst for the Leigh Barrier and Stile Bridge storage reservoirs, respectively.

4.3.2 Non-structural Options

Whilst storage and local protection measures would provide reduced flood risk for a number of key areas in the catchment, some areas would not experience any significant improvement. Thus the following non-structural measures were considered alongside the structural measures, as an integral part of the Strategy for flood risk management:

- Establishing closer co-operation between local authority planning departments and Agency development control to reduce the inappropriate development of properties in the flood plain. Where properties in the flood plain are re-developed ensuring that flood proofing (or resilience) measures are incorporated in the properties and that this is enforced through planning consents
- Improving the flood warning network and the operation and take-up of targeted flood warning. Educate the public in the options available to minimise flood damage. Continued close working with local authorities will be essential to ensure the success of take-up.

- Provide education and assistance to the public in individual property flood proofing. Whilst the Agency does not have a duty to provide flood protection, it has a remit to manage flood risk. Measures that could be taken would include:
 - Pro-active programme of providing technical advice on flood proofing to the properties which cannot be economically protected by Agency schemes
 - Seek to obtain financial incentives and support from central government to encourage householders' initiatives (similar to Government grants which are available for house insulation)
 - Influence the Association of British Insurers to provide differential excesses and no claims discounts on insurance policies in respect of flood damage for householders who take positive action on property flood proofing. This might work in a similar fashion to motor insurance.
- Over the life time of the strategy influence farmers, developers etc outside the immediate flood plain to improve catchment management practices to assist with reducing the predicted impact of climate change.

4.4 Short List of Options

The resulting short list of options appraised is presented in Table 4.2. These have been repeated in a pull-out table presented in Appendix A to enable easy reference.

Table 4.2 Options Appraised in Strategy Study

Option No.	Option Description	Key Flood Risk Areas Benefiting
BASE CASES		
1	Do nothing	None
2	Do minimum	Tonbridge, East Peckham, Maidstone
STRUCTURAL MEASURES		
3	Online storage on the Eden upstream of Edenbridge	Tonbridge, Maidstone, Laddingford, East Peckham
4	Increased online storage at the Leigh Barrier	Tonbridge, Maidstone, Laddingford
5	Online storage on the Teise upstream of Lamberhurst with online storage on the Bourne upstream of Little Mill	None
6	Online storage on the Beult upstream of Stile Bridge	Yalding, Maidstone, Laddingford
7	Offline storage on the Teise upstream of Great Cheveney	Laddingford, Collier Street, Maidstone
8	Edenbridge with Leigh Barrier	Tonbridge, Yalding, Maidstone, Laddingford, East Peckham
9	Leigh Barrier with Stile Bridge	Tonbridge, Yalding, Maidstone, Laddingford, East Peckham

Option No.	Option Description	Key Flood Risk Areas Benefiting
10	Great Cheveney with Stile Bridge	Yalding, Laddingford, Maidstone, Collier Street
11	Stile Bridge with mitigation at Staplehurst	Yalding, Maidstone, Laddingford
12	Not used	
13	Not used	
14	Local defences at Yalding (1 % annual probability of flooding)	Yalding
15	Not used	
16	Leigh Barrier with mitigation at Leigh	Tonbridge, Maidstone, Laddingford
17	Local defences at Collier Street (1% annual probability of flooding)	Collier Street
18	Local defences at Maidstone (1% annual probability of flooding)	Maidstone
19	Local defences at East Peckham (1% annual probability of flooding)	East Peckham
NON-STRUCTURAL MEASURES		
-	Improvements to flood warning	Whole catchment
-	Improved catchment (land) management	Whole catchment
-	Assistance with individual property protection	Whole catchment

Note: Flood risk areas listed where 20 or more properties benefit in descending order of impact

A summary plan locating the options appraised within the catchment is presented in Figure B1. A detailed discussion of the implementation and benefits of each option is presented in Volume 3.

5. STRATEGIC ENVIRONMENTAL ASSESSMENT

The Strategic Environmental Assessment (SEA) has been carried out in conjunction with this Strategy Study and is presented in Volume 5.

5.1 Approach to Strategic Environmental Assessment

The SEA regulations do not apply to this Strategy as it was started before the regulations came into force and will be adopted before July 2006. For this reason, the strategy and SEA cannot be taken as fully complying with all of the SEA Regulations. However, as the regulations and guidance are now current best practice, they have been applied wherever possible to the strategy plan and production of the SEA.

5.2 Options Appraisal

In order to effectively assess the impacts, benefits, opportunities for enhancement and potential mitigation for each flood defence option, a series of Environmental Themes were used. These themes set out the high level areas for considering the impacts of options. Under each theme a number of Environmental Objectives were set, against which each option was appraised. To ensure relevance and objectivity the themes, objectives and indicators were developed in consultation with the SEA Officer for the Medway Catchment and with internal Agency specialists representing Biodiversity, Water Resources, Recreation and Fisheries. Environmental Indicators were used to measure whether each option met the objectives.

Options were evaluated against the Environmental Objectives using an SEA Impacts Matrix. In order to measure whether Environmental Objectives are met or not, a number of Environmental Indicators were developed. The SEA Impacts Matrix assesses the potential impacts, benefits, opportunities for enhancement and possible mitigation measures for each option. The significance of impacts are considered over the short term (0-5 years) e.g. construction phase, and medium to long term (5+ years). Impacts have been measured using a five point scale ranging from high negative to high positive impact.

This methodology has enabled a comparative assessment of the options to establish whether, overall, they are:

- Not recommended from an environmental perspective
- Environmentally neutral
- Provides opportunities for enhancement

Table 5.1 Environmental Themes, Objectives and Indicators used in the SEA Appraisal

Environmental Theme	Environmental Objectives	Environmental Indicator
Policies & Plans	1. Provide protection from flooding in a sustainable manner consistent with plans, policies and objectives	Change in condition of human and built environment
		Properties defended to an agreed standard
		Agreement/conflict with plans, policies and objectives
Human/Social	2. Protect/enhance water and adjacent land based recreation and amenity	Loss or gain of water or adjacent land-based recreation
	3. Protect/enhance navigation on River Medway	Navigation closures due to flood flow or loss of draught
Climate Change	4. Ensure strategy is sustainable in terms of long term climate change	Ability to adapt and upgrade flood defences in response to future predicted climate change
Flora and Fauna	5. Protect and enhance sites of nature conservation importance (including designated sites), protected species and habitats and the wider countryside (particularly wetland habitats)	Maintain and enhance protected sites in favourable condition and improvement of protected sites currently in unfavourable condition
		Contribute to catchment biodiversity action plan targets
Fisheries	6. Maintain, improve and develop fisheries (including pro-actively enhancing the economic and social contribution of fisheries, which includes the angling and fish stock component)	Change in fish movements
		Change in area of habitat of value to fisheries
Archaeology & Cultural Heritage	7. Protect and enhance features of archaeological and heritage importance throughout the Medway	Change in condition of protected archaeological sites
		Change in opportunities for archaeological discovery
Landscape & Visual	8. Conserve and enhance the landscape character and visual amenity of the area, integrating all works into the local landscape character	Change in landscape character and visual amenity
	9. Protect/enhance protected landscape sites such as Greenbelt and AONB	Change in condition of Greenbelt/AONB
Geomorphology	10. Protect and enhance geomorphological processes within the Medway Catchment	Change in sediment regime
		Change in physical habitat quality
		Promotion of natural floodplain conditions, for example, increased connectivity with river floodplain
Water	11. Protect and enhance the water quality of the Medway and its tributaries	Change in current chemical and biological water quality

5.3 Environmental Strategy and Policy

The planning policy context for the study area comprises Local and Structure (Development) Plans, Regional Planning Guidance and National Planning Guidance. The Middle Medway area falls within the county of Kent and two district/boroughs. Other planning guidance documents relevant to this Strategy include:

- Regional Planning Guidance RPG9 covering the South East of England
- National Planning Policy Guidance PPG7: Countryside
- PPG9: Nature Conservation
- PPG25: Development and Flood Risk.

5.4 Opportunities, Benefits and Mitigation

Flood storage options meet more Environmental Objectives than local defences and non-structural options. They provide the greatest reduction to flood risk and present some limited opportunities for small scale environmental enhancement, through the creation of ponds and scrapes and the introduction of fish passes where appropriate. Such enhancements have been successfully implemented at the Leigh Barrier and would contribute to UK and regional BAP programmes. However, there is the possibility that some predatory fish may enter these habitats during flooding.

Online storage schemes would result in temporary inundation of the floodplain during flooding, thus there is little potential for creation of washlands and wetlands (areas of floodplain where water is stored in time of flood). The offline storage option at Great Cheveney would provide the opportunity for longer periods of inundation, however due to the limited land area available to maximise storage, it is unlikely there would be sufficient volume required for washland creation. In a typical washland, storing water to a peak depth of 2m, 5 to 20% additional area may be required to have the same flood alleviation impact. This additional storage volume would not be available at Great Cheveney.

The impacts on recreational navigation (on the River Medway) are likely to be negligible as a result of the storage and local defence options appraised by this study. The option of increasing storage capacity at the Leigh Barrier may present an opportunity to enhance its use through, for example, the provision of an educational visitor centre.

Consideration has been given to opportunities for contributing towards BAP targets and to measures which allow for enhancements sympathetic to the geomorphology of the rivers within the catchment.

To ensure that enhancement opportunities from flood storage sites are maximised, further consultation will be undertaken with the EA Biodiversity team and English Nature during feasibility stage. Such opportunities will include positive enhancement of the Beult SSSI under the Stile Bridge flood storage option.

A summary of the likely environmental impact and opportunities for environmental enhancement associated with individual options is presented in Table 5.2.

Where options are combined, the environmental impacts along with the scope for mitigation are assessed cumulatively. The net reduction in flood risk provided by combined options is also assessed cumulatively.

Table 5.2 Summary of Options Appraised with Environmental Impacts and Opportunities

Option¹	Type	Properties removed from flood risk²	Key Impacts	Mitigation	Key Enhancements
1	Do Nothing	None	Increased flood risk	None	None
2	Do Minimum	270	Possible increased flood risk with climate change	None	None
3	Online Storage	543	Eden Valley Walk may be flooded when storage in operation Adverse visual impact Import of significant fill volumes Development within Greenbelt Earthworks may disturb buried archaeology (SAM, APP and Roman road)	Provide alternative paths Liaison with English Nature / Local Authorities Potential to win fill material from excavation for ponds Liaison with English Nature / Local Authorities Desk study and site survey to identify and record archaeology	Habitats - permanent and riffle/pool sequences creation
4	Online Storage	409	Possible spread of invasive species e.g. zebra mussel Import of significant fill volumes Increased flood risk in Leigh	Surveys pre and post-construction None – rip-rap stone protection cannot be sourced locally Provision of local defence (in Option 16)	Habitat – enhance existing ponds and scrapes
5	Online Storage	204	Public rights of way may be flooded when storage in operation Adverse visual impact Import of significant fill volumes Development within Greenbelt Earthworks may disturb buried archaeology	Provide alternative paths Liaison with English Nature / Local Authorities Potential to win fill material from excavation for ponds Liaison with English Nature / Local Authorities Desk study and site survey to identify and record archaeology	Habitats - permanent and riffle/pool sequences creation
6	Online Storage	382	Public rights of way may be flooded when storage in operation Adverse visual impact Possible adverse impact on commercial fish farm Possible adverse impact on SSSI Import of significant fill volumes	Provide alternative paths Liaison with English Nature / Local Authorities Liaison with fish farm owner Potential to win fill material from	Habitats - permanent and riffle/pool sequences creation

Option ¹	Type	Properties removed from flood risk ²	Key Impacts	Mitigation	Key Enhancements
			Development within Greenbelt Increased flood risk in Staplehurst	excavation for ponds Liaison with English Nature / Local Authorities Provision of local defence (in Options 11)	
7	Offline Storage	384	Public rights of way may be flooded when storage in operation Adverse visual impact Import of significant fill volumes	Provide alternative paths Liaison with English Nature / Local Authorities Potential to win fill material from excavation for ponds	Habitats - permanent and riffle/pool sequences creation
8	Online Storage	605	Cumulative reduction in flooded properties No net increase in adverse impacts	As individual options	As individual options
9	Online Storage	502			
10	Offline/ Online Storage	480			
11	Storage + local mitigation	406	Reduction in flooded properties compared with Stile Bridge storage reservoir alone Adverse visual impact in Staplehurst from mitigation measures in addition to Stile Bridge storage reservoir Local disruption to services and drainage systems from Staplehurst defences	As individual options plus: Liaison with English Nature / Local Authorities / Utilities / Internal Drainage Board	As individual options
14	Local defences	369	Potential adverse impacts to SAM at Yalding Bridge Import of significant fill volumes Local disruption to services	Sensitive design and consultation with English Nature / County Archaeologist Investigate local sources of fill Liaison with Local Authorities	None
16	Storage + local mitigation	428	Cumulative reduction in flooded properties Reduction in adverse impact of flooding from local defences Local changes to services and drainage systems from Leigh defences	As individual options plus: Liaison with Local Authorities / Utilities / Internal Drainage Board	As individual options
17	Local	315	Import of significant fill volumes	Investigate local sources of fill	None

Option¹	Type	Properties removed from flood risk²	Key Impacts	Mitigation	Key Enhancements
	defences		Local disruption to services and drainage systems	Liaison with Local Authorities / Utilities / Internal Drainage Board	
18	Local defences	366	Local disruption to services and drainage systems Steel sheet piled flood walls would have adverse visual impact and may adversely affect fish spawning	Liaison with Local Authorities / Utilities / Internal Drainage Board Sensitive design and liaison with English Nature / Local Authorities	None
19	Local defences	372	Import of significant fill volumes Local disruption to services and drainage systems Steel sheet piled flood walls around Branbridges islands will have adverse visual impact, may adversely affect fish spawning and may restrict conveyance.	Investigate local sources of fill Liaison with Local Authorities / Utilities / Internal Drainage Board Sensitive design and liaison with English Nature / Local Authorities	None
-	Conveyance	-	Loss of riparian habitat Adverse effects on protected species e.g. otter and depressed mussel Increased washout of fish during high flows	None	Improved navigation

Notes:

(1) – Refer to pull-out summary table in Appendix A for option descriptions

(2) – number of properties removed from flood risk from a 1% annual probability flood event. These figures include includes properties outside the Middle Medway catchment in the Edenbridge and Edenbridge/Penshurst flood risk areas for Options 3 and 8.

(3) – Option numbers 12, 13 and 15 not used

5.5 Environmental risk

Any specific requirements for further data collection, surveys or consultation at the next stage of assessment will involve identification of scheme options to be appraised. This will involve undertaking an Environmental Impact Assessment in accordance with the Environment Agency's EIA Guidance documentation (2002).

Some will fall under the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 and / or the Environmental Impact Assessment (Land Drainage Improvement Works) Regulations 1999. Any requirements under the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 will be confirmed by seeking a screening opinion from the local planning authority to determine whether there are likely to be significant environmental effects. If significant environmental effects are likely then an Environmental Statement/Environmental Report will need to be prepared. At that stage, further site specific data will be collected, surveys undertaken and wider consultation will be conducted with all appropriate statutory and non-statutory stakeholders.

Construction impacts will be considered in detail, however an allowance has been made in this study's cost estimates for disposal of non-contaminated construction waste. Impacts will be identified and defined through the following:

- Protected species and habitat surveys;
- Archaeological site walkovers and intrusive investigations if necessary;
- A landscape and visual assessment;
- Contaminated land investigations if necessary and
- Noise and air quality surveys.

An Environmental Action Plan will be produced to implement the recommendations from the Environmental Statement/Environmental Report.

5.6 Consultation

Consultation with key stakeholders has formed an important part of this Strategy. Consultation has been ongoing since the inception of the Strategy Study and has been co-ordinated with the consultation for the Medway CFMP through the implementation of a joint Communications Plan. The consultation process at this stage aims to:

- Ensure the strategy takes full account of the views of all statutory and non-statutory groups with an interest in the flood risk management of the Medway catchment; and

- Inform consultees of the current flood risk management options under consideration, and invite their comments and views.

Consultees from statutory, local and other interested groups were identified through their involvement and activities within the catchment. A Communications Plan was developed for the Strategy and CFMP to set out the timings and levels of consultations carried out. To assist the consultation process, external consultees were divided into two groups – Professional Partners (stakeholders with a direct interest) and Wider Stakeholders (stakeholders with an indirect interest).

In addition to the above, a Fluvial Group, comprising drainage engineers and planners from the various councils and Agency, meet regularly to discuss flooding issues and have been included in the consultation on the Strategy. Residents and business interests were covered by the local councils. At this high-level stage, it was not considered appropriate to consult with local interest groups (e.g. anglers). However, it is recommended that local interest groups be consulted prior to Environmental Impact Assessment stages for individual projects, to identify further opportunities and constraints at specific locations and for specific measures. Internal specialists within the Environment Agency have also been consulted. Specialist disciplines consulted included: - Biodiversity, Fisheries, Navigation and Recreation and Water Resources. A full list of consultees is provided in Volume 5, Appendix I7.

Forms of consultation under the Strategy included letters, newsletters, meetings and workshops, and publishing information on the project website:

<http://kbrgis.halliburton.com/ea/medway/medway.htm>

Responses and comments from this process have been fed back into the Strategy at each stage. Each stage of the consultation is outlined below:

- Introductory consultation on the CFMP and Strategy aims and objectives in January 2002 with all consultees
- Interim Report – highlighting progress on the Strategy and CFMP, issued to all consultees in January 2003
- Strategy Initial Consultees Report – sent to internal Agency consultees, and posted on the website in November 2003. The report summarised the characteristics of the catchment and current flood management practices, and identified and ranked a shortlist of possible flood risk management options. Comments on this shortlist were invited from the consultee groups. A pro-forma for comments was included within the report which allowed easy response by email. The report was also made available in local libraries, on the Agency's website and on request to the Agency.

- Newsletter – sent to external primary and secondary consultees to inform of Strategy progress and the publication of the Initial Consultees Report in November 2003.
- Telephone/email – ad hoc consultation with key statutory consultees from March to May 2004.
- Environmental Objectives – environmental objectives and indicators were sent to internal EA consultees for comment and approval from March to April 2004.

Prior to finalising this strategy, two public exhibitions were held, one in Tonbridge and the other in Maidstone. These were to inform the public as to what the strategy recommendations are and to seek their views on these. The exhibitions were widely advertised through newspapers, radio announcements, parish councils and the local flood action groups. Approximately 200 people attended these exhibitions with most communities represented. There was general support for the strategy options; no objections were raised although some had concerns relating to the proximity of proposed defences to their property. There was particular support for the flood storage schemes and an acceptance that all works have to be justified economically. Further events in flood prone communities have been or are due to be held. One such event held in East Peckham attracted attendance from 90% of flood effected households.

Full details of consultation responses are presented in Volume 5, Appendix I8. A condensation of the comments made by consultees and the actions taken or responses made during the preparation of the Strategy is given in Appendix D accompanying the PAR in Volume 1. In total, 18 comments were raised in connection with the Medway, 16 comments on the Teise and Lesser Teise, 9 comments on the Beult, 3 comments on the Bourne with a further 2 non-location specific points. The comments were wide ranging covering issues such as:

- Impacts of options at a local scale
- Perceived effectiveness of options proposed
- Possible unintended consequences
- Local issues relating to flood defence and ecological sensitivity
- Other possible options not included in the proposed strategy
- Requests for specific problems to be taken into consideration
- Requests for explanation of reasoning behind proposals

As can be seen in Appendix D, queries were answered where possible, explanations, provided, points noted for action at a later stage, and distinctions drawn between strategic solutions to wider problems and specific issues requiring local solutions.

5.7 Strategic Environmental Appraisal of Options

The full details of environmental themes, objectives, indicators, description of impact and impact scores is given in the SEA matrices in Appendix I9, Volume 5 for individual and combined options. A summary assessment of the options against the environmental objectives, derived from the above, is presented in Table 5.5. The options are shown in order of environmental preference in accordance with the SEA.

