

Strategy Appraisal Report

Authority scheme reference

Defra/WAG LDW number

Promoting authority

Environment Agency Midlands Region

Strategy name

Isle of Axholme Flood Risk Management Strategy



Upstream side of Keadby Pumping Station on River Torne (about 2009)

Date

June 2012

Version

Version 2 – Submission to LPRG

StAR for *Isle of Axholme Flood Risk Management Scheme*

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1	Submission to LPRG			24/01/2012
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For technical approval of the business case

Environment Agency Region:

Project name: Isle of Axholme Flood Risk Management Strategy

Approval Value: £ 823,000,000

Sponsoring Director: David Jordan **Director of Operations**

Non-financial scheme of delegation

Part 11 of the Non-financial scheme of delegation states that approval of FCERM Strategies/Complex Change Projects, following recommendation for approval from the Large Projects Review Group, is required from the Regional Director or Director, Wales and Director of Operations.

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Approval history sheet

APPROVAL HISTORY SHEET (AHS)			
1. Submission for review (to be completed by team)			
Project Title: Isle of Axholme FRMS		Project Code: IMMI000778	
Project Manager: John Pygott		Date of Submission: 24 January 2012	
Lead Authority: Environment Agency		Version No: 2	
Consultant Project Manager: Mike Dobson		Consultant: Black & Veatch	
<p><i>The following confirm that the documentation is ready for submission to PAB or LPRG. The Project Executive has ensured that relevant parties have been consulted in the production of this submission.</i></p>			
Position	Name	Signature	Date
Project Executive	Paul Stainer		
	Job Title:	Project Team Manager	
2. Review by: Large Projects Review Group (LPRG)			
Date of Meeting(s):		Chairman:	
Recommended for approval: In the sum of £:		Date:	Version No:
3. Environment Agency NFSoD approval <i>Officers in accordance with the NFSoD.</i>			
Version No:		Date:	
Project Approval	By: In the sum of: £	Date:	
4. Defra or WAG approval <i>(Delete as appropriate)</i>			
Submitted to Defra / WAG or Not Applicable (as appropriate)		Date:	
Version No. (if different):			
Defra/ WAG Approval: or Not applicable (as appropriate)		Date:	
Comments:			

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

1. Project name	Isle of Axholme FRMS		Start date	2013
			End date	2112
Business unit		Programme		
Project ref.		Regional SoD ref.	Head Office SoD ref.	-

2. Role	Name	Post Title
Project Sponsor	Innes Thomson	Area Flood Risk Manager
Project Executive	Paul Stainer	ncpms Project Team manager
Project Manager	John Pygott	ncpms Project Manager

3. Risk Potential Assessment (RPA) Category	Low	<input checked="" type="checkbox"/>	Medium	<input type="checkbox"/>	High	<input type="checkbox"/>
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4. NFSoD value	£k
Whole Life Costs (WLC) of Complex Change Project / Strategic Plan	823,000

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

6. NFSoD approver name	Post title	Signature	Date
Mark Sitton-Kent	Regional Director/Director Wales		
David Jordan	Director of Operations		
NFSoD consultee name	Post title	Signature	Date
Ken Allison	LPRG Chair		
Mark Ross	NEAS Operations Manager		
Innes Thomson	Area Flood Risk Manager		
Andrew Russell	National Operations Manager		