Rankings have been determined using the following criteria, in order of preference:

- Provides protection from flooding
- Provides mitigation for adverse environmental impacts
- Provides opportunities for enhancement

This assessment places increased storage at Leigh Barrier with mitigation at Leigh (Option 16) as the most favourable option from an environmental perspective. It may be noted that to provide the catchment with effective flood management it may be necessary to integrate a combination of the various options.

Table 5.3 Summary Environmental Impacts Matrix – medium to long term (>5 years)

Environmental Objectives	Provide protection from flooding	Protect recreation	Protect navigation	Sustainable for climate change	Protect sites of nature conservation	Develop fisheries	Protect archaeology and heritage	Conserve landscape character	Protect landscape sites	Protect geomorphological processes	Protect water quality
Option¹											
16	++	+	o	+	o	+	o	o	o	o	+
8	++	o	o	+	+	+	o	o	o	+	+
9	++	o	o	+	+	-	o	o	o	-	+
10	++	-	o	+	+	+	o	o	o	-	+
7	++	-	o	+	+	o / -	o	o	o	-	+
3	++	-	o	+	o	+	o / -	o	o	-	+
5	+	o	o	+	o	o / -	o / -	o	o	-	+
11	+	-	o	+	o	-	o / -	o	o	-	+
Non-structural measures	+	o	o	+	o	o	o	-	o	o	o
Local defences (14, 17-19)	++	-	o	+	-	o	o / -	-	o	-	o
Conveyance	+	-	o / +	+	-	-	o / -	-	o	--	-
2	-	-	-	-	-	o	o	o	o	+/-	o
1	--	-	-	--	-	o	o	o	o	+/-	o

Key

o	Neutral	-	Low negative impact	+	Low positive impact	--	High negative impact	++	High positive impact
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Note: (1) - Refer to pull-out summary table in Appendix A for option descriptions

5.8 Making It Happen

The Environment Agency have established priority ‘Local Contributions’ as part of meeting the national vision: ‘Making It Happen.’ In this particular context the term Local refers to contributions made by the Southern Region of the Environment Agency. Those appropriate to this strategy study were selected and implemented either in the delivery of the strategy or embedded in the environmental objectives used to select preferred flood risk management options. At scheme stage the environmental action plan will identify how local contributions can be best delivered through construction works.

Table 5.4 Strategy local contributions delivered

Contribution	How it was achieved
Harmonise Flood Defence, Water Resource and Navigation capital schemes where possible. and Reduce flood risk through Flood Risk Management	A 100 year implementation plan for flood defence works has been produced with detail given for first 5 years of work. This will facilitate better planning of projects and integration of construction works between these three Environment Agency business units. This plan will also serve to assist in the provision of flood defences were this is the preferred option for better flood risk management
Develop a public acceptance of flood risk management. Provide information to advise customers on flood risk Improve coverage of flood warning	The Environment Agency have consulted extensively with the public during the production of the strategy and have spoke in detail to those currently at flood risk. Through our public exhibitions, radio interviews and newspaper articles we have promoted the ethos of flood risk management rather than flood defence. All of our exhibitions were supported by Flood Warning specialists who offered advice and signed up new customers for the flood warning service.

Table 5.5 Strategy local contributions proposed

Contribution	How it can be achieved
<p>Improve waterway regeneration through provision of :</p> <ul style="list-style-type: none"> • Disabled facilities • Canoeing sites • Increased moorings 	<p>There are a number of capital schemes proposed by the strategy and opportunities will be sought during the construction of these to improve facilities for navigation and recreation.</p>
<p>Improve the status of the River Beult SSSI</p>	<p>The SSSI is in an unfavourable condition and there is an opportunity to improve its condition through the flood storage works proposed at Stilebridge if this scheme eventually forms part of the recommended strategy.</p>

6. ECONOMIC APPRAISAL

6.1 Costs of Options

6.1.1 Approach to cost estimates

The approach to estimating the cost of options is presented in Volume 6, Appendix J. In the Appendix, unit cost rates have been presented in mid-2004 prices. For the Main Report however, all prices have been updated to June 2005 on the basis of the Retail Prices Index involving an increase of 3% throughout.

The costs of the various options considered by this Strategy are discussed below. Whole life costs have been estimated for a 100 year period to cover the anticipated life of the structures and are presented as a Present Value (PV) cost.

The costs of options have been phased to reflect the anticipated time required to carry out feasibility studies, detailed design and construction. It has been assumed that no capital spend will commence until the financial year 2006/2007 in line with the Agency's Southern Region 10 year plan.

In the Do Nothing scenario all spending will cease on operation and maintenance of the existing defences. No new defences or works would be carried out. Therefore, there is no cost attributable to the Do Nothing scenario.

Cost estimates have been derived using unit costs for construction items built up from a number of schemes involving similar construction to the options in this study. Sources of cost data include:

- Four projects currently under construction
- Nine pre-feasibility / feasibility studies
- Two strategy studies
- Four regional unit cost databases

The cost estimates presented include an addition of 60% for optimism bias in accordance with FCDPAG3 Supplementary Note to Operating Authorities, March 2003.

6.1.2 Operation and Maintenance and Renewal Costs

Maintenance costs for the financial year 2000/2001, presented in the Medway Asset survey Report (Halcrow, 2001), have been indexed to mid-2005 prices using the Retail Prices Index and used to estimate the PV maintenance costs. The Medway costs include Leigh Barrier maintenance costs together with the Medway Navigation costs which are attributable to flood defence. A breakdown of the maintenance cost for the Middle Medway catchment is presented in Volume 6. The annual cost of maintenance for the Do

Minimum option has been estimated at £426,832 per year, with a PV cost of £16.6 million over 100 years.

Maintenance and operational costs for the intervention options have been estimated over a 100 year period to cover the anticipated design life of the storage reservoirs and local defences. The operation and maintenance allowance has been presented as an annual average of 1.5% of the capital cost of each option.

Renewal costs have been applied as follows:

- Mechanical and electrical works: 50% of the capital cost of the mechanical and electrical work every 30 years
- Civil works upgrades: 5% of the capital construction costs every 30 years

The application of capital costs for mechanical and electrical works and civil works upgrades is based on actual recorded Leigh Barrier operational costs and on projects of similar size and application.

Optimism bias of 60% has been applied to all operation and maintenance and renewal costs, apart from the Do Minimum operation and maintenance costs where a reduced value of 30% has been applied.

Not all the costs are the responsibility of the Agency. Riparian owners should be encouraged to take responsibility for the reaches of river and assets which lie within their property.

6.1.3 Capital Cost of Options

The capital costs for the strategic options have been calculated and presented in Volume 6, Appendix J. These costs have been used in the economic analysis for different options and standards of protection. A summary of the capital, annual maintenance and total PV costs (including renewal costs) associated with strategic storage options is presented in Table 6.1.

Table 6.1 Strategic Storage Option Costs

Option	Capital & Agency Costs with Optimism Bias¹ (£k)	Annual Maintenance Cost (£k)	Total PV Cost ² (£k)
3	12,773	717	32,812
4	3,713	599	21,162
5	12,229	701	32,331
6	9,772	672	29,374
7	20,057	817	42,374

Note: (1) - Represents the initial development, design and construction phase capital costs for the scheme

(2) – Total Strategy life cost, including renewals

Local defences would comprise either reinforced concrete flood walls, with steel sheet piled foundations where constructed along river banks, or flood embankments. A summary of the capital, maintenance and PV costs associated with local defence options is presented in Table 6.2.

Table 6.2 Local Defence Option Costs

Option	Capital & Agency Costs with Optimism Bias¹ (£k)	Annual Maintenance (£k)	PV Cost (£k)
14	8,242	647	27,471
17	2,823	586	20,250
18	18,531	798	40,876
19	8,620	651	27,973

Note: (1) - Represents the initial development, design and construction phase capital costs for the scheme

6.1.4 Capital Cost of Combined Options

A summary table of the cost of combined options incorporating both storage and local defences is presented below.

Table 6.3 Combined Flood Defence Option Costs

Option	Capital & Agency Costs with Optimism Bias¹ (£k)	Annual Maintenance (£k)	PV Cost (£k)
8	16,485	761	37,403
9	13,485	716	33,966
10	29,829	933	55,177
11	18,540	778	40,330
16	6,391	626	24,745

Note: (1) - Represents the initial development, design and construction phase capital costs for the scheme

6.2 Benefits of Options

6.2.1 Approach to flood damage assessment

The evaluation of flood damages is based on the residential and non-residential property flood damage values obtained from the Flood Hazard Research Centre's Multi Coloured Manual (MCM) (FHRC, 2002) and the property type recorded in the National Property Database (NPD). Costs for emergency services have also been included in accordance with MCM as 10.7% of the direct property damage. Other damages including transport, clean-up, and indirect damages have not been evaluated, thus the evaluation is conservative. Similarly, below threshold flood damage has not been evaluated and the threshold level has been taken as ground level, an assumption tested during the sensitivity analysis. The level of accuracy of the overall damage assessment in this strategy study does not warrant any explicit evaluation of these damages at this stage. However it will be important to consider such damages explicitly in any subsequent feasibility level studies which may arise out of this strategy study. For the purposes of the Strategy this has been assessed in a sensitivity analysis.

The damage assessment has been carried out within a GIS framework using elements of the Modelling Decision Support Framework (MDSF) developed for use in the preparation of Catchment Flood Management Plans. The property data within MDSF has been updated since its use for the CFMP, which has resulted in a significant number of additional properties being added.

The ground levels in the flood plain were obtained on a 10m grid from the photogrammetry (Medway catchment) and LiDAR (Beult and Teise catchments) surveys with an assessed level of accuracy of $\pm 0.1\text{m}$ and $\pm 0.25\text{m}$ respectively.

The National Property Database (NPD) has been used to input property data into the MDSF. Adjustments were made to exclude any properties within the flood risk area which were known to be flood-proofed or not sensitive to flooding as advised by EA Area staff. The property threshold level was assumed to be the same as the ground level in the relevant 10 m grid.

The values given in the MCM are based on field survey carried out in mid 2002. To bring the damages to the same base date as the costs, the values given in MCM have been increased by 4.9%, as given in the Appendix, representing the change in Retail Prices Index from May 2002 to July 2004. For the Main Report however, all values have been updated to June 2005 on the basis of the retail Prices Index involving an increase of 3% throughout.

Damages for each property and the numbers of properties lying within the flood risk area for each option have been determined by the MDSF for annual probability events of 20%, 10%, 4%, 1% and 0.5%. MDSF assumes that there is no continuation of the gradient of the damages curve to infinity (i.e. infinity damages = 0.5 % annual probability event

damages) to determine the total average annual damages for each property. This is a conservative assumption.

Where necessary, the Average Annual Damages (AAD) for non-residential properties have been capped to the write-off value of a property whenever this would be exceeded. The AAD are summed within MDSF to provide a total for the Middle Medway Strategy area, these are presented in Volume 6. The costs and benefits are calculated for the 100 year Strategy period and discounted to Present Value at the following Treasury variable discount rates:

Time period (years)	% Discount
0 – 30	3.5
30 – 75	3.0
75 +	2.5

Those properties contributing to the top 1 percentile of the total damages were selected for scrutiny in accordance with recommended guidance (Halcrow Group & JB Chatterton Associates, 2004) against the following criteria:

- the property type assigned by National Property Database (which is based upon AddressPoint and Focus data) was reasonable
- AAD predicted by MDSF was compared with a manual calculation using FCDPAG3 spreadsheets
- If capping was applicable this was being applied by MDSF

Any single property that contributed significantly (after capping) was further reviewed to ensure that the capping value allocated was consistent with known information regarding the particulars of the property and its assigned type. This review gave confidence in the outputs from MDSF.

In principle, the analysis described above could have been carried out without the use of the MDSF. Several factors contributed to the decision to adopt this package for the flood damage assessment. There are over 9,500 properties in the Indicative Floodplain within the study area. In the 1% Do Nothing case, over 1,100 of these are flooded. The MDSF provides data on the locations of all these properties together with a classification system allowing depth-damage curves to be associated with each property. Furthermore, it computes the annual average damages from a range of different probability flood events taking into account any need to cap the damages.

Had the MDSF not been used, it would still have been necessary to adopt a GIS-based approach. This would have relied on the same data that was used in the development of the MDSF: AddressPoint and the Focus database for commercial properties. This would amount to re-inventing the National Property Database. The damage calculations could

have been carried out on PAG spreadsheets. This would have required the identification of properties flooded in a GIS environment, the exporting of the results to spreadsheets for each flood event tested, the collation of the data for the different flood probabilities, association of the properties with the property types and the identification of the appropriate depth-damage curves, leading to the calculation of flood damage. In this process, floor areas would have been required for the commercial properties and this data is not readily available. This alternative process involving extensive data exchange between different packages would have been onerous and time consuming and would have significantly increased the cost of the study. In principle, it could have provided more accurate results by making fuller use of the range of depth-damage curves available, provided that floor areas were known.

Ultimately, both approaches make use of the MCM and when applied to a wide scale problem, in which thousands of properties are potentially at risk, then the benefits of using a package where the process is seamless becomes apparent and the scope for the introduction of human error in data transfer, file naming, inserting data into the correct place on a spreadsheet, etc is minimised. Had the analysis been carried out on PAG spreadsheets, it is unlikely that the results would be significantly different or that a different ranking of options would have resulted. The MDSF is an appropriate tool for use at catchment scale with large numbers of properties at risk and for choosing between options. The detailed approach based upon PAG spreadsheets is more appropriate for use in feasibility studies or with smaller numbers of properties involved and options to be compared.

6.2.2 Flood risk areas benefiting

To assist the decision making process, the impact of the options on the flood risk areas and their contribution to flood risk management, where the CFMP policy is to reduce flood risk, is indicated in terms of the number of properties removed from existing flood risk in the 4% and 1% annual probability flood events in Table 6.4.

Table 6.4 Properties removed from current flood risk in a 1% annual probability flood (properties removed in a 4% annual probability flood shown in brackets)

Option		Collier Street	Paddock Wood	Laddingford	Yalding	Tonbridge	East Peckham/ Little Mill	Teston/ East Farleigh	Maidstone	Outside study area	Other Flood Risk Areas	Total
3	Online storage on the Eden upstream of Edenbridge		2 (0)	32 (0)	15 (13)	75 (1)	26 (11)	2 (1)	33 (16)	89 (4)	-1 (0)	273 (49)
4	Online storage at the Leigh Barrier			28 (0)	13 (13)	79 (2)	11 (10)	2 (0)	32 (16)	0 (0)	-26 (-19)	139 (22)
5	Online storage on the Teise upstream of Lamberhurst with online storage on the Bourne upstream of Little Mill	8 (11)					-3 (5)	-4 (0)	-73 (-1)	0 (0)	8 (2)	-66 (16)
6	Online storage on the Beult upstream of Stile Bridge	10 (4)		38 (7)	21 (49)		9 (3)	3 (1)	39 (29)	0 (0)	-8 (-26)	112 (67)
7	Offline storage on the Teise	33 (30)		34 (0)	9 (14)		4 (3)		23 (17)	0 (0)	11 (5)	114 (69)

Option		Collier Street	Paddock Wood	Laddingford	Yalding	Tonbridge	East Peckham/ Little Mill	Teston/ East Farleigh	Maidstone	Outside study area	Other Flood Risk Areas	Total
	upstream of Great Cheveney											
8	Edenbridge with Leigh Barrier		2	41	28 (54)	113 (3)	32 (22)	4 (1)	50 (28)	89 (4)	-24 (8)	335 (119)
9	Leigh Barrier with Stile Bridge	10 (4)	2	53 (7)	38 (60)	79 (1)	25 (20)	3 (1)	56 (29)	0 (0)	-34 (-45)	232 (77)
10	Great Cheveney with Stile Bridge	37		59 (12)	38 (77)		9 (4)	3 (4)	57 (29)	0 (0)	7 (-18)	210 (139)
11	Stile Bridge with mitigation at Staplehurst	10 (4)		38 (7)	21 (49)		9 (3)	3 (1)	39 (29)	0 (0)	16 (10)	136 (103)
14	Local defences at Yalding (1 % annual probability of flooding)				100 (94)					0 (0)	-1 (0)	99 (94)
16	Leigh Barrier with mitigation at Leigh			28 (0)	13 (13)	79 (2)	11 (10)	2 (0)	32 (16)	0 (0)	0 (7)	165 (48)
17	Local defences	46 (23)									-1 (0)	45 (23)

Option		Collier Street	Paddock Wood	Laddingford	Yalding	Tonbridge	East Peckham/ Little Mill	Teston/ East Farleigh	Maidstone	Outside study area	Other Flood Risk Areas	Total
	at Collier Street (1 % annual probability of flooding)											
18	Local defences at Maidstone (1 % annual probability of flooding)								93 (32)		-1 (0)	92 (32)
19	Local defences at East Peckham (1 % annual probability of flooding)						100 (82)	-1 (0)			-1 (0)	98 (82)

The modelling of offline storage on the Teise indicates that significant benefits would be experienced downstream in Collier Street, Laddingford, Maidstone and Yalding. However, the operation of this storage may actually delay peak flows from the Teise so that they coincide with peak flows from the Medway and the Beult resulting in increased damages downstream. This was not found with the storm used for modelling, however the benefits predicted by modelling off line storage at Great Cheveney may be overstated for this option alone and should be viewed with caution.

Modelling of local storage on the Teise and Bourne in combination, indicates that limited benefits would be experienced immediately downstream of each storage reservoir. However, storage on the Bourne had an adverse impact on areas further downstream on the Medway because of the delay in flood peak. Local storage would not provide significant catchment wide benefits and has not been taken forward as part of the preferred strategy. However, these schemes would provide some benefits locally in Lamberhurst and Little Mill and consideration should be given to further study including mitigation of adverse impacts, possibly funded from local levy.

Local defences provide benefits within the immediate area of their construction and the modelling carried out for the CFMP did not indicate any noticeable adverse impacts downstream arising from their installation. However, it is recommended that as part of more detailed studies, the possible need for local compensation storage be investigated along with their potential wider impacts.

Across the catchment around 70% of the properties which are removed from flooding by the options considered are residential properties.

7. CHOICE OF PREFERRED OPTION

7.1 Decision Making Criteria

As discussed in earlier sections, shortlisting of options was carried out using a multi-criteria analysis. The final selection of the options comprising the preferred strategy is made in accordance with FCDPAG series of documents and is primarily based on the economic effectiveness and environmental acceptability. The Defra priority score will influence the timing and order of implementation of the components of the strategy.

The strategic options which can benefit more than one flood risk area have been modelled and their economic effectiveness assessed. A single standard of protection cannot be stated for the strategic storage options, as they each provide improvement to more than one flood risk area. In most cases, the standard of protection provided by a single strategic storage option differs in each flood risk area. However the total number of properties removed from existing flood risk in a 4% and 1% annual probability event is stated for each option.

The range of schemes evaluated in detail for the strategy include four strategic storage options, one local storage option and four local defence options. To determine the preferred combination of these nine separate schemes a specific methodology has been formulated based on the principles of the FCDPAG3 decision rule process. This is described in section 7.2 where summary tables of the economic analysis in FCDPAG3 format are presented.

The criterion for option selection in accordance with FCDPAG3 is as follows:

- Where the standard of protection, with the option being evaluated, is below the indicative standard of protection the incremental benefit-cost ratio must be robustly greater than 1 (generally taken as 1.5)
- Where the standard of protection lies within the indicative standard of protection the incremental benefit-cost ratio must be greater than 3

Where strategic measures are uneconomic or provide no benefit to a particular area and local defences appear unlikely to be viable, the focus of the strategy will be on assisting the residents to improve their own management of flood risk.

7.2 Evaluation of Options

7.2.1 Step 1

All options were analysed individually based on the catchment wide Do Nothing damages. The benefit-cost ratio for each option was determined together with the incremental benefit-cost ratio with respect to the Do Minimum option for the whole strategy area.

For convenience the benefit-cost tables are presented by the location of the schemes on a sub-catchment basis for the Medway (Table 7.1) and the two main tributaries, the Beult (Table 7.2) and the Teise (Table 7.3).

It should be noted that benefits from the strategic storage schemes are obtained across one, two or sometimes all three of the sub-catchments, thus Options 1 (Do Nothing) and 2 (Do Minimum) are common for all three tables.

Table 7.1 Proposed options on the River Medway

	Option 1: Do Nothing	Option 2: Do Minimum	Option 3: Edenbridge Storage	Option 4 Leigh increased storage	Option 16: Leigh increased storage with local protection to properties affected upstream	Option 18 Stand Alone protection at Maidstone 1% SoP	Option 19: Stand Alone protection at East Peckham 1% SoP
PV costs PVc	0	17,420	33,652	22,010	25,590	41,712	28,817
PV damage PVd	431,369	227,936	182,648	190,362	189,101	198,033	210,488
PV damage avoided		203,432	248,721	241,008	242,268	233,336	220,881
Total PV benefits PVb		203,432	248,721	241,008	242,268	233,336	220,881
Net Present Value NPV		185,984	215,069	218,998	216,678	191,624	192,063
Average benefit/cost ratio		11.7	7.4	11.0	9.5	5.6	7.7
Incremental benefit/cost ratio			2.8	8.2	4.8	1.2	1.5
Properties protected 4%			49	22	48	32	82
Properties protected 1%			273	139	165	92	98

Note: Costs in £1000's

Table 7.2 Proposed development options on the River Beult

	Option 1: Do Nothing	Option 2: Do Minimum	Option 6: Stile Bridge Storage	Option 11: Stile Bridge storage with local protection to properties affected upstream (Staplehurst)	Option 14 : Yalding 1% SoP
PV costs PVc	0	17,420	30,217	41,168	28,316
PV damage PVd	431,369	227,936	207,797	183,095	198,859
PV damage avoided		203,432	223,571	248,274	232,510
Total PV benefits PVb		203,432	223,571	248,274	232,510
Net Present Value NPV		186,013	193,354	207,106	204,193
Average benefit/cost ratio		11.7	7.4	6.1	8.2
Incremental benefit/cost ratio			1.6	1.9	2.7
Properties protected 4%			67	103	94
Properties protected 1%			112	136	99

Note: Costs in £1000's

Table 7.3 Proposed development options on the River Teise

	Option 1: Do Nothing	Option 2: Do Minimum	Option 5: Lamberhurst and Little Mill	Option 7: Great Cheveney Storage	Option 17: Stand Alone protection at Collier Street 1% SoP
PV costs PVc	0	17,420	33,172	43,211	21,097
PV damage PVd	431,369	227,936	229,753	203,630	223,658
PV damage avoided		203,432	201,616	227,739	207,711
Total PV benefits PVb		203,432	201,616	227,739	207,711
Net Present Value NPV		186,013	168,443	184,529	186,613
Average benefit/cost ratio		11.7	6.1	5.3	9.8
Incremental benefit/cost ratio			-0.1	0.9	1.2
Properties protected 4%			16	69	23
Properties protected 1%			-66	114	45

Note: Costs in £1000's

The modelling and economic evaluation suggests that the combined local storage schemes of Lamberhurst and Little Mill (Option 5) may have an adverse impact on other areas of the catchment. The option of a flood storage scheme at Little Mill appeared to be the main contributor to the adverse impacts identified on the Medway downstream. In contrast, the storage at Lamberhurst appears to have a much less significant effect. The construction of a flood storage scheme at Lamberhurst on a smaller scale as envisaged by the Upper Medway IDB could be expected to have a correspondingly smaller effect.

The economic analysis of this combined option suggests that it is not economically viable. However this result should be treated with caution as optimising the schemes individually at a local scale might result in a different conclusion. Any such local storage schemes should be evaluated with a view to their wider impacts to confirm that either they will have no adverse effect on any other part of the catchment or that appropriate mitigation measures can be provided. Option 5 was not considered further in the development of the strategy. All other options were taken forward.

7.2.2 Step 2

The first individual scheme is selected on the following basis:

- Strategic storage schemes are preferred over local defence schemes where economic parameters are similar.
- All storage options are required to have mitigation measures to ensure there are no additional damages caused to other properties. Options 4 and 6, where properties upstream are affected (and not protected), were therefore discarded
- The option with the highest benefit-cost ratio and highest incremental benefit-cost ratio is preferred
- The option with a significantly greater number of properties brought into the indicative range of protection is preferred where economic parameters are similar

Table 7.4 summarises the benefit-cost ratio and incremental benefit-cost ratio analysis as well as the number of properties protected for the strategic storage options.

Table 7.4 Summary of key economic parameters and properties protected for strategic storage options

Option	Average benefit/cost ratio	Incremental benefit/cost ratio	Properties protected 4% AP	Properties protected 1% AP
Option 3 – Edenbridge Storage	7.4	2.8	49	273
Option 16 – Leigh increased storage with mitigation	9.5	4.8	48	165
Option 11 – Stile Bridge storage with mitigation	6.0	1.9	103	136
Option 7 – Great Cheveney Storage	5.3	0.9	69	114

Based on the selection criteria Option 16 (Leigh Barrier increased storage with mitigation) was selected as the first scheme. Its benefit-cost ratio and incremental benefit-cost ratio are significantly better than the other strategic storage options.

7.2.3 Step 3

The other three strategic storage options were analysed in addition to Option 16 already selected. The criteria for selection of the second scheme are the same as Step 2, although with the decision to include the next scheme based on the incremental benefit-cost ratio. Combined strategic storage options have been modelled to ensure that there is no duplication of benefits.

Table 7.5 illustrates the benefit-cost analysis of options 3, 11 and 7 in combination with Option 16. Incremental benefit-cost ratios are calculated with respect to Option 16.

Table 7.5 Benefit cost table for Option 16 with further strategic storage

	Option 1 – Do Nothing	Option 2 – Do Minimum	Option 16 – Leigh increased storage with mitigation	Option 16+3 – Leigh increased storage with mitigation and Edenbridge	Option 16+11 – Leigh increased storage with mitigation and Stile Bridge with mitigation	Option 16+7 – Leigh increased storage with mitigation and Great Cheveney
PV costs PVc	0	17,420	25,590	41,822	49,338	51,381
PV damage PVd	431,369	227,936	189,101	152,191	153,891	165,809
PV damage avoided		203,432	242,268	279,177	277,478	265,559
Total PV benefits PVb		203,432	242,268	279,177	277,478	265,559
Net Present Value NPV		186,013	216,678	237,355	228,139	214,178
Average benefit/cost ratio		11.7	9.5	6.7	5.6	5.2
Incremental benefit/cost ratio				2.3	1.5	0.9
Properties protected 4%			48	145	139	110
Properties protected 1%			165	361	282	270

Note: Costs in £1000's

Option 3 (in addition to Option 16) provides an incremental benefit-cost ratio of 2.3 with respect to Option 16. Over 350 properties are provided with protection in a 1% AP flood event. This option provides a standard of protection of approximately 4% AP to East Peckham and less than this to Yalding. Given that Yalding and East Peckham would not, with this option, attained their respective indicative standard of protection, the selection of Option 16 with Option 3 complies with the FCDPAG3 decision rules process.

Option 7, Great Cheveney, has an incremental benefit-cost ratio of less than 1. This option does not meet the FCDPAG3 decision rules and was therefore excluded from further evaluation.

7.2.4 Step 4

The next step is the analysis of the remaining storage option, Option 11, in addition to Option 16+3 which has already been selected. The criteria for selection of the next strategic storage scheme are the same as for Step 3. Table 7.6 illustrates the benefit-cost analysis of Option 11 with Combined Option 16+3.

Table 7.6 Benefit cost table for Option 16+3 with further strategic storage

	Option 1 – Do Nothing	Option 2 – Do Minimum	Option 16 – Leigh increased storage with mitigation	Options 16 & 3 – Leigh increased storage with mitigation and Edenbridge	Options 16, 3 & 11 – Leigh increased storage with mitigation, Edenbridge and Stile Bridge with mitigation
PV costs PVc	0	17,420	25,590	41,822	65,571
PV damage PVd	431,369	227,936	189,101	152,191	124,727
PV damage avoided		203,432	242,268	279,177	306,642
Total PV benefits PVb		203,432	242,268	279,177	306,642
Net Present Value NPV		186,013	216,678	237,355	241,072
Average benefit/cost ratio		11.7	9.5	6.7	4.7
Incremental benefit/cost ratio					1.2
Properties protected 4%			48	145	200
Properties protected 1%			165	361	450

Note: Costs in £1000's

The addition of Option 11 achieves an incremental benefit-cost ratio of 1.2 with respect to Option 16+3. This is just below the minimum value required by the FCDPAG3 decision rules of 1.5, thus Option 11 is not selected.

However it will be considered in sensitivity analysis to evaluate whether further investigation would be beneficial in particular to accommodate future changes in the catchment.

7.2.5 Step 5

Local defence options are considered as additional schemes with Combined Option 16+3. Costs for the local defence options have been estimated to vary between 70% and 100% of the cost of the local defences with no upstream storage depending on the number of properties in each location already protected by the strategic storage scheme. For example at Yalding 90% of the cost of the stand alone defence options has been taken, where the total number of properties protected increases from 28 (strategic storage alone) to 100.

Table 7.7 illustrates the benefit-cost analysis.

Table 7.7 Benefit cost table for local defence options with strategic storage Option 16 and 3

	Option1 – Do Nothing	Option 2 – Do Minimum	Option 16 & 3 – Leigh increased storage with mitigation and Edenbridge	Option 16, 3 & 14 – Leigh increased storage with mitigation and Edenbridge and local defences at Yalding	Option 16, 3 & 17– Leigh increased storage with mitigation and Edenbridge and local defences at Collier Street	Option 16, 3 & 18– Leigh increased storage with mitigation and Edenbridge and local defences at Maidstone	Option 16,3 & 19– Leigh increased storage with mitigation and Edenbridge and local defences at East Peckham
PV costs PVc	0	17,420	41,822	51,629	45,500	58,827	50,941
PV damage PVd	431,369	227,936	152,191	131,256	147,913	138,539	140,441
PV damage avoided		203,432	279,177	300,113	283,456	292,830	290,929
Total PV benefits PVb		203,432	279,177	300,113	283,456	292,830	290,929
Net Present Value NPV		186,013	237,355	248,484	237,956	234,003	239,988
Average benefit/cost ratio		11.7	6.7	5.8	6.2	5.0	5.7
Incremental benefit/cost ratio				2.1	1.2	0.8	1.3
Properties protected 4%			145	185	168	149	205
Properties protected 1%			361	433	407	404	429

Note: Costs in £1000's

Option 16+3+14 (Yalding local defences) has the highest incremental benefit-cost ratio of 2.1. This is robustly greater than 1.0 and thus selection of this option complies with FCDPAG3 since Option 14 is required to bring Yalding to within the indicative standard of protection. Similarly options 16+3+17 (Collier Street local defences) and 16+3+19 (East Peckham local defences) have incremental benefit cost ratios of 1.2 and 1.3 respectively and can also be selected for similar reasons. Option 16+3+18

(Maidstone local defences) cannot be selected since the incremental benefit-cost ratio is less than 1.0.

7.2.6 Step 6

Table 7.8 presents the benefit-cost analysis for the preferred strategy for the Combined Option 16+3+14+17+19. The incremental benefit-cost ratio is calculated with respect to the Do Minimum option.

Table 7.8 Benefit cost table for preferred strategy

	Option 1 – Do Nothing	Option 2 – Do Minimum	Option 16+3+14+17+19 – Leigh increased storage with mitigation and Edenbridge and local defences at Yalding, Collier Street and East Peckham
PV costs PVc	0	17,420	64,424
PV damage PVd	431,369	227,936	115,226
PV damage avoided		203,432	316,142
Total PV benefits PVb		203,432	316,142
Net Present Value NPV		186,013	251,718
Average benefit/cost ratio		11.7	4.9
Incremental benefit/cost ratio			2.4
Properties protected 4%			268
Properties protected 1%			547

Note: Costs in £1000's

The final preferred scheme is the Combined Option of Leigh Barrier increased storage (with mitigation), Edenbridge storage with local defences in Yalding, Collier Street and East Peckham (Options 16+3+14+17+19). A benefit-cost ratio of 4.9 and an incremental benefit-cost ratio of 2.4 with respect to the Do Minimum Option has been obtained for this combination scheme. This project protects approximately 547 properties to a 1% AP standard of protection or greater. Further analysis at the Project Appraisal Report stage will be required to confirm if the standard of protection for the local defences can be improved further.

7.2.7 Phasing of works

The phasing of the works was reviewed by evaluating whether implementing Yalding local defences ahead of Edenbridge storage would result in a higher benefit-cost ratio. The benefit cost-ratio obtained by implementing 16+14 (Yalding local defences ahead of Edenbridge storage) is 7.6 compared with 6.8 for implementing in order 16+3. The two remaining local defence schemes are then implemented in order of descending benefit-cost ratio.

The preferred phasing of works is as follows:

- **Leigh Barrier increased storage with mitigation**; proceed with PAR
- **Yalding local defences**; proceed with further study to see if the project risks can be reduced to lower scheme costs, to review the benefits in detail and determine the optimum standard of protection
- **Edenbridge storage**; proceed with further study to evaluate the alternative sites, to see if the project risks can be reduced to lower scheme costs and to review the benefits in detail
- **East Peckham local defences**; proceed with further study to see if the project risks can be reduced to lower scheme costs, to review the benefits in detail and determine the optimum standard of protection
- **Collier Street local defences**; proceed with further study to see if the project risks can be reduced to lower scheme costs, to review the benefits in detail and determine the optimum standard of protection

Further evaluation of the Stile Bridge storage will also be carried out in sensitivity testing to evaluate whether further study is also warranted on this option.

7.3 Risk assessment

The principal risks which affect the viability of the strategic and local protection options arise in the following areas:

- Flood risk assessment
- Property thresholds
- Damage assessment
- Cost estimation
- Environmental risks

A financial risk assessment for the Yalding local defences component of the preferred strategy is included in more detail in Section 8.9.

7.3.1 Flood risk assessment

The hydraulic model developed as part of this strategy provides a good overall representation of the effect of flooding over the whole Middle Medway area.

However when considering a specific location there are two main sources of uncertainty:

- The flood hydrographs were selected as a reasonable representation of behaviour across the catchment but the critical storm at a particular location may differ particularly in duration, but also in peak. This issue has been recognised as being relatively pronounced at Lamberhurst and the flood levels adjusted accordingly. However similar issues may also affect predicted flood levels at other locations, but to a lesser extent.
- In the calibration and verification runs the difference between recorded and modelled levels is small, with an average value of 0.06m from 43 locations in the October 2000 flood, and a standard deviation of $\pm 0.24\text{m}$. The true error is likely to be less than this however, as the recorded flood levels are themselves subject to error and arise from three different sources. Further, flooding at particular hotspots is exacerbated by tributaries which are not currently included in the model. When evaluating in detail a specific location, for example at feasibility study, additions would be made to the model and the accuracy of calibration at that location would be improved.

The impact of this has been evaluated by sensitivity testing on water levels.

7.3.2 Property thresholds

As indicated in Section 3 the property threshold level has been taken as the ground level from the survey plans. No field survey check has been made on property threshold levels. On average across the Middle Medway catchment the results are likely to be reasonable. However at individual locations there could be significant differences.

The impact of this has been evaluated by sensitivity testing on water levels and on benefits.

7.3.3 Damage assessment

For residential properties no distinction between property types has been made. For commercial properties no verification of business type or individual assessment of floor area has been made.

The impact of this has been evaluated by sensitivity testing on the benefits.

7.3.4 Cost estimation

The cost estimates are based on a broad brush assessment of the principal quantities and unit rates. An optimism bias of 60% has been applied to all capital and recurrent cost estimates.

The impact of this has been evaluated by sensitivity testing on the costs.

7.3.5 Environmental risks

The Strategic Environmental Assessment is a high level assessment, which identifies the major environmental issues. The assessment of the options has been at the scoping level. While the key issues will have been identified, no site specific environmental surveys have been carried out. Where major issues have been identified some allowance for environmental mitigation has been made in the cost estimates. Construction of Stile Bridge storage reservoir within a SSSI is a particular risk. However, the SSSI is currently in an unfavourable condition presenting an opportunity for enhancement.

7.4 Sensitivity testing

To evaluate the impact of the above risks the following sensitivity testing has been carried out:

- Varying the cost by $\pm 20\%$, this represents the impact of uncertainty in the cost estimates over and above that provided by optimism bias
- Varying the benefits by $\pm 20\%$, this represents the impact of uncertainty in property threshold levels and verification of property types and floor area for commercial properties
- Varying the water levels by $+ 200\text{mm}$ for the Do Minimum, this test represents the impact of underestimating potential benefits resulting from both the flood modelling and error in the Digital Terrain Model (DTM). This has been implemented in MDSF by adding 200mm to the flood depth grids input from the hydraulic model
- Varying the water levels by $- 200\text{mm}$ for Do Minimum; Edenbridge; Leigh barrier; Edenbridge with Leigh Barrier; and Stile Bridge options to assess the impact of overestimating benefits resulting from the flood modelling, DTM error and property threshold levels. This has been implemented in MDSF by subtracting 200mm from the flood depth grids input from the hydraulic model.

The tests identified above for evaluating the sensitivity to water level variations are for this purpose extreme. Any water level modelling inaccuracies are likely to be random or at worst localised. The tests provided here raise or lower water levels at all locations. As such the results of the tests provide an upper bound to the impact of modelling errors on the flood damage assessment.

The tests on variation of water level are also used to provide an indication of sensitivity to variation in property thresholds. Similar considerations apply. The accuracy of the DTM is in the order of $\pm 0.2\text{m}$ depending upon location. The accuracy obtainable from LiDAR may in principle be higher but is subject to the adequacy of the algorithms applied to remove buildings, trees, hedges, etc to produce a bare earth DTM. In reality the errors in ground level will be random from location to location, whereas the test provides a global upwards or downwards shift. With regard to the accuracy of the ground model, this test therefore presents an upper bound on the impact on flood damage assessment.

Residential property thresholds are variable and a typical value of 0.15m above ground level is often quoted, however commercial property thresholds are often at ground level to allow for vehicular access. Given that commercial properties often contribute a large proportion of flood damages the test of globally reducing flood depth as presented here provide an upper bound to the sensitivity of flood damage to this parameter.

The global sensitivity tests on costs and benefits have been applied to all options as shown in Volume 6, Appendix K and are summarised in Table 7.9 for the strategic storage options evaluated in Section 7.2.

Table 7.9 Sensitivity testing on selection of first strategic storage option

Option	Benefit / Cost Ratio				
	Base	Case 1: Costs + 20%	Case 2: Costs - 20%	Case 3: Benefits + 20%	Case 4: Benefits - 20%
2	11.7	-	-	-	-
3	7.4	6.7	8.2	7.7	7.1
16	9.5	8.9	10.1	9.8	9.2
11	6.0	5.4	6.8	6.2	5.8
7	5.3	4.7	6.0	5.4	5.2

The benefit-cost ratios for all scheme options remains well above unity varying from a minimum of 4.7 to a maximum of 10.1 demonstrating a robust economic case. The selected option (Option 16) has a higher minimum benefit-cost ratio than the outcome of these sensitivity tests on all of the other options. The selection of Option 16 (Leigh barrier increased storage with mitigation) is robust.

The sensitivity of the selection of Option 3 (Edenbridge) ahead of Option 11 (Stile Bridge) as the second strategic storage scheme is illustrated in Table 7.10.