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Glossary

Term	Description
Appropriate Assessment	Prescribed in Article 6(3) and (4) of the Habitats Directive (92/43/EEC) an assessment which must be appropriate to its purpose under the Habitats Directive and Regulations, neither of which specify how the stages of AA should be undertaken.
BAP	Biodiversity Action Plan
BCR	Benefit Cost Ratio. A ratio attempting to identify the relationship between the cost and benefits of a proposed project. It is used to measure both quantitative and qualitative factors as sometimes benefits and costs cannot be measured exclusively in financial terms.
CFMP	Catchment Flood Management Plan
FDEM	Flood Damage Economics Method – a GIS method for applying property level damages
FDGiA	Flood Defence Grant in Aid
FRMS	Flood Risk Management Strategy
GIS	Geographical Information System
HSE	Health & Safety Executive
IDB	Internal Drainage Board
LiDAR	Light Detection and Ranging. An optical remote sensing technology analogous to Radar processed in order to produce a variety of products including contour maps, cross-sections and digital elevation models.
MCM	Multi-coloured Manual. The Benefits of Flood and Coastal Risk Management: A Manual of Assessment Techniques, Flood Hazard Research Centre (2005) and The Benefits of Flood and Coastal Risk Management: A Handbook of Assessment Techniques - 2010, Flood Hazard Research Centre (2010)
NPD3	National Property Dataset version 3
NVZ	Nitrate Vulnerable Zones. Areas of land that drain into waters polluted by nitrates.
Onset of flooding	Like 'standard of protection', this defines the probability of a flood event occurring. However, in this case it is when a defence is likely to be at risk of overtopping and some flooding is likely to occur. For this reason, the water level which causes the onset of flooding has a lower probability (i.e. it is less likely to occur) than the design water level that is used to calculate standard of protection.
PS	Pumping station
RAG	Red Amber Green list – typically used to specify safe and less safe activities
Ramsar	The Convention on Wetlands (Ramsar, Iran, 1971), the "Ramsar Convention". An intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their Wetlands of International Importance and to plan for the "wise use", or sustainable use, of all of the wetlands in their territories.
RBMP	River Basin Management Plan
SAC	Special Area of Conservation
SoP	Standard of Protection. The probability of the flood event that the defence has been designed to protect against. However, an event that results in a higher water level than this design level would not necessarily overtop the defence. This is because the height of a defence includes an allowance for uncertainties and the many factors that can affect the water level, such as waves, seasonal variations in vegetation, settlement of defences and super-elevation of flow on bends. This allowance is commonly referred to as 'freeboard'.
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
WFD	Water Framework Directive
WLMP	Water Level Management Plan

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1 Executive summary

1.1 Introduction and background

- 1.1.1 The Isle of Axholme (IoA) is located across East Riding of Yorkshire, Doncaster, North Lincolnshire and Nottinghamshire. The IoA FRMS covers an area of 520km², of which 380km² is dependent on artificial drainage and pumping carried out by the Environment Agency and IDBs; without this it would be regularly flooded with ground levels of less than 3.0mOD which is below tidal levels in the rivers that border it. In addition to this drainage system, the strategy concentrates on managing flood risk from the Rivers Torne and Idle where they flow across this low lying area. It is recognised that there is a clear link between land drainage and flood risk management activities in controlling flood risk. Most of this area is also at risk from tidal or fluvial flooding from the Rivers Trent, Ouse and Don and is protected from this by large flood banks adjacent to these rivers. The study area is shown in Figure 1.1.
- 1.1.2 The area contains 28,000 properties and over 30,000 hectares of high-grade agricultural land which is a significant contributor to the local economy, with several high value crops of national significance. There is also significant infrastructure and many businesses. The area also contains nationally and internationally important habitats including the Hatfield and Thorne Moors SACs (which combine as a single SPA) and further fourteen SSSIs.
- 1.1.3 There is a strong local community wish for the flood defences to be maintained at their current standard. During the course of the Strategy, local views and opinions have been considered by regular meetings of a Steering Group chaired by the local MP and attended by the local authorities and other key stakeholders
- 1.1.4 The Isle of Axholme Study Area is part of Policy Unit 1 of the River Trent CFMP. The agreed CFMP Policy for this unit is to take further action to sustain the current level of flood risk into the future (responding to the potential increases in flood risk from urban development, land use change and climate change). There have been limited flooding events in the area since the terminal pumping stations were installed, indicating that there is a robust flood risk management system in place. The majority of the area currently has a standard of protection in excess of 0.5% (1:200 chance of happening in each year).
- 1.1.5 The objectives of the IoA FRMS were set and agreed by the Project Board at an early stage in the development of the strategy as: to provide the most cost effective approach for land drainage and flood risk management; to demonstrate resilience in the face of extreme events and/or future change; to maximise the overall carbon efficiency and sustainability of the options considered; to improve the management of existing biodiversity and incorporate gains where possible; to ensure that the strategy is understood and supported by key partners and the wider community.
- 1.1.6 The Rivers Torne and Idle discharge into the River Trent at the terminal pumping stations at Keadby and West Stockwith. In total there are 14 pumping stations operated by the Environment Agency, a further 47 operated by IDBs. Water levels are managed by 93km of linear flood defences along the Torne and Idle and associated main drain channels. Along the River Idle there are significant lengths of minor embankments, designed to overtop at lower flood events and inundate washland areas.
- 1.1.7 Flooding to the study area from other sources (the Rivers Trent, Don and Humber) have been considered in separate strategies developed specifically for these rivers; we have