Table 7.10 Sensitivity testing of selection of the second strategic storage scheme

Option	Benefit -Cost Ratio (Incremental Benefit-Cost ratio)				
	Base	Case 1: Costs + 20%	Case 2: Costs - 20%	Case 3: Benefits + 20%	Case 4: Benefits - 20%
16	9.5	-	-	-	-
16+3	6.7 (2.3)	6.2 (2.1)	7.2 (2.5)	6.9 (2.3)	6.5 (2.3)
16+11	5.6 (1.5)	5.1 (1.3)	6.2 (1.7)	5.8 (1.5)	5.5 (1.5)
16+7	5.2 (0.9)	4.7 (0.8)	5.7 (1.0)	5.3 (0.8)	5.1 (1.0)

The selected option (Option 16+3 – Leigh Barrier increased storage with mitigation and Edenbridge) has an equal or higher benefit-cost ratio than the other options under all scenarios. Option 16+3 also has a minimum incremental benefit-cost ratio of 2.1 under all scenarios demonstrating that the selection is economically robust.

Option 16+7 (Leigh Barrier increased storage with mitigation and Great Cheveney) achieves a maximum incremental benefit-cost ratio of 1.0 under the most favourable scenario, which remains well below the selection criterion value of 1.5. This confirms the rejection of Great Cheveney from further consideration.

The sensitivity of the selection of a third strategic storage scheme is illustrated in Table 7.11.

Table 7.11 Sensitivity testing of selection of the third strategic storage scheme

Option	Benefit -Cost Ratio (Incremental Benefit-Cost ratio)				
	Base	Case 1: Costs + 20%	Case 2: Costs - 20%	Case 3: Benefits + 20%	Case 4: Benefits - 20%
16+3	6.7	-	-	-	-
16+3+11	4.7 (1.2)	4.4 (1.0)	5.0 (1.4)	4.8 (1.4)	4.6 (0.9)

Under only one scenario does the incremental benefit-cost ratio reduce below 1.0 and it achieves a value of 1.4 where costs are reduced by 20%. The costs of Option 11 are strongly influenced by the cost of the mitigation measures upstream. At this stage the assessment of the impact of increased flooding upstream has been conservative and the costs could certainly reduce by 20% when threshold surveys are carried out. Thus Stile Bridge storage should remain under consideration as a possible option but it will not be included in the preferred strategy as a confirmed component at this stage. However, provision for a pre-feasibility study to improve the accuracy of estimated benefits and costs is included as part of the preferred strategy. This will provide an opportunity for possible inclusion in later strategy reviews.

The sensitivity of the selection of the local defence options is illustrated in Table 7.12

Table 7.12 Sensitivity testing of selection of the local defence options

Option	Benefit -Cost Ratio (Incremental Benefit-Cost ratio)				
	Base	Case 1: Costs + 20%	Case 2: Costs - 20%	Case 3: Benefits + 20%	Case 4: Benefits - 20%
16+3	6.7	-	-	-	-
16+3+14	5.8 (2.1)	5.6 (1.8)	6.0 (2.7)	5.9 (2.6)	5.7 (1.7)
16+3+17	6.2 (1.2)	6.1 (1.0)	6.3 (1.5)	6.2 (1.4)	6.2 (0.9)
16+3+18	5.0 (0.8)	4.7 (0.7)	5.3 (1.0)	5.0 (1.0)	4.9 (0.6)
16+3+19	5.7 (1.3)	5.5 (1.1)	5.9 (1.6)	5.8 (1.5)	5.7 (1.0)

The selection of Yalding (Option 14) and East Peckham (Option 19) local defences in addition to the strategic storage schemes (Option 16+3), is economically robust under all scenarios with the incremental benefit-cost ratios remaining above 1.0.

Local defences at Collier Street (Option 17) achieves a maximum benefit-cost ratio of 1.5 with a minimum of 0.9 for these scenarios. The inclusion of these scheme in the preferred strategy for further investigation is warranted but the economic case should be kept under review.

The rejection of Maidstone local defences (Option 18) is also confirmed with the incremental benefit-cost ratio varying between 0.6 and 1.0 under the range of scenarios tested.

The impact of varying the water levels by $\pm 200\text{mm}$ on the Do Minimum annual average damages is shown in Table 7.13.

Table 7.13 Sensitivity testing on water levels for Option 2 Do Minimum

Case	Annual Average Damages £k	Change from base case
Base	6,381	0%
-200mm	4,320	-32%
+200mm	9,877	+55%

The changes in water level have a significant impact on damages. The sensitivity to an increase in water level (55% increase) is slightly greater than the sensitivity to water level decrease (32% reduction). Only the case where benefit-cost ratios would reduce (decrease in water level) is evaluated explicitly as shown in Table 7.14. This illustrates the variation in benefit cost ratio for selected storage options for water levels reduced by 200mm.

Table 7.14 Sensitivity testing on reduced water level for storage options

Option	Benefit / Cost Ratio		
	Base	200mm decrease in water level	Change from base case
2	11.7	6.8	-42%
3	7.4	4.4	-42%
4	11.0	5.0	-56%
6	7.4	4.4	-42%
8	6.7	3.6	-51%

With a 200mm reduction in water levels the benefit cost ratios for storage options remain reasonably robust and would reduce from between 7.4 and 11.7 to between 3.6 and 5.0. A similar increase in water level would result in benefit cost ratios of between 10 and 15 arising from the slightly increased sensitivity referred to above.

The preferred strategy is robust in economic terms to variations in the predicted flood levels, ground levels and threshold levels but there would be an impact on the Defra priority score.

7.5 Sustainability considerations

The consideration of sustainability is a key element in the environmental assessment of the options reported in Section 4. These issues have been considered in relation to the outline design of the options and environmental mitigation and enhancement measures.

A further aspect of sustainability, which is considered explicitly in the strategy is the impact of global warming as represented by a 20 % increase in peak fluvial flows. The increase in flood levels across the catchment for the Do Nothing and Do Minimum options, for the 1 % annual probability event, has been assessed to determine the number of properties at risk from flooding. The total number of properties affected by flooding across the catchment is shown in Table 7.15.

Table 7.15 Impact of climate change

Option	Number of properties flooded		Percent increase
	Base case	Climate change	
1 (Do Nothing)	1,135	1,564	38%
2 (Do Minimum)	865	1,370	58%

An increase of 20 % in flood peak flow over a 50 year period would lead to a 58 % increase in the number of properties at risk of flooding in the 1 % annual probability event for the Do Minimum option. The average annual damages could be expected to increase by a similar percentage. Further measures would be required in the long term to protect these properties from flood damage.

The increase in flood levels varies across the catchment in the 1% annual probability event from up to 0.25m in the Teise, Beult and Upper Medway to between 0.35m and 0.65m in the downstream area from Yalding to Maidstone. Flood risk areas which show an increase in excess of 20 properties flooded in the 1 % annual probability event for the Do Minimum option are shown in Table 7.16.

Table 7.16 Flood Risk Areas most affected by climate change

Flood Risk area	Number of properties flooded		
	Base case	Climate change	Increase
Tonbridge	114	193	79
East Peckham/ Little Mill	133	189	56
Laddingford	88	157	69
Yalding	166	213	47
Maidstone	128	304	176
Remaining flood risk areas	236	313	77

The principal impact of climate change on the option selection process is likely to be an improvement in the economic parameters of all strategic storage options. The impacts are likely to be similar on all storage options but the case for implementation of Stile Bridge option could become economically robust, with only a small change in benefits required to achieve this.

The two storage options included in the preferred strategy have been modelled to achieve the maximum available storage. The options available for responding to climate change are implementation of a third storage option at Stile Bridge, the raising of local defences and the construction of new local defences.

Storage at Stile Bridge would have an impact on flood levels in Yalding, Laddingford and Maidstone, areas which represent over 50% of the increase in properties at risk. This option should therefore be retained to counter future adverse changes in the catchment, including climate change. Provision should also be made in the design of local defences to facilitate future raising to accommodate raised water levels due to climate change. In the event that Stile Bridge storage is not implemented, new local defences may become economically viable, for example in Maidstone, with the substantial increase in properties at risk.

The CFMP investigated the impact of improved catchment management practices and concluded that, although they could make a contribution, on a catchment wide basis the reduction in flood levels that might be achieved would be less than the potential increase resulting from climate change.

In order to maintain the current and proposed future levels of flood protection, in the face of climate change, it would be necessary to implement further structural and non-structural solutions as discussed above. This can be addressed during the five year strategy reviews.

7.6 Defra priority score

An indicative Defra priority score for the proposed strategy has been evaluated in accordance with the Scheme Prioritisation System issued by Defra for guidance in March 2002, as shown in Table 7.17. As indicated previously, a conservative approach has been taken to the economic analysis and a level of detail appropriate to a strategy study has been applied to assess these priority scores (for example no score has been allocated to heritage features which may be protected).

The scores have been assessed for the strategy as a whole as each additional scheme is implemented.

Table 7.17 Indicative Defra priority score

Option	Description	Defra Priority Score
2	Do Minimum	21
16	Increased storage at the Leigh Barrier with mitigation	18
16+14	Increased storage at the Leigh Barrier with mitigation and local defences at Yalding	15
16+14+3	Increased storage at the Leigh Barrier with mitigation, local defences at Yalding and Edenbridge storage	12
16+14+3 +17+19	Increased storage at the Leigh Barrier with mitigation, local defences at Yalding, Edenbridge storage and local defences at Collier Street and East Peckham	10

The priority score reduces from 18 to 10 as the additional schemes are implemented.

The Defra priority score threshold required to secure funding is 19 for the financial year 2005/2006 reducing to 15 for 2007/2008. Further reductions could be anticipated in future years but are unlikely to reduce to below 15 in the near future. Thus the first two schemes in the strategy have a reasonable chance of securing funding in the short to medium term.

As recommended earlier further study of the other schemes should be carried out to see if project risks can be reduced to lower scheme costs and benefits reviewed in detail to confirm if a higher priority score can be achieved.

The sensitivity tests on cost and benefits demonstrated that the benefit-cost ratio could vary by around plus or minus 1, which would result in corresponding changes in the Defra priority score of plus or minus 2.

7.7 Preferred flood management strategy

From the analysis carried out in Sections 7.2 to 7.6, the preferred flood risk management strategy comprises both structural and non-structural elements.

The following non-structural measures would form an essential part of the strategy to deal with the flood risk in areas without flood protection:

- Improved operation of the Leigh Barrier
- Development control
- Flood warning
- Assistance with flood proofing
- Improved catchment management

The structural measures will provide a significant degree of protection to around 550 properties in key flood risk areas in Tonbridge, East Peckham, Collier Street, Laddingford, Yalding and Maidstone. These measures are likely to be implemented over a period of possibly 20 years, both because of their magnitude and the likelihood that the priority scores of some of the measures may be below the threshold to receive grant aid from Defra in the near future.

Even when these measures are fully implemented there will remain a significant number of properties at risk (around 420) both in those flood risk areas and throughout the remainder of the catchment. The non-structural measures are proposed to assist in managing the flood risk for these properties.

The potential impact of climate change will result in an increasing number of properties (around 500) which cannot be protected by the proposed programme of works. Further structural measures can be implemented which will provide a number of these properties with protection. These measures are likely to include Stile Bridge storage and either raising of existing or the construction of new local defences. Non-structural measures are proposed to assist in managing the flood risk of any unprotected properties.

The residual flood risk in those areas which are provided with flood protection (where the flood event exceeds the standard of flood protection) would also be managed by flood warning and development control.

Key economic parameters for the proposed structural measures are given in Table 7.18 with the likely timing of implementation grouped into 5 year bands. The benefit-cost ratio and Defra priority score given in this table are cumulative values as each additional component of the strategy is delivered. Those measures that could be implemented within the first five years of the strategy are considered to be 'short term', with measures beyond five years referred to as 'medium term'.

Table 7.18 Key parameters for preferred structural and storage measures

Option	Benefit Cost Ratio	Defra Priority Score	5 year period for implementation
16	9.5	18	0-5
14	7.4	15	0-5
3	5.8	12	5-10
19	5.1	10	10-15
17	4.9	10	10-15

Although local defences at Yalding are implemented ahead of storage at Edenbridge the development of the storage options will affect the required level of the local protection downstream. Hence the feasibility studies for Yalding local defences should include confirmation of the location, capacity and mode of operation of Edenbridge storage. The optimum combined arrangement would be identified in this feasibility study.

In order to ensure that a storage site is available on the river Beult to provide additional protection from the effects of climate change, initial studies should be carried out to confirm the location, capacity and upstream impacts of the storage reservoir at Stile Bridge. This will enable the affected land to be identified and agreement reached with the local authority on land use planning to preserve the area for this purpose

7.8 Properties benefiting by Postcode Sector

7.8.1 ABI Flood Risk Categories

The economic criterion used to assess the options is the reduction in flood damages as per FCDPAG 3. The following section uses the categories defined by the Association of British Insurers (ABI) to show the impact on individual properties of implementing schemes at Yalding and Leigh, the short term measures.

The ABI categories are detailed in Table 7.19 and are matched with the most appropriate return period modelled as part of the strategy appraisal.

Table 7.19 ABI Flood Risk Categories and Modelled Return Periods

ABI risk category and return period		Modelled return periods
Low	< 0.5%	None
Moderate	<1.3% and > 0.5%	1% and 0.5%
Significant	>1.3%	4%

The ABI categories do not exactly match the modelled return periods used in the strategy appraisal and in particular, the number of properties within the ABI category of Significant risk is likely to be underestimated. All properties in the post code area are considered to be at low risk if they have a risk of flooding of less than 0.5% even though many will not be within the floodplain or considered to be vulnerable to surface water flooding. This explains the apparently high number of properties at Low risk in the following tables.

7.8.2 Properties Benefiting from Yalding Scheme

The Yalding local defences will defend 73 properties to a 1% standard, reducing flood risk for these properties from Significant to Moderate as shown in Table 7.20

Table 7.20 Properties benefiting from Yalding local defences by Postcode Sector

Postcode Sector	ABI risk classification at present			ABI risk classification following scheme implementation		
	Significant	Moderate	Low	Significant	Moderate	Low
ME186	119	257	611	46	330	611

The raising of the Leigh Barrier in combination with Yalding local defences will reduce flood risk from Significant to Moderate for 110 properties (=382-272) and from Moderate to Low for a further 260 properties (=48,958-48,698). This is shown in detail in Table 7.21.

Table 7.20 Properties benefiting from the Strategy by Postcode Sector: Yalding local defences combined with raising the Leigh Barrier

Postcode Sector	ABI risk classification at present			ABI risk classification following scheme implementation		
	Significant	Moderate	Low	Significant	Moderate	Low
ME141	2	44	1622	1	38	1629
ME142	0	5	4206	0	2	4209
ME150	8	10	1716	8	9	1717
ME156	1	79	3992	1	67	4004
ME160	3	62	5081	3	62	5081
ME168	26	70	4455	11	58	4482
ME169	5	10	2353	5	6	2357
ME185	7	0	2022	7	0	2022
ME186	119	257	611	44	259	684
TN110	17	9	1850	10	13	1853
TN118	1	0	1358	1	0	1358
TN119	7	13	2373	7	2	2384
TN120	20	32	2481	20	32	2481
TN125	91	107	1203	81	77	1243
TN126	9	23	4195	9	17	4201
TN129	57	50	1824	57	50	1824
TN171	0	3	840	0	3	840
TN278	0	9	1496	0	9	1496
TN279	4	21	1804	4	21	1804
TN3 8	2	21	660	2	21	660
TN9 1	3	181	2556	1	110	2629
Total	382	1006	48,698	272	856	48,958

7.9 Strategy for individual flood risk areas

The strategy proposed for each of the flood risk areas comprising the Middle Medway area is set out in Volume 1, Appendix C.

7.10 Summary of strategy measures

The storage and local protection measures recommended in the preferred strategy provide around 547 properties with protection in the 1% annual probability flood.

Thus of the 967 properties (865 in the Middle Medway study area and 102 around Edenbridge) currently at risk during the 1 % annual probability flood, storage and local protection measures are likely to be economically viable to around 60% of the properties leaving a large number for which non-structural measures will be required to provide flood risk management. The preferred strategy is summarised below.

7.10.1 Short term structural measures: 0 to 5 years

- Feasibility study and implementation of increasing the storage capacity of Leigh Barrier
- Feasibility study of local defences for Yalding (further developing the findings of the Pre-Feasibility Study, 2001). This study should also identify the preferred location, capacity and mode of operation of storage at Edenbridge in combination with Leigh barrier as this is an essential requirement of determining the optimum standard of protection for Yalding.
- Implementation of Yalding local defences
- Prefeasibility study of Stile Bridge storage to identify the preferred location, capacity and mode of operation to enable the identified area to be acknowledged in local authority long term land use planning for this purpose. A key component of this study is to identify the extent and location of protection to upstream properties that would otherwise be put at increased flood risk by construction of the storage reservoir. Stile Bridge storage reservoir forms part of the long term planning for mitigating the impacts of climate change.

7.10.2 Non-structural measures: 0 to 5 years and ongoing

- Operations study of Leigh Barrier to optimise control rules taking into particular account operating experience and developments in telemetry
- Establish closer co-operation between local authority planning departments and Agency development control to reduce the inappropriate development of properties in the flood plain. Where properties in the flood plain are re-developed ensure that flood proofing (or resilience) measures are incorporated in the properties and that this is enforced through planning consents
- Improve the operation and take-up of targeted flood warning. Educate the public in actions to take to minimise flood damage.
- Provide education and assistance to the public in individual property flood proofing. While the Agency does not have a duty to provide flood protection it has a remit to manage flood risk.
- Over the life time of the strategy influence farmers, developers etc outside the immediate flood plain to improve catchment management practices to assist with reducing the predicted impact of climate change.

- Cooperate with local authorities and emergency services to maintain up to date emergency plans for managing major flood events and for post-flood recovery.

7.10.3 Medium term structural measures: 5 to 20 years

- Feasibility study and implementation of a storage reservoir on the River Eden
- Feasibility study and implementation of local defences at Collier Street
- Feasibility study and implementation of local defences at East Peckham
- Feasibility study of an integrated approach to fluvial and sewer flooding in Paddock Wood
- Phased programme of implementation of any resulting flood alleviation scheme

7.10.4 Long term measures: beyond 20 years

- Feasibility study of Stile Bridge storage reservoir in response to increasing flood risk
- Feasibility studies of the extension and raising of structural protection in response to increasing flood risk
- Phased programme of implementation of any resulting flood alleviation schemes
- Programme of renewal of flood defence structures

8. PROJECT PLAN

8.1 Overview

Following approval of this strategy, the intention is to embark on the development of the Leigh Barrier and Yalding Schemes. These will be developed as two separate projects, starting with a project planning phase, in 2006. This current project plan demonstrates how procurement, legal and other project planning activities will be addressed.

8.2 Procurement of Internal and External Resources

8.2.1 Funding

The Area client has confirmed that there is sufficient funding to carry out recommended works. Scheme estimates are included in the medium term plan and funding will be available via the Defra Block Grant and Agency contribution, subject to SoD approval.

Contributions will be sought from key stakeholder and scheme beneficiaries in order to ensure their involvement and support for the schemes. Potential contributors to the Leigh Barrier Scheme include Tonbridge and Malling Borough Council, Railtrack and Kent County Council. Potential contributors to the Yalding scheme include Tonbridge and Malling Borough Council, Kent County Council (Highways) and Yalding Parish Council and Flood Action Group. The Southern Region External Funding Manager has been advised regarding these intentions and will assist the project manager in obtaining contributions.

8.2.2 Internal Staff

The development of the project will continue to be managed by the NCPMS Southern Appraisal Team. Project Executive will remain as Chris Harding and Project Manager Richard Hull. This will be reviewed taking into account their existing and predicted workload. Early advice will be sought from the Agency's Legal and Estates in order to begin drafting the necessary legislation and negotiate access, easements and compensation. A member of the legal team will sit on the project board for these PAR's and a Land Agent will be engaged through the Estates team to assist in land negotiations.

8.2.3 Consultant

It is proposed that NEECA consultant Babbie Brown and Root (BBR) carry out further appraisal work to develop scheme Project Appraisal Reports (PARs) for additional storage at Leigh Barrier and local defences in Yalding. Their selection will depend on a competent project team being made available and a satisfactory statement of interest. This will be confirmed following the project planning stage for these projects which will start following NRG agreement and Defra approval.

BBR have significant knowledge of the catchment and their experience in the river modelling will be of critical importance for future appraisal work. In addition to this strategy, BBR have successfully delivered the Medway CFMP, Leigh Barrier improvements and Yalding Bascule Bridge Replacement.

BBR's appointment will depend on their appointment on NEECA 2. If BBR are not appointed, expressions of interest will be sought from other NEECA consultants with suitable experience. There is sufficient consultant resource within BBR and NEECA to deliver this project to the proposed programme.

8.2.4 Planning Supervisor

Shear management (RSKENSr) are proposed as Planning Supervisor under an existing contract for provision of services in Southern Region. Shear management have a number of planning supervisors available with suitable experience and local knowledge. They also have good experience of Environment Agency operation and maintenance activities. Shear management have sufficient resources available to assist in the delivery of the Leigh Barrier and Yalding Schemes and this will be further investigated and confirmed during the formal appointment process.

8.2.5 Cost Consultant

A Cost Consultant will be engaged from the NCPMS Cost Consultants framework at an appropriate stage in the PAR development process. This is not a critical appointment at this stage and will be addressed later.

8.2.6 Contractor

Mowlem will provide cost and construction advice during the production of the PARs. They have relevant experience and have confirmed their availability to give advice at this stage. Their selection does not imply preferred status at construction stage, construction contracts will only be awarded following the approval of a Contract Award Report.

8.2.7 Site Investigation Contractor

Site investigations will be needed during the PAR and detailed Design Stage. Contractors on the current NCPMS framework will have the skills and resource to carry out this routine work.

8.3 Legal Issues

There are various legal issues that will need to be addressed during the PAR development and construction process. These are different for both the Leigh Barrier improvement works and the Yalding Local flood defences. Detail is given below on what these issues are and how they will be addressed during the PAR development.

8.3.1 Leigh Barrier

Operation of the existing flood storage scheme has to be in accordance with a scheme approved by Defra which details the maximum level or quantity of water to be retained. To use the existing freeboard a revised scheme must be submitted to Defra. There is a consultation process and power for the Minister to order an Inquiry. Therefore 24 months has been allowed for this process. It is not entirely clear that the power to acquire easements has lapsed (the power to acquire land has) under the Act. If the works require additional operational land, it will be acquired by agreement or Compulsory Purchase Order (CPO). It is not currently envisaged that further

operational land will be required but this will be resolved early on to enable land negotiations to run concurrent with any possible inquiry. The existing deeds of the scheme are being reviewed by the legal team and at this stage it seems that there are fairly extensive easements to flood marked on our land terrier.

8.3.2 Yalding

The intention is to carry out the proposed works using powers of entry, following extensive consultation and dialogue with those who are likely to be affected. Consultation will be on alignment and how the defence will appear rather than on whether the scheme should go ahead, so expectations are not raised unduly. As this is new works there will be a requirement for planning permission, and that will be backed up by a full EIA. The planning authority will be represented on the project team and EIA will be carried out under the guidance of NEAS. Compensation issues will be dealt with by the estates team who will consider depreciation to properties and any betterment the scheme will bring.

During detailed design stage, landowner searches will be undertaken to confirm notice serving powers. Prior to works, the Agency will issue a NoE and take account of the risk of a judicial review for which a time contingency will be made. Compensation will be negotiated following completion of the works. CPO or other land acquisition will only be considered where active control of the flood defence is required and that is unnecessary in this case. Therefore, no inquiry is expected.

8.4 Implementation Programme

The proposed implementation programme, excluding the long-term measures, is shown in Table 8.1 below with the first five year's programme illustrated in Figure C28.

Table 8.1 Proposed strategy implementation programme

Measure	Implementation period
Short-term structural measures	
Feasibility study of additional storage at Leigh Barrier	2006-2008
Feasibility study of local defences at Yalding (taking account of other possible measures, including Edenbridge storage)	2006-2008
Pre-feasibility study of storage at Stile Bridge	2006-2008
Design and construction of additional storage at Leigh Barrier	2008-2010
Design and construction of local defences at Yalding	2008-2010
Non-structural measures	
Operations study of Leigh Barrier	2006
Flood warning improvements	2005 to 2008
Development control improvements	2005 and ongoing
Assistance with flood proofing	2005 and ongoing
Medium term structural measures	
Storage on the River Eden	2010-2015
Local defences at Collier Street	2015-2020
Local defences at East Peckham	2015-2020
Integrated flooding study of Paddock Wood	2010-2015

8.5 Spend Profile

The Agency's Southern Region medium term 10 year financial plan includes three studies starting in 2006/2007. The anticipated annual spend including optimism bias for the short term structural options studied and implemented in the first five years is presented in Table 8.2.

Table 8.2 Expenditure profile for short term structural measures

Proposed measure	Expenditure £ million (without inflation)					
	2001-6	2006-7	2007-8	2008-9	2009-10	Total
Strategy costs	0.66					0.66
Feasibility study of additional storage at Leigh Barrier		0.31	0.31			0.62
Design and construction of additional storage at Leigh Barrier				2.06	3.71	5.77
Feasibility study of local defences at Yalding		0.41	0.41			0.82
Design and construction of local defences at Yalding				3.09	4.33	7.42
Stile Bridge pre-feasibility study		0.05	0.05			0.10
Total						15.4

The anticipated expenditure including optimism bias for the 100 year life of the strategy is presented in Table 8.3.

Table 8.3 Expenditure profile for 100 year strategy

Item	Expenditure £ million (without inflation)							
	0-4	5-9	10-14	15-24	25-49	50-74	75-99	Total
Feasibility studies, design & construction	15.4	12.8	11.4	0	0	0	0	40
Renewal	0	0	0	0	7.4	7.4	7.4	22.2
Operation & Maintenance	2.8	3.6	4.4	10.1	25.1	25.1	25.1	96.2
Total								158

8.6 Health & Safety

The Construction (Design and Management) Regulations 1994 place obligations on both the Client and Designer(s) to take account of health and safety risks during the design of the works. The Planning Supervisor appointed will ensure co-ordination between designers making sure that operational safety requirements of local authorities and the Agency are incorporated into the design. The Planning Supervisor will also assist in the preparation of the Health and Safety file for the works. The Agency's

appointed Reservoir Supervising Engineer will need to be satisfied that any changes to operation of the Leigh Barrier and new reservoirs falling under their remit meet the requirements of the Reservoirs Act 1975.

The significant health and safety hazards identified by this Study, which are to be addressed and mitigated at feasibility level (and subsequently detailed design and construction) are:

- Significant volumes of construction traffic (import of fill for embankments)
- Flooding during the construction period
- Working at height during construction
- Operation during flood events
- Working near water

8.7 Management of Residual Flood Risk

Residual flood risk will be mainly addressed using flood warning and development control. However, assistance should also be given by the Agency to promoting the availability and use of individual property protection.

8.8 Risks to Strategy Implementation

The high level residual risks associated with the implementation of this strategy and mitigating actions are considered in Table 8.4.

Table 8.4 Risks and Mitigation

Risks	Mitigation
Acts of Parliament or Statutory Instruments required for storage reservoirs under Section 3 of the Transport and Works Act 1992	Plan for minimum five year approval process for new storage embankments
Capital cost estimation	Optimism bias of 60% applied to whole life costs
Overestimate of flows and water levels	Sensitivity to water level fall tested with benefit cost ratios of preferred options remaining economically robust
Consent from landowners	Early involvement of landowners in the consultation process
Significant consultation required to obtain community buy-in to storage schemes and local defences	Co-ordinated approach to communication plans for individual feasibility studies across the catchment
Protracted negotiations with affected landowners in resolution of compensation arrangements and the development of design to general satisfaction	Targeted development of communication strategy at feasibility stage to identify landowners affected and engage in early consultation
Strategy needs to be implemented by July 2006 otherwise it will need to be fully revised to comply with the SEA regulations	Efforts undertaken to achieve earliest possible approval programme
Planning permission required for new schemes. Constraints from local policies include: Built-up area boundary, Green Wedge, Land of Local Amenity Importance, Area of Outstanding Natural Beauty (AONB)	Early involvement of statutory consultees and stakeholders, continued use of project website to update and communicate proposals
Confirmation required of potential benefits achievable	Refinement of the hydrological and hydraulic model developed for the Middle Medway catchment to be included in the design of the storage options. More detailed assessment of threshold levels in key flood risk areas to be included
Impacts on the River Beult SSSI during construction of the Stile Bridge storage reservoir	Consultation with English Nature at an early stage

8.9 Financial Risk Assessment for Yalding Local Flood Defences

One of the risks to implementation of the strategy in the first 5 years is increase in cost of the construction of Yalding local defences. The risk of financial cost increases exceeding the allowance made using optimism bias has been evaluated by carrying out a risk assessment using a Monte Carlo analysis. Twenty key risks were identified with probability ranging from 20% to 50% and a minimum, most likely and maximum cost was assessed for each risk.

The four risks which made the largest contributions were:

- Poor ground conditions requiring shallower flood embankment slopes
- Insufficient space for flood embankments requiring a design change to retaining walls
- Cost of service diversions underestimated
- Increased number of pumping stations required to deal with local drainage

The 50% risk value is £1,676,000 and the 95% risk value is £1,803,000. These compare with the risk allowance adopted for economic analysis using optimism bias of £3,117,000. The risk allowance adopted is thus confirmed to be robust.

9. RECOMMENDATIONS SIGN OFF

NRG recommend Environment Agency Board approval (A9) of the strategy for £61,803k capital cost over the 100 year appraisal period. This capital cost is for construction of increased storage at the Leigh Barrier, local defences at Yalding, storage at Edenbridge and local defences at Collier Street and East Peckham, including renewal costs.

NRG recommend Financial Scheme of Delegation approval (A2) for £11,160k for feasibility studies investigating increased storage at the Leigh Barrier and Stilebridge and feasibility and construction for local defences at Yalding.

NRG recommend that the strategy be submitted to Defra for approval of the strategy and the £158,000k whole life cost over the 100 year appraisal period.

This strategy should be reviewed at five year intervals to take account of changing conditions in the catchment. The need for additional flood storage at Stilebridge to counter the effects of climate change should be considered during review.

9.1 Operating Authority [Environment Agency]

Strategy recommended for approval & submission to DEFRA for- approval at a cost of (£)

Project Manager

Name		Signature	
			Date

Strategy recommended for approval & submission to DEFRA for- approval

Project Executive

Name		Signature	
			Date

Strategy recommended for approval & submission to DEFRA for- approval

Budget Manager

Name		Signature	
			Date

* Select as appropriate but at least one option must be selected from the options in brackets.

Select as appropriate or delete whole line as far as this point. Note: -

Fin. Mem. agreement applies to Environment Agency Financial Memorandum agreements only.

9.2 Department for Environment Food and Rural Affairs

*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

Regional 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

Chief Engineer

Name		Signature	
		Date	

* Select as appropriate

10. REFERENCES

- Babtie Brown & Root, 2001 Yalding Pre-Feasibility Study for ‘Stand Alone’ Flood Defence Scheme at Yalding, February 2001
- Babtie Brown & Root, 2004 Medway Catchment Flood Management Plan, July 2004
- Defra, 1993 Strategy for Flood Defence, 1993
- Defra, 2001a Flood and Coastal Defence Project Appraisal Guidance for Strategic Planning and Appraisal (FCDPAG 2), 2001
- Defra, 2001b Flood and Coastal Defence Project Appraisal Guidance for Economic Appraisal (FCDPAG 3), 2001
- English Nature, 2001 Managing Floodplains to Reduce Flood Risk and Enhance Biodiversity, 2001
- English Nature / Environment Agency, 2001 River Beult Conservation Strategy, 2001
- Environment Agency, 1997 Kent Biodiversity Action Plan, 1997
- Environment Agency, 1999 Medway LEAP, Local Environment Agency Plan, Environmental Overview, January 1999
- Environment Agency, 2001 Regional and Area Flood Reports, 2001
- Environment Agency, 2003 Middle Medway Strategy Study, Initial Consultees Report, November 2003
- Environment Agency, 2003 State of the Environment Report, 2003
- Flood Hazard Research Centre, 2003 The benefits of Flood and Coastal defence: Techniques and Data for 2003, Flood Hazard Research Centre, Middlesex University, 2003
- Flynn & Rothwell, 1995 River Medway Regime Study, October 1995
- Halcrow Group, 2001 Medway Asset Survey, Middle Medway Catchment Management Report, December 2001
- Halcrow Group and JB Chatterton & Associates, 2004 National Property Database Guidance
- MAFF, 2001 Flood and Coastal defence project appraisal guidance (Overview including general guidance, FCDPAG1)
- Sir M. MacDonald, 1971 River Eden Flood Control Report, 1971
- Mott MacDonald, 2001 River Medway Flood Risk Mapping, Phase 1 Study, March 2001
- Mott MacDonald, 2004 River Medway Operations Considerations – Scenario Tests Final Report, February 2004
- National Rivers Authority, 1993 River Medway Management Plan, Final Report, July 1993
- Southern Water Authority Land Drainage Survey, Kent River and Water Division, , undated
- Tonbridge and Malling Borough Council, 2004 East Peckham Flood Relief Scheme, Project Appraisal Report, March 2004
- Weeks Consulting, 2002 Lamberhurst Flood Alleviation Study for Upper Medway Internal Drainage Board, January 2002

11. DEFRA SUBMISSION CHECK LIST (See latest Grant Memorandum)

EXHIBIT

Signed LDW1 forms (two original forms – no photocopies)	
Project Appraisal Report (Engineer's Report)	
Hard copy of Approval History Sheet, with signatures	
Hard copy of SoD Coversheet, with signatures	
Letter from English Nature giving their support to the proposals	
Planning Certificate granting Planning Approval including a copy of the Section 106 agreement (If appropriate).	
Copies of SI 99/1783 adverts, responses (if appropriate) and ES if produced	
FEPA Licence (if appropriate)	
Department of Transport approval (if appropriate)	
Letter of approval from English Heritage (if appropriate)	
Letter of approval from the Countryside Agency(if appropriate)	

NOTE: The revised Grant Memorandum is applicable from 1 July 2003. This envisages Defra approval at option choice stage (with the exception of projects affecting sites of international importance under the Habitats Regulations where formal approval of the detailed design will still be needed from Defra in its role as a competent authority). For many of the above issues it will be sufficient to demonstrate the appropriate measures are in hand and that the Agency will obtain necessary letters and approvals before start of construction.

12. PROJECT 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):	IMHK40164	LDW/CPW
Project Name (60 characters max.):	The Middle Medway Strategy for Flood Risk Management	
Promoting Authority:	Defra ref (if known)	40436
	Name	Environment Agency Southern Region
	RE Region:	
Emergency Works:	(Y/N)	N
Strategy Plan Reference:	NA	LDW/CPW
Shoreline Management Plan:	-	LDW/CPW
Project Type:	Strategy Plan	
Shoreline Management Study/ Preliminary Study/ Strategy Plan/Prelim. Works to Strategy/ Project within Strategy/Stand-alone Project		
Grant Type:	Non-Tidal Flood Defence	
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:	NA	
Estimated duration in months:	NA	
Contract type	NA	
Direct labour, Framework, Non Framework, Design/Construct	Date application received:	
Application submission date:	April 2005	Last papers received:

Defra use only, below this line on this page - pls continue overleaf

(Defra database: Sh-F6)

GRANT ELIGIBLE COSTS

APPLICATION (£)

Defra ADJUSTMENT (£)

Preliminary Investigation:		
Instrumentation:		
Construction Works:		
Land Purchase:		
Compensation Payments:		
Staff Costs:		
Consultants Fees:		
Other Costs:		
Contingencies:		
TOTAL:		

CONTRIBUTIONS:

Windfall Contributions:		
Deductable Contributions:		
ERDF Grant:		
Other Ineligible Items:		
NET GRANT ELIGIBLE COSTS:		

Recommendation:	Formal Approval		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:				
Progress:	Officer (Surname)	Start (date)	Complete (date)	Days
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):	Southern Region	Ref.
Name of watercourse (fluvial projects only):	Medway, Eden, Teise and Beult	
District Council Area of project (all projects):	Tonbridge and Malling	Ref.
Grid Reference (all projects):	TQ 563461	
(OS Grid reference of typical mid point of project in form ST064055)		
Specific town/district to benefit:	Tonbridge, Yalding	

DESCRIPTION

Brief project description including essential elements of proposed project/study

(Maximum 3 lines each of 80 characters)

Flood risk management strategy for the Middle Medway catchment area. The main items covered in the first 5 years are:
Feasibility study, design and construction of additional storage at the Leigh Barrier; feasibility study, design and construction of local defences at Yalding; and a pre-feasibility study for storage on the Teise at Stile Bridge;

Postcodes of protected property wholly or partially within proposed benefit area

TN9; TN11; TN12; ME14; ME15; ME16; ME18

DETAILS

Design standard (return period):	1:100 yrs	yrs
Existing standard of protection (return period)	Varies	yrs
Design life of project:	100 yrs	yrs
Fluvial design flow (fluvial projects only):	NA	m ³ /s
Tidal design level (coastal/tidal projects only):	NA	m
Length of river bank or shoreline improved:	NA	m
Number of groynes (coastal projects only):	NA	
Total length of groynes* (coastal projects only):	NA	m
Beach Management Project? Y/N	N	
Water Level Management (Env) Project? Y/N	N	
Defence type (embankment, walls, storage etc)	Walls, embankments storage	

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

ADDITIONAL AGREEMENTS:

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

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

ENVIRONMENTAL CONSIDERATIONS

English Nature (or equivalent) approval:	YES	Not Applicable/Received/Awaited	
Date received	12/10/2004		

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):	N	
Ramsar Site	N	
Biosphere Reserve	N	
World Heritage Site	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	
Area of Outstanding Natural Beauty (AONB):	Y	
National Park	N	
National Nature Reserve	N	

Other Environmental Considerations

Listed structure consent	N	Not Applicable/Received/Awaited	
Water Level Management Plan Prepared? Y/N	Y		
FEPA licence required? NA/R/A	N		
Water Fringe Area affected? Y/N	N		

Compatibility with other plans

Shoreline Management Plan	NA	Yes/No/Not Applicable	
Water Level Management Plan	Y	Yes/No/Not Applicable	
Local Environment Agency Plan	Y	Yes/No/Not Applicable	

Environmental Impact Assessment

Environmental Impact Assessment	SEA undertaken	
Advertised/Planning Approval granted/SI 1217 not applicable/Statement prepared		
Environmental Statement prepared? Y/N	N	
Objections received	NA	
(None/Overruled/ Sustained/ Outstanding)		
Countryside Agency agreement?	NA	

Not Applicable/Received/Awaited (CA approval required if ES issued)

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

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)			
<i>Local authorities only:</i> 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:	ha			
of which present use is:	FD	CE	FD	CE
Agricultural:	ha	ha	ha	ha
Developed:	ha	ha	ha	ha
Environmental/Amenity	ha	Ha	ha	ha
Sched. for development:	ha	Ha	ha	ha

Property protected

	Number		Value (£'000s)			Number		Value (£'000s)	
	FD	CE	FD	CE		FD	CE	FD	CE
'Resid.	572		NA						
Comm./ind.	245		NA						
Other: (description below)									
Description:						Description:			

Costs and Benefits

'Present value of total project (whole life) costs (£'000s):	64,424			
Project to meet statutory requirement? Y/N	N			
	£'000s		£'000s	
	FD	CE	FD	CE
Present value of urban benefits:	316,142			
Present value of agricultural benefits:	-			
Present value of environmental/amenity benefits:	-			
'Present value of total benefits (FD & CE)	316,142			
Net present value:	251,718			
Benefit/cost ratio:	4.9:1		:1	
	Category U/UA/AU/EU etc:			
Base date for estimate:	June 2005			
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)?	Y	Risk*:	0	BAP net gain (Ha):	92
		Vuln**:	0	SSSI protected (Ha):	0
				Other habitat (Ha):	0
				Heritage sites***:	0

*(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):	
Reason (max 100 chars):	

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

PRIORITY SCORE CALCULATION FLOWCHART

ECONOMIC SCORE

	Benefits (£'000s)		Costs (£'000s)	Economic Score
Divide	316,142	by	64,424	multiply by 2 and subtract 1 = 8.8

Economic score = (benefits / costs * 2) - 1

(Max is 20)

PEOPLE SCORE

PEOPLE SCORE							Affluence factor:	Add:		
No of residences	Cost (£'000s)	Base People Score		Risk factor very high = 2 high = 1	1 to 300 301 to 1500 1501 to 6664 6665 to 8114 8115 to 8414		+2 +1 no adjustment -1 -2		People Score	
572	multiplied by 75, divided by	64,424	=	0.7	plus	0	plus	0	=	0.7

(Max is 8)

(Max. is 12)

People score = (number of residences protected * 75 / cost) + risk factor + vulnerability factor

ENVIRONMENTAL SCORE

BAP (Ha)		SSSI (Ha)		Other (Ha)		Cost (£'000s)	Heritage I or II* = 2 II or other = 1	Environmental Score			
(92	multiplied by 2)	(0	multiplied by 1.5)								
((184)	plus	(0)	plus	0)	multiplied by 25 divided by	62,548	plus	0	=	0.1

Environmental score = (((BAP area created * 2) + (SSSI area protected * 1.5) + other designated area protected) * 25 / cost) + heritage factor

(Max is 12)

TOTAL SCORE

Economic + People + Environmental =	9.6
-------------------------------------	-----

Studies should be scored as for the works to which they relate; studies not related to works (eg coastal process studies for SMPs) score 20.