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maintained links to these strategies throughout the Isle of Axholme FRMS. We have avoided double counting of benefits by maintaining these links

History of Flooding

- 1.1.8 There is a long history of flooding within the Isle of Axholme and the area has been subject to continued inputs to manage flood risk and improve land drainage since the 17th Century
- 1.1.9 Since the 18th century, there have been a number of large floods recorded, including some which lasted for several months. The most significant recent floods were in November 2000 and June 2007). On the River Torne the most significant flooding resulted from the breach of the embankment at Kilham in June 2007, including damage to a gas main. On the River Idle flooding was limited to the washlands. During both floods, surface water flooding was also experienced.

1.2 Problem

- 1.2.1 The Isle of Axholme study area depends on the operation of pumping stations and flood defences to discharge river flows and surface water. The loss of discharge through a cessation of pumping and defence maintenance leads to a progressive increase in flood volume (and level); this poses the greatest flood risk to assets in the study area. .
- 1.2.2 If it is not possible to continue to maintain the terminal pumping stations they would form a blockage across river and drainage channels. Based on operational experience, in the short term siltation will block the gravity outfalls. The result would be the flooding of the low lying land within the Isle of Axholme to a significant depth.
- 1.2.3 Modelling identified that Do Nothing water levels could reach a maximum of 5.25mOD (the height of the lowest defences on the River Trent) over an estimated five years. This would have a massive impact on the area, resulting in the permanent flooding of the following:
- 17,920 residential properties and 2,627 non residential properties; with a further 9,851 isolated by the flooding.
 - Permanent flooding of agricultural land, much of it in the highest grades
 - 36 kilometres of motorway and other critical infrastructure including high pressure gas pipelines, aviation fuel pipelines, Keadby Power Station and railway lines.
- 1.2.4 This flood level would overtop Keadby Canal and flood the area to the north of the Isle of Axholme, (Flood Cell 13 of the Humber Flood Risk Management Strategy). This area and the impacts of flooding have therefore been included within the Isle of Axholme strategic study area.
- 1.2.5 The most notable environmental impact of Do Nothing would be the loss of two internationally designated sites which are the two largest remaining raised bogs in lowland England: Hatfield Moors, and Thorne, Crowle and Goole Moors. Although not protected, the rare fenland landscape created in the mid 17th century would also be lost. The strategy has been appraised over 100 years.
- 1.2.6 Dependence on the operation of flood defence assets, particularly pumps, makes the area vulnerable to changes in their condition and failure. Within the 100yr appraisal period all pumping stations and linear flood defences will need to be refurbished or replaced. As highlighted in the CFMP this is costly and raises questions about whether it is justifiable or affordable to maintain the same high standard of protection that the area currently experiences.

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- 1.2.7 There are several localised areas where the linear flood defences are in poor condition. Should these defences be overtopped, experience shows it will lead to a breach and flooding. However, extreme river flows that cause channels to overtop and breach only result in localised flooding of a small number of properties. This suggests that defence standards are not optimised and there may be scope to lower defence levels.
- 1.2.8 The Humber River Basin Management Plan (RBMP) identifies measures and actions needed to bring all water bodies in the study area to 'good' overall status under the Water Framework Directive (WFD). Issues include: physical modification as a result of land drainage, flood protection, recreation, diffuse pollution and over-abstraction.

1.3 Options considered

- 1.3.1 Initially the Foresight Future Flooding Report was used to ensure that a full range of potential response measures was considered. A public consultation was undertaken; the results of which informed the selection of a long list of options for further assessment. A high level review, rejected a number of options as they did not provide a significant (strategic level) technical, economic or environmental flood risk management benefit.
- 1.3.2 The remaining options formed the short list of options shown in Table 1.1. The Do Minimum prolongs the life of the system but only serves to delay the onset of the Do nothing impacts. Due to the severe impacts, Do Nothing and Do Minimum are considered non implementable.
- 1.3.3 The short list options were subjected to more detailed studies, including an assessment of technical feasibility, economic impacts and mitigation requirements and cost.