(Max is 44)

Please note there is an Internet Score Calculator at <http://www.defra.gov.uk/envirion/fcd/policy/grantaid.htm>

APPENDIX A

Pull-Out Options Summary Table

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Table A1 Options Summary Table

Option No.	Option Description	Key Flood Risk Areas Benefiting
BASE CASES		
1	Do nothing	None
2	Do minimum	Tonbridge, East Peckham, Maidstone
STRUCTURAL MEASURES		
3	Online storage on the Eden upstream of Edenbridge	Tonbridge, Maidstone, Laddingford, East Peckham
4	Online storage at the Leigh Barrier	Tonbridge, Maidstone, Laddingford
5	Online storage on the Teise upstream of Lamberhurst with online storage on the Bourne upstream of Little Mill	None
6	Online storage on the Beult upstream of Stile Bridge	Yalding, Maidstone, Laddingford
7	Offline storage on the Teise upstream of Great Cheveney	Laddingford, Collier Street, Maidstone
8	Edenbridge with Leigh Barrier	Tonbridge, Yalding, Maidstone, Laddingford, East Peckham
9	Leigh Barrier with Stile Bridge	Tonbridge, Yalding, Maidstone, Laddingford, East Peckham
10	Great Cheveney with Stile Bridge	Yalding, Laddingford, Maidstone, Collier Street
11	Stile Bridge with mitigation at Staplehurst	Yalding, Maidstone, Laddingford
14	Local defences at Yalding (1 % annual probability of flooding)	Yalding
16	Leigh Barrier with mitigation at Leigh	Tonbridge, Maidstone, Laddingford
17	Local defences at Collier Street (1% annual probability of flooding)	Collier Street
18	Local defences at Maidstone (1% annual probability of flooding)	Maidstone
19	Local defences at East Peckham (1% annual probability of flooding)	East Peckham
NON-STRUCTURAL MEASURES		
-	Improvements to flood warning	Whole catchment
-	Improved catchment (land) management	Whole catchment
-	Assistance with individual property protection	Whole catchment

Notes:

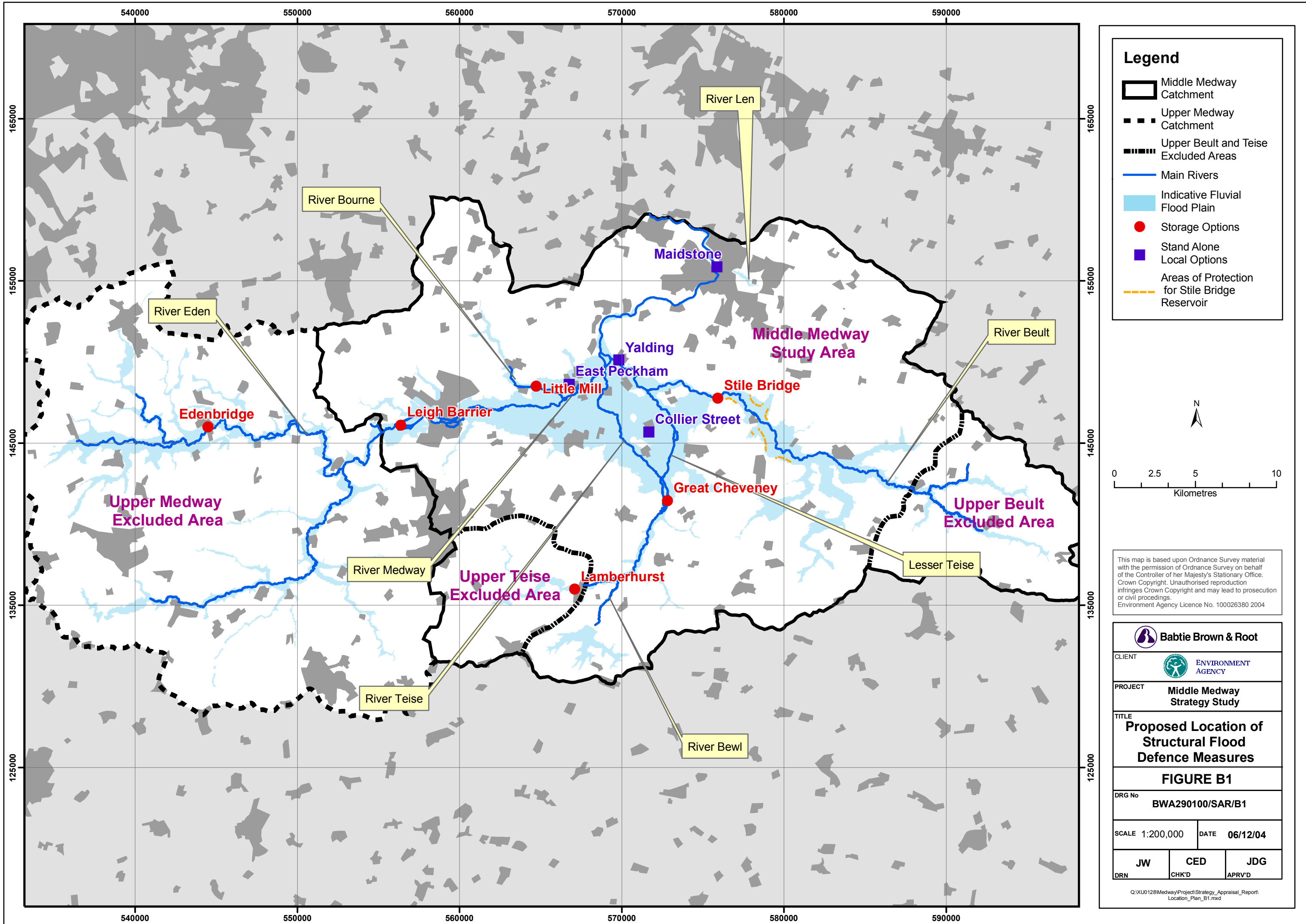
- 1) Flood risk areas listed where 20 or more properties benefit and are shown in descending order of magnitude
- 2) Option numbers 12, 13 and 15 not used

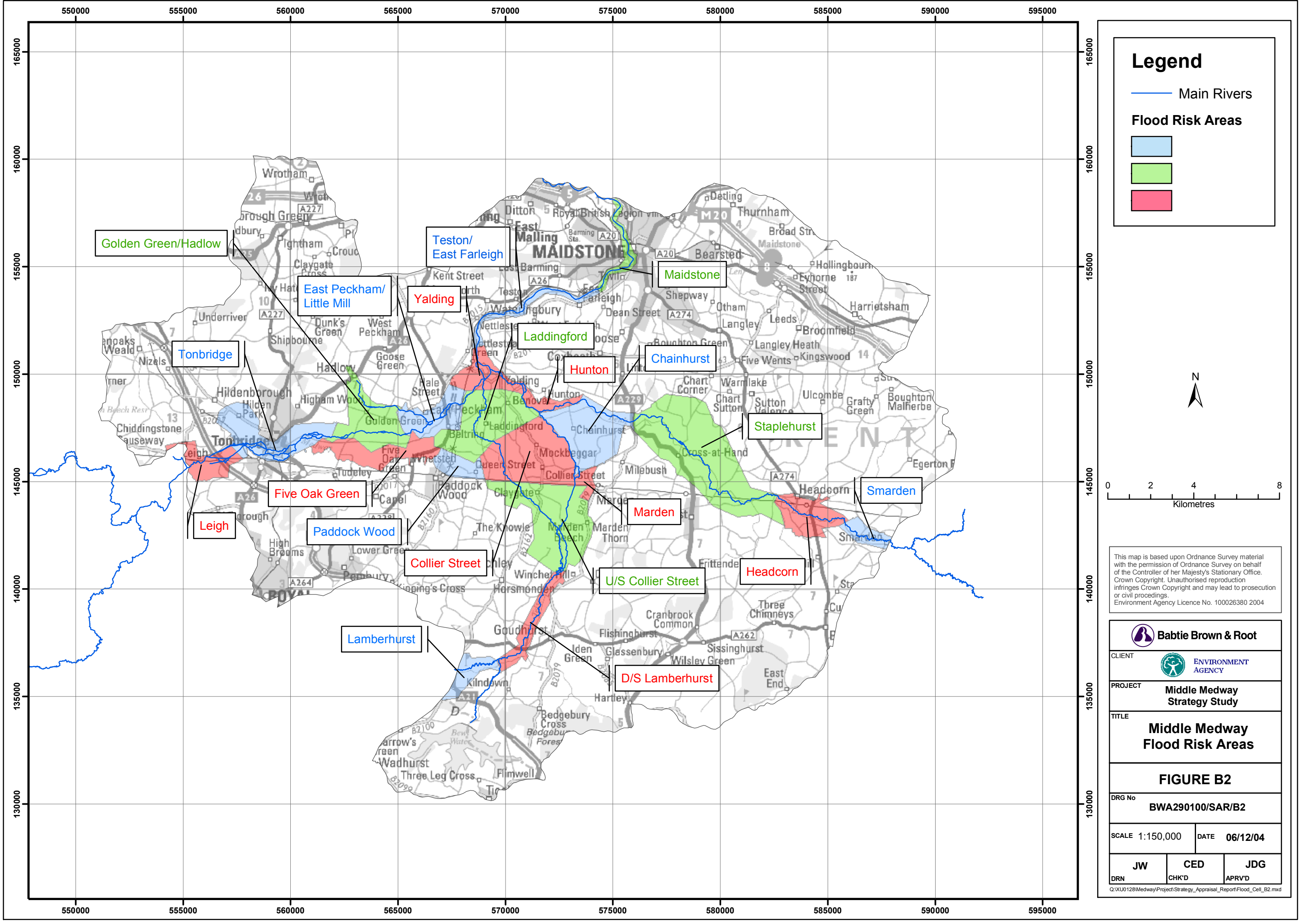
APPENDIX B

Project Appraisal Report Figures

Figure B1 Proposed Location of Structural Flood Defence Measures

Figure B2 Middle Medway Flood Risk Areas





Legend

Main Rivers

Flood Risk Areas

N

0248

Kilometres

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Babtie Brown & Root

CLIENT

ENVIRONMENT AGENCY

PROJECT

Middle Medway Strategy Study

TITLE

Middle Medway Flood Risk Areas

FIGURE B2

DRG No

BWA290100/SAR/B2

SCALE 1:150,000

DATE **06/12/04**

JW

DRN

CED

CHK'D

JDG

APRV'D


Q:\XU0128\Medway\Project\Strategy_Appraisal_Report\Flood_Cell_B2.mxd


APPENDIX C


Strategy for Individual Flood Risk Areas


Flood Risk Area	Page
Lamberhurst.....	Ciii
Downstream Lamberhurst.....	Civ
Upstream Collier Street.....	Cv
Marden.....	Cvi
Collier Street.....	Cvii
Paddock Wood.....	Cviii
Laddingford.....	Cix
Smarden.....	Cx
Headcorn.....	Cxi
Staplehurst.....	Cxii
Chainhurst.....	Cxiii
Hunton.....	Cxiv
Yalding.....	Cxv
Leigh.....	Cxvi
Tonbridge.....	Cxvii
Golden Green / Hadlow.....	Cxviii
Five Oak Green.....	Cxix
East Peckham / Little Mill.....	Cxx
Teston / East Farleigh.....	Cxxi
Maidstone.....	Cxxii


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RIVER:	TEISE	
FLOOD RISK AREA:	LAMBERHURST	
Location of properties at risk Almost all of properties at risk are in the centre of Lamberhurst, with the majority upstream of the A21 bridge over the River Teise.		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	15	
Residential	9	
Commercial	6	
Existing standard of protection	4 % annual probability of flooding	
Indicative standard of protection	1 – 4% annual probability of flooding	
Present value Do Nothing damages	£1.2 million	
CFMP Policy	Maintain present flood risk (short term)	
Proposed strategy None of the strategic storage measures evaluated will have a significant impact on Lamberhurst. Local protection would be the only potentially viable structural option. Initial studies have been completed for a local protection scheme, comprising storage upstream of Lamberhurst with structural defences giving a 1 % annual probability event standard of protection. These were shown to have a benefit cost ratio around 3, however such measures are unlikely to achieve a high enough Defra priority score to be included in a programme in the near future. This scheme should be considered further in the medium term. In the short term the flood risk will be managed through flood warning		
Managing residual flood risk <ul style="list-style-type: none">Flood warningDevelopment control		
Future changes The predicted increase in future flood risk as a result of climate change is significant, with a near doubling of the number of properties at risk during the 1 % annual probability flood. This reinforces the need to consider a local protection scheme in the medium term, particularly if this increase in flood risk is realised.		


RIVER:	TEISE	
FLOOD RISK AREA:	DOWNSTREAM LAMBERHURST	
Location of properties at risk The properties at risk comprise a single property adjacent to the A262 road bridge over the River Teise.		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	1	
Residential	1	
Commercial	0	
Existing standard of protection	4 % annual probability of flooding	
Indicative standard of protection	10 - 80 % annual probability of flooding	
Present value Do Nothing damages	<£0.1 million	
CFMP Policy	Maintain present flood risk (short term)	
Proposed strategy No construction measures are proposed		
Managing residual flood risk <ul style="list-style-type: none">Flood warningDevelopment control		
Future changes The predicted increase in future flood risk as a result of climate change is small, with two additional properties at risk during the 1 % annual probability flood. No additional construction measures are proposed.		


RIVER:	TEISE	
FLOOD RISK AREA:	UPSTREAM COLLIER STREET	
Location of properties at risk The majority of properties at risk are situated in Claygate just south of the railway line with a few additional rural properties at risk to the west and south of Marden.		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	12	
Residential	11	
Commercial	1	
Existing standard of protection	5 % annual probability of flooding	
Indicative standard of protection	10 - 80 % annual probability of flooding	
Present value Do Nothing damages	£0.9 million	
CFMP Policy	Maintain present flood risk (short term)	
Proposed strategy No construction measures are proposed		
Managing residual flood risk <ul style="list-style-type: none">• Flood warning• Development control		
Future changes The predicted increase in future flood risk as a result of climate change is small, with no additional properties at risk during the 1 % annual probability event flood. An additional 6 properties are at risk during a 0.5 % annual probability flood. No additional construction measures are proposed as protection measures are unlikely to be economic for the properties put at risk of increased frequency of flooding.		


RIVER:	TEISE	
FLOOD RISK AREA:	MARDEN	
Location of properties at risk No properties are at risk during a 1 % annual probability flood		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	0	
Residential	0	
Commercial	0	
Existing standard of protection	1 % annual probability of flooding	
Indicative standard of protection	1 - 4 % annual probability of flooding	
Present value Do Nothing damages	<£0.1 million	
CFMP Policy	Maintain present flood risk (short term)	
Proposed strategy No construction measures are proposed		
Managing residual flood risk <ul style="list-style-type: none">Flood warningDevelopment control		
Future changes The predicted increase in future flood risk as a result of climate change is modest, with nine additional properties at risk during the 1 % annual probability flood. No additional construction measures are proposed.		


RIVER:	TEISE	
FLOOD RISK AREA:	COLLIER STREET	
Location of properties at risk The majority of the properties are concentrated in the centre of Collier Street while around one third of the properties are scattered around the area.		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	69	
Residential	62	
Commercial	7	
Existing standard of protection	>20 % annual probability of flooding (1 commercial & 14 residential properties at 20%)	
Indicative standard of protection	1 - 4 % annual probability of flooding	
Present value Do Nothing damages	£7.2 million	
CFMP Policy	Reduce flood risk	
Proposed strategy The only strategic measure which would have an impact on Collier Street is Great Cheveney off-line storage which would protect one half of the properties currently at risk in the 4 % annual probability flood. This was shown to have a benefit cost ratio of 5 and an incremental benefit cost ratio of 1.0, below the minimum criteria of FCDPAG 3 (1.5). Local structural protection to the concentration of properties in the centre of Collier Street is recommended in the preferred strategy for further consideration. When considered alone this scheme may not achieve a high enough Defra priority score for implementation from block grant. If this is the case, funding could be considered from the local levy In the short term flood risk could be managed by assisting residents to develop their own individual property protection		
Managing residual flood risk <ul style="list-style-type: none">Flood warningDevelopment control		
Future changes The predicted increase in future flood risk as a result of climate change is small with no additional properties at risk during the 1 % annual probability flood. No additional construction measures are proposed apart from re-evaluation of extent and height of structural protection to the cluster of properties in the centre of Collier Street.		


RIVER:	TEISE	
FLOOD RISK AREA:	PADDOCK WOOD	
Location of properties at risk While Paddock Wood is an intensively developed urban area only a few properties on the fringe are at risk of fluvial, main river, flooding. Other flooding is understood to occur from ordinary watercourses and urban drainage.		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	3	
Residential	0	
Commercial	3	
Existing standard of protection	4 % annual probability of flooding	
Indicative standard of protection	2 – 4 % annual probability of flooding	
Present value Do Nothing damages	£15.5 million	
CFMP Policy	Reduce flood risk	
Proposed strategy None of the strategic storage options on the Eden and the Medway made any significant contribution to reducing fluvial flood risk. Local structural protection to the single commercial property which provides around 90% of the benefits is likely to be viable. In view of the small number of properties at risk from fluvial flooding in the short term the flood risk will be managed through flood warning. However, there is a need for an integrated approach to flooding considering both fluvial and sewer flooding. In the medium term an integrated assessment of both fluvial and sewer flooding should be carried out co-funded by the responsible bodies prior to defining a preferred solution. The CFMP policy should be revised to “maintain present flood risk (short term)”.		
Managing residual flood risk <ul style="list-style-type: none">Flood warningDevelopment control		
Future changes The predicted increase in future flood risk as a result of climate change is small, with no change in the number of properties at risk during the 1 % annual probability flood. No additional construction measures are proposed.		


RIVER:	TEISE	
FLOOD RISK AREA:	LADDINGFORD	
Location of properties at risk The properties at risk in Laddingford are primarily dispersed along the B2162 over a length of around 1.5km. There are a number of separate clusters of properties, which range in size from 5 to 15 properties.		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	88	
Residential	60	
Commercial	28	
Existing standard of protection	>20 % annual probability of flooding	
Indicative standard of protection	1 - 4 % annual probability of flooding	
Present value Do Nothing damages	£25.4 million	
CFMP Policy	Reduce flood risk	
Proposed strategy The proposed strategic measures will have a significant impact on Laddingford with combined Leigh Barrier increase storage and Edenbridge storage protecting around half of the properties currently at risk in the 1 % annual probability flood. This measure has a benefit cost ratio of 6.8 and a Defra priority score of 14. Due to the dispersed nature of the remaining properties at risk, there is no suitable local defence scheme. The proposed measure is the construction of increased storage at Leigh barrier and on-line storage at Edenbridge.		
Managing residual flood risk <ul style="list-style-type: none">Flood warningDevelopment control		
Future changes The predicted increase in future flood risk as a result of climate change is significant, with a near doubling of the number of properties at risk during the 1 % annual probability flood. The viability of a storage reservoir at Stile Bridge and local defences should be considered in the long term if the increase in flood risk is realised.		


RIVER:	BEULT	
FLOOD RISK AREA:	SMARDEN	
Location of properties at risk Properties at risk are located near to Town Bridge in the centre of Smarden, primarily on the right bank of the river		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding		5
Residential		4
Commercial		1
Existing standard of protection		2 - 4 % annual probability of flooding
Indicative standard of protection		1 – 4 % annual probability of flooding
Present value Do Nothing damages		£0.2million
CFMP Policy		Maintain present flood risk (short term)
Proposed strategy No construction measures are proposed		
Managing residual flood risk <ul style="list-style-type: none">Flood warningDevelopment control		
Future changes The predicted increase in future flood risk as a result of climate change is small, with 4 additional properties at risk during the 1 % annual probability flood. No additional construction measures are proposed.		


RIVER:	BEULT	
FLOOD RISK AREA:	HEADCORN	
Location of properties at risk The majority of the village of Headcorn is situated away from the River Beult. Two small clusters of properties are at risk as follows: <ul style="list-style-type: none">Along the right bank tributary joining the Beult at the downstream limit of the villageAlong the left bank tributary at Bletchenden/Waterman Quarter		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	15	
Residential	14	
Commercial	1	
Existing standard of protection	4 % annual probability of flooding	
Indicative standard of protection	2 - 20% annual probability of flooding	
Present value Do Nothing damages	£0.9 million	
CFMP Policy	Maintain present flood risk (short term)	
Proposed strategy No construction measures are proposed		
Managing residual flood risk <ul style="list-style-type: none">Flood warningDevelopment control		
Future changes The predicted increase in future flood risk as a result of climate change is small, with an additional 8 properties at risk during the 1 % annual probability flood. A local protection scheme should be considered in the long term if the increase in flood risk is realised.		


RIVER:	BEULT	
FLOOD RISK AREA:	STAPLEHURST	
Location of properties at risk The properties at risk are distributed throughout the area, with the majority situated in four separate clusters as follows: <ul style="list-style-type: none">• On the right bank adjacent to Herstfield Bridges• On the left bank near Sweetlands Farm• On the right bank at Hawkenbury• On the left bank near Cottons Farm		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	43	
Residential	36	
Commercial	7	
Existing standard of protection	20 % annual probability of flooding	
Indicative standard of protection	2 - 20% annual probability of flooding	
Present value Do Nothing damages	£7.8 million	
CFMP Policy	Maintain present flood risk (short term)	
Proposed strategy No strategic proposals will provide protection in this flood risk area.		
Managing residual flood risk <ul style="list-style-type: none">• Flood warning• Development control		
Future changes The predicted increase in future flood risk as a result of climate change is significant, with a doubling of the number of properties at risk during the 1 % annual probability flood. In addition, properties in this area may be adversely affected by the construction of the proposed Stile Bridge storage reservoir. Local protection in this area forms part of the Stile Bridge option to mitigate the increased risk. Four separate local defences comprising embankments and associated drainage measures are proposed. In addition any other individual isolated properties, which are adversely affected by the Stile Bridge option, will be provided with a local defence or individual property flood-proofing to maintain the current flood risk. The case for providing an improved standard of protection through raising these or providing additional local defences should be considered in the long term if the increase in flood risk is realised.		


RIVER:	BEULT	
FLOOD RISK AREA:	CHAINHURST	
Location of properties at risk The properties at risk are scattered throughout the Chainhurst flood risk area.		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	14	
Residential	13	
Commercial	1	
Existing standard of protection	10 % annual probability of flooding	
Indicative standard of protection	10 - 80% annual probability of flooding	
Present value Do Nothing damages	£1.0 million	
CFMP Policy	Maintain present flood risk (short term)	
Proposed strategy No construction measures are proposed		
Managing residual flood risk <ul style="list-style-type: none">Flood warningDevelopment control		
Future changes The predicted increase in future flood risk as a result of climate change is small, with an increase of 9 properties at risk during the 1 % annual probability flood. No additional construction measures are proposed.		


RIVER:	BEULT	
FLOOD RISK AREA:	HUNTON	
Location of properties at risk The properties at risk are primarily concentrated along and adjacent to Bishops Lane, to the south of Hunton.		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	12	
Residential	12	
Commercial	0	
Existing standard of protection	20 % annual probability of flooding	
Indicative standard of protection	2 – 10 % annual probability of flooding	
Present value Do Nothing damages	£0.9 million	
CFMP Policy	Maintain present flood risk (short term)	
Proposed strategy No construction measures are proposed		
Managing residual flood risk <ul style="list-style-type: none">• Flood warning• Development control		
Future changes The predicted increase in future flood risk as a result of climate change is small, with one additional property at risk during the 1 % annual probability flood. No additional construction measures are proposed		


RIVER:	BEULT	
FLOOD RISK AREA:	YALDING	
Location of properties at risk The majority of properties at risk in Yalding are situated in the centre of the village on the left bank of the River Beult. There are further small concentrations of up to 15 properties in four other locations as follows: <ul style="list-style-type: none">• The centre of Yalding on the right bank• Adjacent to Yalding station• Near Twyford bridge		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	166	
Residential	131	
Commercial	35	
Existing standard of protection	> 20 % annual probability of flooding (19 commercial & 32 residential properties at 20%)	
Indicative standard of protection	0.5 - 2% annual probability of flooding	
Present value Do Nothing damages	£134million	
CFMP Policy	Reduce flood risk	
Proposed strategy The preferred strategic storage measures will have a significant impact at Yalding, where Leigh Barrier increased storage and Edenbridge storage will halve the number of properties at risk during the 4 % annual probability flood. To provide an increased standard of protection to 50% of the properties in Yalding to around the 1% annual probability flood, local defences combined with the strategic storage schemes are proposed. This combined scheme will have a benefit-cost ratio of 6.0 and a Defra priority score of 12. These three options should be combined to minimise the visual impact in Yalding and provide benefits over a wider area with opportunities for environmental enhancement. The proposed measures are as follows: <ul style="list-style-type: none">• Increased storage at Leigh Barrier and on-line storage at EdenBridge, combined with• Local defences. This is likely to require the construction of one or more embankments, the diversion of local drainage and a pumping station to drain runoff from within the protected area. Access to the properties would still be cut off during a major flood but flood damage would be minimised.		
Managing residual flood risk <ul style="list-style-type: none">• Flood warning• Development control		
Future changes The predicted increase in future flood risk as a result of climate change is modest, with an additional 47 properties (around 25%) at risk during the 1 % annual probability flood. The construction of Stile Bridge storage reservoir and extensions to the local defences scheme should be considered in the long term if the increase in flood risk is realised.		


RIVER:	MEDWAY	
FLOOD RISK AREA:	LEIGH	
Location of properties at risk The properties indicated to be at risk by the modelling and MDSF are principally the sailing clubhouse and properties downstream of the Leigh Barrier. The latter is not a true reflection of the actual situation and has been discounted. The table below has therefore been amended to show that the MSDF results represent an upper bound. As part of the construction of the Leigh Barrier scheme it is understood that properties at risk in the village of Leigh would not be put at risk in a 2 % annual probability flood.		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	<7	
Residential	<5	
Commercial	<2	
Existing standard of protection	Approx. 2% annual probability of flooding	
Indicative standard of protection	1 - 4% annual probability of flooding	
Present value Do Nothing damages	<£1 million	
CFMP Policy	Increase flood risk to agricultural land. No additional properties would be placed at risk.	
Proposed strategy		
Increasing the capacity of Leigh Barrier would increase flood risk in Leigh. Additional local defences will be provided as part of the Leigh Barrier increased storage scheme to maintain the existing flood risk to property.		
Managing residual flood risk		
<ul style="list-style-type: none">Flood warningDevelopment control		
Future changes		
The predicted increase in future flood risk as a result of climate change is small, with one additional property at risk during the 1 % annual probability flood. No additional construction measures are proposed.		


RIVER:	MEDWAY	
FLOOD RISK AREA:	TONBRIDGE	
Location of properties at risk The properties at risk are distributed along a 2km length in the centre of Tonbridge, with two main clusters as follows: <ul style="list-style-type: none">On the right bank upstream of the castleOn the left bank adjacent to Bath Fields		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	114	
Residential	74	
Commercial	40	
Existing standard of protection	Approximately 1% annual probability of flooding	
Indicative standard of protection	0.5 - 2% annual probability of flooding	
Present value Do Nothing damages	£55 million	
CFMP Policy	Reduce flood risk	
Proposed strategy		
<p>Continued maintenance of the Leigh Barrier and review of the operating rules is a key element of the strategy to protect Tonbridge. Increasing the storage at Leigh Barrier and storage at Edenbridge are major components of the proposed strategy for the Middle Medway area. The combination of these would provide protection from a 1 % annual probability event.</p> <p>The proposed measures are as follows:</p> <ul style="list-style-type: none">Continue maintenance and optimised operation of the Leigh BarrierIncrease the storage at Leigh Barrier and construct a storage reservoir upstream of Edenbridge		
Managing residual flood risk		
<ul style="list-style-type: none">Flood warningDevelopment control		
Future changes		
<p>The predicted increase in future flood risk as a result of climate change is significant, with an additional 79 properties at risk during the 1 % annual probability flood. Raising of the local defences should be considered if this increase in flood risk is realised.</p>		

RIVER:	MEDWAY / BOURNE	
FLOOD RISK AREA:	GOLDEN GREEN / HADLOW	
Location of properties at risk The majority of properties are at risk from flooding from the River Bourne. Properties are clustered in three areas as follows: Hadlow, Golden Green, and adjacent to Hartlake Bridge across the River Medway.		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	13	
Residential	10	
Commercial	3	
Existing standard of protection	20 % annual probability of flooding	
Indicative standard of protection	1 - 4% annual probability of flooding	
Present value Do Nothing damages	£3.2 million	
CFMP Policy	Maintain present flood risk (short term)	
Proposed strategy No construction measures are proposed.		
Managing residual flood risk <ul style="list-style-type: none">Flood warningDevelopment control		
Future changes The predicted increase in future flood risk as a result of climate change is small, with two additional properties at risk at the 1 % annual probability flood. No additional construction measures are proposed.		

RIVER:	MEDWAY	
FLOOD RISK AREA:	FIVE OAK GREEN	
Location of properties at risk The properties at risk are dispersed throughout the Five Oak Green flood risk area. The main property concentrations are found in the hamlets of Hartlake to the north of the River Medway and Tudeley Hale to the south of the Medway.		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	10	
Residential	9	
Commercial	1	
Existing standard of protection	10 % annual probability of flooding	
Indicative standard of protection	10 - 80% annual probability of flooding	
Present value Do Nothing damages	£2.3 million	
CFMP Policy	Maintain present flood risk (short term)	
Proposed strategy No construction measures are proposed.		
Managing residual flood risk <ul style="list-style-type: none">Flood warningDevelopment control		
Future changes The predicted increase in future flood risk as a result of climate change is small, with one additional property at risk at the 1 % annual probability flood. No additional construction measures are proposed.		

RIVER:	BOURNE / MEDWAY	
FLOOD RISK AREA:	EAST PECKHAM/ LITTLE MILL	
Location of properties at risk The majority of properties at risk in East Peckham are situated in four locations as follows: <ul style="list-style-type: none">• Branbridges industrial estate on the right bank• On the island in the River Medway• Along Old Road on the left bank• Hale Street The properties at risk in Little Mill are on both banks of the river Bourne primarily upstream of the bridge		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	133	
Residential	117	
Commercial	16	
Existing standard of protection	> 20% annual probability of flooding	
Indicative standard of protection	0.5 - 2% annual probability of flooding	
Present value Do Nothing damages	£66 million	
CFMP Policy	Reduce flood risk	
Proposed strategy		
<p>The preferred strategic storage measures would provide some reduction in flood risk in East Peckham/ Little Mill. Additional storage at Leigh Barrier combined with storage upstream of Edenbridge would reduce the number of properties flooded in the 1% annual probability flood by 32. To provide an increased standard of protection to around 100 of the properties in East Peckham to around the 1% annual probability flood, local defences combined with the strategic storage schemes are proposed. The combined scheme has a benefit cost ratio of 5.2 and a Defra priority score of 10.</p> <p>Storage on the River Bourne providing local protection for Little Mill appears to have a detrimental effect downstream on the Medway and would not proceed without mitigation.</p> <p>The proposed measures are as follows:</p> <ul style="list-style-type: none">• Increased storage at Leigh Barrier and on-line storage at EdenBridge, combined with• Local defences to properties in East Peckham. This will require the construction of a number of separate embankments/walls, the diversion of local drainage and a pumping station to drain runoff from within the protected area. Access to a number of the properties would still be cut off during a major flood but flood damage would be minimised.• In the medium term re-evaluate the potential for local defences to Little Mill		
Managing residual flood risk		
<ul style="list-style-type: none">• Flood warning• Development control		
Future changes		
<p>The predicted increase in future flood risk as a result of climate change is significant at the 1 % annual probability event, with an increase of 44 in the number of properties at risk. Consideration should be given to raising the local defences or providing additional local defences if this increase in flood risk is realised.</p>		

RIVER:	MEDWAY	
FLOOD RISK AREA:	TESTON/ EAST FARLEIGH	
Location of properties at risk Almost all of the properties at risk are situated in East Farleigh with the majority on the left bank of the River Medway		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	16	
Residential	9	
Commercial	7	
Existing standard of protection	> 20% annual probability of flooding	
Indicative standard of protection	1 - 4% annual probability of flooding	
Present value Do Nothing damages	£23 million	
CFMP Policy	Reduce flood risk	
Proposed strategy The preferred strategic storage schemes at Leigh Barrier and Edenbridge reduce the number of properties at risk by four. Additional local protection to the properties at risk in East Farleigh has not been evaluated at this stage but should be considered in the medium term. In the short term flood risk should be managed through flood warning.		
Managing residual flood risk <ul style="list-style-type: none">Flood warningDevelopment control		
Future changes The predicted increase in future flood risk as a result of climate change is significant, with a doubling in the number of properties at risk during the 1 % annual probability flood. This reinforces the need to consider local defences in the medium term, particularly if the increase in flood risk is realised.		

RIVER:	MEDWAY	
FLOOD RISK AREA:	MAIDSTONE	
Location of properties at risk The properties at risk in Maidstone are distributed along both banks of a 2km long stretch of the River Medway.		
Current Situation		
Number of properties at risk in 1 % annual probability of flooding	128	
Residential	37	
Commercial	91	
Existing standard of protection	10 % annual probability of flooding	
Indicative standard of protection	0.5 - 2% annual probability of flooding	
Present value Do Nothing damages	£68 million	
CFMP Policy	Reduce flood risk	
Proposed strategy		
<p>The preferred strategic storage schemes of Leigh Barrier increased storage and Edenbridge storage increase the standard of protection in Maidstone to 4 % annual probability of flooding and reduce the properties at risk in the 1 % annual probability flood by 50.</p> <p>To provide improved protection, a stand-alone local protection scheme has been evaluated and would comprise three separate stretches of flood wall immediately adjacent to the river with associated drainage measures. This option has a benefit cost ratio of 5.1 but an incremental benefit cost ratio of less than 1.0. This is not likely to proceed in the short to medium term.</p> <p>The proposed measures are as follows:</p> <ul style="list-style-type: none">Construct additional storage at Leigh BarrierConstruct storage upstream of Edenbridge andIn the long term re-evaluate local defences to further increase the standard of protection		
Managing residual flood risk		
<ul style="list-style-type: none">Flood warningDevelopment control		
Future changes		
<p>The predicted increase in future flood risk as a result of climate change is significant, with the number of properties at risk during the 1 % annual probability flood more than doubling. The construction of Stile Bridge storage reservoir and a review of the case for local defences should be considered if this increase in flood risk is realised.</p> <p>On the basis of the present model study, and study by Mott MacDonald (2001), the future 1% and 0.5% annual probability tidal flood events in Maidstone are likely to be lower than the present fluvial flood events of the same return periods. However, it is recommended that this issue be examined as part of a future model study of the tidal Medway which should take into account the impact of sea level rise as a result of climate change</p>		

APPENDIX D**Strategy Consultation: Summary of Comments and Actions**

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River/ Location	Description	Comments/Action(s) taken in Strategy Study
River Beult	Den Lane/Farm - IDB Ditch 104 discharges into Beult; can improvements be made to it? It acts as a critical relief for water affecting properties in Den Lane and Haviker Street	Only likely to have local benefits. Can be considered as part of a local scheme.
	<ul style="list-style-type: none"> ♦ Dredging of the Beult would destroy some of the clay river flora within the SSSI, plus geomorphological benefits would be negative. ♦ Lower invert level of Beult along with dredging 	<ul style="list-style-type: none"> ♦ Channel re-profiling has only been considered along the Medway and the SEA highlights the high negative environmental impact of this option ♦ No significant impact likely. Not modelled in Strategy. Negative environmental impacts.
	R. Beult SSSI in unfavourable condition due to diffuse source pollution (mostly from sewage stations on the Beult - phosphate stripping plants)	Noted, but strategic options provide few opportunities to address sources of pollution.
	Offline storage at Headcorn. The positive impacts in Headcorn would be fairly small as much of Headcorn flooding does not originate from Main Rivers.	In 1960 the High Street flooded. However, not likely to have significant benefits and not modelled in the Strategy.
	The flood defence wall in Smarden suggests that there is a definite location for a wall. Properties affected by flooding are disparate so this may not work; how is that a wall is likely to cause the loss of meanders?	This option was not modelled. However, local structural defences in Smarden have been considered as part of the Strategy.
	Flood defence wall for Yalding. Please see stand alone flood defence strategy for Yalding.	The stand alone Feasibility report for Yalding was consulted as part of this Study and has been used in the development of stand alone defence recommendations.
	Dredging. Dredging the Beult may lessen impact of lower order events however flood flow is well out of bank, lack of slope on lower reaches of Beult tends to be critical factor. SSSI killer blow	Conveyance options not modelled but considered as part of the Strategy. High negative environmental impacts noted in SEA.
	Is it possible that we have not considered conveyance improvement downstream of Yalding, or do we feel that it is not an option?	Conveyance along the Beult not considered as a strategic option.
River Bourne	Removal of bunds on Bourne - seen to increase the flood risk at Little Mill with no significant benefit elsewhere.	No formal defences are maintained by the Agency. The Agency is not aware of any bunds on the Bourne - possibly formed of dredged deposits. There are no proposals to remove bunds on the Bourne.
	Online storage at Hadlow - only benefits to Hadlow are at the agricultural college, but slab levels prevent flooding most of the time. Further downstream in Little Mill there are about 20 or 30 houses that flood	Strategy modelled online storage upstream of Little Mill
	Removal of bunds on the Bourne. Didn't know there were bunds on the Bourne in Hadlow, this sounds nice, does this become a "storage option" and why would it increase levels in East Peckham, is this because it delays the peak?	EA not aware of any bunds on the Bourne - possibly formed of dredged deposits (locations unconfirmed). No formal defences are maintained by the Agency. Not considered as a strategic option.

River/ Location	Description	Comments/Action(s) taken in Strategy Study
Medway	Consider effects of increasing Leigh Barrier capacity on Leigh	Locally raises water levels in Leigh, so local structural defences proposed in combination with this option.
	Option for online storage on the Eden should consider additional benefits for Edenbridge (outside study area)	Online storage has been modelled upstream of Edenbridge
	East Peckham Flood Relief Scheme ongoing	PAR issued in April 2004 and referenced in this Study
	Will raising barriers in Tonbridge be needed if Leigh Barrier raised?	Addressed with Leigh Barrier option – Tonbridge already has a 1 in 100 year standard of defence.
	River Sherway SNCI, Kelsham Farm Orchards SNCI should also be considered, but likely to be many others (Kent Wildlife Trust)	Environmental baseline data updated and addressed in Strategic Environmental Assessment (SEA) report
	Overtopping of River Medway above sluice weir gives flood flows through the Hop Farm/Branbridges Ind Est into the Tudeley Brook above Branbridges Road culvert	Local water levels in this area investigated to ensure that flooding in East Peckham more accurately modelled.
	Online storage on the Eden - what effect on Edenbridge, could this further promote the scheme?	Online storage has been modelled upstream of Edenbridge and the effects on Edenbridge considered.
	Online storage on the Eden and increased storage capacity of the Leigh Barrier – unlikely to protect Five Oak green as it is so remote from the flood plain	Protection to Five Oak Green not considered as a strategic option.
	Offline Storage at Hildenborough. The recreation grounds are estimated to flood on about a 1 in 7 year event. Should we construct a washland there and add floodplain enhancements where would the rugby club play? Secondly it is believed that flooding in Hildenborough is caused by water coming down the Hildenbrook and flowing back up the Hawden stream into Hildenborough.	Local effects of Hildenbrook and Hawden stream not considered as part of the Strategy as not included in the hydraulic model.
	East Peckham offline storage. If the positive impact of this scheme is focussed downstream of E. Peckham it would seem that a gravel pit is being defended. There are no other benefits downstream of E. Peckham within the range of so small a scheme	No obvious area available for storage and no obvious protection would be provided. Therefore, not modelled in the Strategy.
	Flood defence wall in Tonbridge. Does the model include the effects of the mill stream, botany stream and gas works streams (braids of the Medway) which are at some points culverted as well?	These local affects are not included in the model as it focuses on catchment wide effects.

River/ Location	Description	Comments/Action(s) taken in Strategy Study
Medway (continued)	Depending on the level of detail you are going into at this stage you may find that tributaries kill many of your wall options in East Peckham and Collier Street.	Modelling of tributaries was not carried out as part of the Strategy due to time and budgetary constraints, it was also not considered appropriate at this level of modelling. Local structural defences have been considered in both East Peckham and Collier Street.
	It is felt that some attention should be paid to the possibility of renovation of Eldridges Lock. At the moment some of the flooding that occurs in Tonbridge is caused by backing up from this structure	Conveyance options not modelled but considered as part of the Strategy.
	How was the decision taken to limit the Strategy to exclude Edenbridge? It seems that the low standard of service (1 in 30) at this location and high number of people (200 houses) at risk may mean that we are missing a trick	Scope of Strategy (and hydraulic model) extended to include Edenbridge.
	Suggest Teise and Beult need attention with respect to flood risk management before upgrading the Medway defences further.	Storage options on the Teise and Beult considered as strategic options.
	Suggest Dredging Beult = rank 1, Flood relief channel at Lamberhurst and restriction of flow into Lesser Teise = rank 2 (best if done together), Removal of bunds on the Bourne = rank 4	Noted, but these options were not modelled as part of the Strategy.
	Structural protection - not seen as affording any appropriate protection for more than a few properties because of the diverse flow channels into and through the village under flood conditions.	A number of isolated, localised flood embankments considered as part of strategy for defending East Peckham
	Depressed mussel is a designated species and is found between Tonbridge and Yalding	Noted and considered in SEA
River Teise	Measures to control Teise and structural protection around lower parts of village should also be considered	Local structural defences have been considered at Yalding.
	Embankments on the Teise are flood defences and were built in the 40s and 50s. Some maintenance has been carried out in the last decade, but they are in poor condition	Some local bunds may be present south of Collier Street, but these are not tied into high ground and thus do not form a viable defence. These are not formally recognised and maintained by the Agency.
	Offline storage at Great Cheveney. This one looks nice, but do the comments for online storage at Lamberhurst kill this one?	No, Great Cheveney offline storage modelled and considered as a strategic option.
	Offline storage at Claygate. Will not protect Lamberhurst unless it stops the tide reaching there!	No viable location for storage at Claygate was found. A storage option for Lamberhurst was modelled.
	Offline storage at Collier Street. The landowner has indicated that she will be reluctant to sell more of her land for flood defence schemes.	Environmental opportunities - hobby sheep grazing area, but not considered as a strategic option.
	Flood defence walls in Lamberhurst. How does building a wall cause loss of meanders?	May require local realignment of river banks. Flood defence wall in Lamberhurst modelled as part of the Lamberhurst online storage option.

River/ Location	Description	Comments/Action(s) taken in Strategy Study
River Teise (continued)	Flood defence walls around perimeter of Collier Street. See above location of walls, would have to take account of tributaries outflanking linear defences, annular defences would need to show no negative storage impacts.	Reviewed in Strategy – local defences considered around Collier Street along with individual property protection.
	The area of Laddingford that floods is defined by the pub in the centre and a couple of houses near that, but the real benefits are found on the left bank of the Teise among the isolated properties between the Teise and the B2017.	Local defences in Laddingford considered as part of the Strategy.
River Teise at Collier Street	Widen/raise piers on Spitz Bridge (restricts flows)	Only likely to have local benefits. Not modelled in Strategy, but worthy of consideration at local scheme level.
	IDB Ditch 19 is designated wildlife reserve for section through Haviker Street (Kent Wildlife Trust)	Noted. No scheme proposed by strategy directly affects this stream.
	IDB Ditch improvements - open cut section added in summer 2003 along Benover Road to piped section	Noted. No scheme proposed by strategy directly affects this stream.
	Would prefer off/on-line storage instead of wall	No space for locating local storage at Collier Street with potential for catchment wide benefits. Strategic storage options modelled in Strategy do reduce flooding in Collier Street, but some properties will still flood. Local defences required around Collier Street to defend remaining properties; these are likely to compromise small flood embankments
Lesser Teise	Consider reopening meanders running from Lesser Teise to Beult via Chainhurst	No significant impact likely. Environmental opportunity - small effects. Not considered as an option with catchment wide benefits. May be beneficial for inclusion at individual scheme level.
	Include Marden Mill Stream which enters Lesser Teise at Brook Farm in modelling	No significant impact likely. High points in the area mean few properties flooded. Not included in model.
	Flood defence wall through Marden. I would be interested to know which parts of the Marden/Hadlow town flood as we do not think any parts of the town do. The places to build walls would be around houses in the centre of the flood plain. (see storage above for where the benefits are in Hadlow i.e. Little Mill)	Reviewed in Strategy – no local defences in Marden considered as a strategic option
	Restriction of flow into the Lesser Teise. This one is interesting, but what happens to Laddingford and Yalding	Conveyance along the Teise not considered as a strategic option.
Other	Would like technical seminars for stakeholders	Under consideration by the Agency

River/ Location	Description	Comments/Action(s) taken in Strategy Study
	English Nature advocates multi-benefit washlands into which flood flows can be diverted	Washland creation has been considered for the main storage options and commented upon in the SEA

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APPENDIX E

NRG MINUTES AND QUERY / RESPONSE SHEET

**Extract of Minutes of meeting held on 28th April 2005
For Middle Medway Strategy Study**

Attendees

Members

David Cotterell – Chairman (National FD Technical Manager – Improvements) (DC)
Pat Else (Regional Procurement Manager) (PE)

Peter Midgley (Southern Regional Strategic Manager) PM
Kevin Boulton (NCPMS Client Manager – Midlands) (KB)
John Corkindale (Senior Economist – Environmental Policy HO) (BW)
Bernard Ayling (NCPMS) (BA) Supporting Member
Ross Marshall (NEAS Manager) (RM)

NRG Observers

John Parker – Head of Investment and Funding (Water Management) (JP)
Jane Rawson – Flood Risk Management Policy Co-ordinator (Flood Defence) (JR)

Jenny Buffrey - NRG Technical Manager (JB)

Submissions For Review	Project Manager / Executive	Project Reference	Level of EIA	Recommendation
Middle Medway Strategy Study	Chris Harding Richard Hull	IMHK40164	SEA	The submission is not recommended for approval at this stage.

ITEM	Actions
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2.0 Projects and Strategies Submitted for Review

2.1 Middle Medway Strategy Study

Agency Approval Value: £17.352 (five-year programme of works)

Whole Life Cost (100 years):£152m

Project Manager: Richard Hull

Project Executive: Chris Harding

Presented by: Richard Hull, Chris Harding, and John Gosden (BB&R)

2.1.1 Background

The Middle Medway Strategy investigates and recommends Flood Risk Management options for two thirds of the Middle Medway fluvial catchment, which includes most of the Medway river basin, including the Bourne, Eden, Beult and Teise tributaries. A significant feature of the Medway is that it is maintained for navigation from its mouth to Leigh, a distance of 31km. To provide sufficient draft for vessels a cascade of 10 control structures controls the river levels. These affect the river hydraulics and natural processes. At Leigh, the Medway is also regulated by the Leigh Barrier flood storage scheme, which was commissioned to protect the town of Tonbridge from flooding. The confluence of the Beult and Teise poses a particular risk. Flood risk affects numerous settlements, all with different standards of defence. Some 865 properties are at risk from flooding in a 1% annual probability event and 382 from a 4% annual probability event. 490 properties flooded during the last major event in 2000.

A long list of options were developed in the Catchment Flood Management Plan. This was reduced to a short list following consultation and high level assessment and only the environmentally acceptable options were taken forward for detailed appraisal. Final selection was based on economics the differences were

environmentally neutral.

£613k has been incurred on preparation costs of the Strategy.

2.1.2 Environmental

The River Beult and Lingfield Cernes are designated sites of special scientific interest and a Strategic Environmental Assessment has been undertaken. However, since the Strategy and SEA were initiated prior to introduction of formal SEA regulations, the SEA may not fully comply with all the regulations. However, as the regulations and guidance are now current best practice, they have been applied wherever possible to the strategy plan and to production of the SEA.

Agreement to the proposals has been provided by English Nature and other consultees. There are opportunities for modest environmental improvements.

2.1.3 Preferred Strategic Solutions

The following options were selected on economic grounds:

- 3.1 Mm³ additional flood storage to be provided above the Leigh Barrier
- 5.6 Mm³ Flood Storage above Edenbridge

Preferred Local Solutions

- Flood walls and embankments in Yalding, East Peckham and Collier Street

2.1.4 Funding

The Defra Priority Score for the whole of the Strategy is 9.6, which is considerably below the current Defra threshold. Individual scores are 18 for the Storage at Leigh and 15 for the work proposed at Yalding.

2.1.5 Economic Justification of the Preferred Strategy

Present Value costs	£62.548k	Incremental B/C	2.4
Present Value damage	£111,870k	Properties protected (4% probability):	268
Present value benefits	£306,934k.	Properties protected (1% probability):	547
Net Present value	£244,386k		
Benefit Cost ratio	4.9		

2.1.6 Implementation Risks and Proposed Mitigation

1. Acts of Parliament or Statutory Instruments required for storage reservoirs.	1. Plan for minimum 5 year approval for new storage embankments
2. Inaccurate capital cost estimation	2. Optimism Bias of 60%
3. Consent from landowners	3. Early involvement
4. Community acceptance of proposals	4. Communication plan for feasibility studies across the catchment

2.1.7 NRG General Comments

The direction of the document was generally supported, although the report was considered to be rather long, over 120 pages. Some of the issues could be drawn into the appendices. A number of amendments to the document are noted under “NRG Issues to be addressed”.

Concern was expressed about achievement of the 5 year timescales, given issues

such as Acts of Parliament, landowner interests, links with Navigation etc. It was also noted that the submission will require Treasury approval, which may take some time to process. This should be identified as a risk. The team were confident that the timescales specified were achievable.

In addition the team were asked to provide confidence that what was being built will be simple to operate with minimum operation costs in relation to manpower resource, etc. The team explained that while use of storage schemes is complex, they were confident that they had the best whole life costs for providing strategic storage and ongoing manning costs had also been included for operations and maintenance. There will be an opportunity to look at linkages between the storage systems to minimise operational costs at the feasibility stage.

Environmental Issues

The team were congratulated for inclusion of a Strategic Environmental Assessment (SEA). A number of improvements were suggested. These are included under “NRG issues to address”.

NRG Summary

The submission is well written and well put together and provides a good strategic solution. The economics have been addressed strategically and as such they are very visible in the main document. However cost per property is very high and little attempt has been made to optimise the appraisal decision by considering options offering different SOS. No attempt has been made to differentiate between any of the properties and the standard of protection that would be achieved and so contributions towards Defra targets cannot be readily identified. There are risks associated with achievement of the 5 year programme in relation to Treasury approval etc. There was some uncertainty about whether work could start before Treasury approve.

2.1.8 NRG Issues to Address

- i. Provide a more objective explanation of the differences between the options in the summary table of the SEA, in terms of environmental acceptability.
- ii. Provide details of how the scoping, consultation, consents and planning time frames, etc. will be taken forward.
- iii. State what has been said by the consultees and how these comments have been addressed
- iv. Demonstrate how the cumulative effects of the proposals for adjoining areas have been considered and identify any links between the CFMP and this Strategy.
- v. Identify what expenditure will be incurred for 05/06 in table 1.3 in the executive summary and revise the table to reflect the 5 year working period.
- vi. Amend wording in table 1.6 to “NRG recommendation for approval April 2005”.
- vii. Provide a strategic procurement strategy and identify risks, i.e. new Consultancy Framework on the horizon (NEECA 2)
- viii. Identify where there is scope for contributions
- ix. Liaise with Legal and Estates to establish an early strategy to enable work to start on dealing with landowner issues
- x. Consider whether to remove the SoD request and issue as a Strategy only

RH/CH

- xi. The team are advised not to identify potential enhancements at the strategic stage as this may establish public expectations that cannot be realised.

Note: Sections of report may need to be edited.

Action: A Query response form should be completed and issued to the NRG Technical Manager along with a revised Strategy document. Please ensure that the version number of all re-submitted documents is revised and ensure that this is clearly visible in the file name and folder.

Action: NRG to resolve confusion concerning Strategy approval

2.1.9 Recommendation: The submission is not recommended for approval at this stage.

2.1.10 Further Approval Process if the submission returns for Chairman's Action:
Once signed by the Chairman, the SoD coversheet should be passed to the Regional SoD Co-ordinator to arrange for Regional approval and then forwarded to the National SoD Co-ordinator to arrange for national sign off and Agency Board approval.

Approvals Query Response Template

	Title of Document being reviewed: Middle Medway Strategy Study		Project Ref: IMSO 000532
	Date of NRG Review Meeting: 28 April 2005 Date Query/Response Form Returned: 12 August 2005		Status: Approved in principle
Item No.	Section & Page Number in PAR / Form G Executive Summary	Comment:	Action proposed by project team
1.	Appendix I (Strategic Environmental Assessment) Page 60 -61	Provide a more objective explanation of the differences between the options in the summary table of the SEA, in terms of environmental acceptability.	Better explanation given of option ranking and how cumulative effects were considered when looking at combined options. Consistency between SEA Matrix and Summary tables improved including adding page reference and explanation of key. Mention of assessment of cumulative effects made in PAR section 5.4, page 30. New section added to table in Appendix I 9 (page 167) explaining the impacts of these combined options.
2.	Section 8 page 72	Provide details of how the scoping, consultation, consents and planning time frames, etc. will be taken forward.	A more detailed project plan has been developed outlining key activities and time scales.
3.	Section 5.6 page 34	State what has been said by the consultees and how these comments have been addressed	Full details of consultation responses are presented in Volume 5, Appendix I8. A condensation of the comments made by consultees and the actions taken or responses made during the preparation of the Strategy is given in Appendix D accompanying the PAR in Volume 1.
4.	Section 4.0 Page 20	Demonstrate how the cumulative effects of the proposals for adjoining areas have been considered and identify any links between the CFMP and this Strategy.	Linkages between the CFMP and strategy are expanded on in the description of how options were developed from CFMP stage through to strategy appraisal. There are no significant cumulative effects due to the dispersed nature of the works and variations in the nature and scale of

Title	Approvals Query Response Template				
No.	128_05_SD02	Status:	Version 2	Issue Date:	08/03/05 Page 1 of 1

Approvals Query Response Template

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	Date of NRG Review Meeting: 28 April 2005 Date Query/Response Form Returned: 12 August 2005		Status: Approved in principle
Item No.	Section & Page Number in PAR / Form G Executive Summary	Comment:	Action proposed by project team
			impacts. However, this comment is fully addressed by the same points made under Item 1 above.
5.	Section 1.7 Page 4	Identify what expenditure will be incurred for 05/06 in table 1.3 in the executive summary and revise the table to reflect the 5 year working period.	Additional monies added in 2005/6 to carry out strategy revisions and table revised to include all anticipated expenditure in five year period
6.	Section 1.11 Page 6	Amend wording in table 1.6 to “NRG recommendation for approval April 2005”.	Changed to NRG recommendation for Approval August 2005
7.	Section 8.2 Page 72	Provide a strategic procurement strategy and identify risks, i.e. new Consultancy Framework on the horizon (NEECA 2)	New Procurement strategy produced addressing these risks
8.	Section 8.2.1 Page 72	Identify where there is scope for contributions	Scope identified although no further work done on seeking these contributions at this stage.
9.	Section 8.3 page 73	Liaise with Legal and Estates to establish an early strategy to enable work to start on dealing with landowner issues	Strategy developed following meeting with Legal. Incorporated in Section 8.
10.	Executive summary and recommendations	Consider whether to remove the SoD request and issue as a Strategy only	Following discussion with NRG Chair, FSoD approval sought on PAR development and also Yalding scheme construction costs. Monte Carlo risk assessment carried out to confirm robustness of optimism bias assumptions.

Title	Approvals Query Response Template				
No.	128_05_SD02	Status:	Version 2	Issue Date:	08/03/05 Page 2 of 1

Approvals Query Response Template

	Title of Document being reviewed: Middle Medway Strategy Study		Project Ref: IMSO 000532
	Date of NRG Review Meeting: 28 April 2005 Date Query/Response Form Returned: 12 August 2005		Status: Approved in principle
Item No.	Section & Page Number in PAR / Form G Executive Summary	Comment:	Action proposed by project team
11.		The team were advised not to identify potential enhancements at the strategic stage as this may establish public expectations that cannot be realised.	References to specific potential environmental enhancements removed throughout the Strategy documents.
12.	Section 7.8 p 69	Following NRG, the chairman requested that further explanation is given of postcode sectors benefiting from the proposed works and how this affects their classification in ABI categories of high, medium and low risk.	Further analysis work undertaken and number of properties moving between ABI categories are identified along with their postcode sector.
13.	Section 1.9, 8.9 and Appendix J	Following NRG, the chairman recommended that the project team carry out a Risk 2.2 Monte Carlo analysis on scheme construction costs, so these could be included in the strategy approval.	<p>Construction costs for the Leigh Barrier scheme are estimated to a level of detail appropriate for strategy A9 approval including a 60% optimism bias. To improve further on these costs would require significant SI works and compensation negotiation. A2 Approval is therefore not appropriate for the Leigh Barrier scheme at this stage.</p> <p>Construction costs for the Yalding Flood walls scheme are more predicable and so further work and site inspections have been carried out to enable a detailed Risk 2.2 register to be compiled and analysed using a 'Monte Carlo' probability simulation. This demonstrated that the risk value is less than the 60% optimism bias used for approval, at a 95% confidence limit. A2 approval is sought for the Yalding scheme.</p> <p>See references under Item 10.</p>

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