Table 1-1 Short List Options

No	Option Description
1	Do Nothing – cessation of all flood defence activities including pumping.
2	Do Minimum – extension to the life of flood defence assets (including pumps) through routine maintenance, eventually leading to a permanent failure and the same impacts as the Do Nothing.
3	Maintain Standard of Service (maintain existing flood defence and pumping system) – continue to operate the existing flood defence system (including pumps), with refurbishment and replacement of assets as needed over the 100 year life. Option does not include for effects of climate change – although modelling shows that climate change results in a minimal increase in water levels.
4	Maintain with Kilham Flood Storage Area and optimised inland pumps – As option 3 but with the addition of a flood storage scheme and the removal of redundancy in the internal pumps; this option provides the same standard of protection as option 3.
5A-D	Option 4 plus: Lower existing raised flood defences to provide protection against flood events with a 10% (1in 10) or greater chance of happening each year – as option 4 but with lowered internal defences. 5B – as 5A but 4% (1 in 25), 5C – as 5A but 1.33% (1in 75) and 5D – as 5A but 1% (1 in 100)
6	Gravity at Terminal Pumping Stations with Option 4 for the internal pumping and defences – Stop pumping and rely on gravity outfalls at both Keadby and West Stockwith pumping stations; current internal pumps and defence levels to be maintained.
7	Lower existing raised defences on the River Torne system to 1.33% (1 in 75). On the River Idle system pumping would be stopped and West Stockwith Pumping Station would revert to a gravity outfall (Option recommended by Consultees) – a combination of option 5C on the Torne and option 6 on the Idle.

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- 1.3.4 Further external consultation was carried out to allow stakeholders to comment on the range of options being considered, identify their preferred option and provide additional information to support the assessment.
- 1.3.5 The major flood risk to the area is from long term loss of the pumping system and flood defences leading to permanent inundation; this only occurs in the Do Nothing and Do Minimum. In comparison, due to the high standard of the existing inland river defences and pumps across the system, all other options have relatively small residual damages (less than 20 properties and 5% agricultural land remains at risk), but high costs. We have examined a range of options with lower standards of protection for the internal defences to examine if there is an optimum standard that lowers whole life costs through reduced internal pumping and defence maintenance.
- 1.3.6 The residual damages of options 3 to 7 are dwarfed by the Do Nothing damages; the result is several options very close together in terms of benefits. The options were ranked by Average Benefit Cost Ratio to select the leading option. All these options have benefits that exceed their costs by a ratio of 16 to 1 or more.

1.4 Preferred option

Description

- 1.4.1 The appraisal concludes that Option 5C is the preferred option; this involves maintaining pumping at both the terminal pumping stations and the internal pumps, combined with lowering the inland flood defences to provide protection against flood events with a 1.33% (1 in 75) or greater chance of happening each year. All but a small number of properties (less than 20, not all residential) and 5% of agricultural land benefit from the same high standard of protection currently provided. The SoP is lowered to 1.33% for the a small number of properties and some agricultural land. In addition, option 5C includes a scheme to formalise an area of overtopping at Kilham into a formal flood storage area which will reduce flooding to approximately 112ha of agricultural land between Kilham Farm and Tunnel Pits Pumping Station. Option 5C is economically preferred with limited environmental impacts.
- 1.4.2 Overall, this option is technically and environmentally acceptable and meets the strategic objectives. It is the most economically viable of the options considered; however, it is sensitive to costs and additional contributions could change the option. The local community has expressed a desire to achieve a 1% SoP for the small number of properties and agricultural land with a reduced SoP; initial discussions indicate their willingness to contribute to achieve this.
- 1.4.3 Modelling assessments have indicated that the further impacts of climate change, even at the upper boundary will have very limited additional impacts on the area; any impacts will be similar to the current small residual damages (approximately 20 properties and 5% of agricultural land).
- 1.4.4 It is also recommended that other engineering and non-engineering flood risk management activities should form part of the preferred option including: reducing overcapacity at individual pumping stations, flood warning, development control and reviewing and potentially transferring operational responsibility for assets to the IDBs.

Environmental considerations

- 1.4.5 The Humber River Basin Management Plan (RBMP) identifies measures and actions needed to bring all water bodies to 'good' overall status under the Water Framework

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Directive (WFD). Issues relevant to the strategy include: physical modification as a result of land drainage issues and flood protection and recreation. Implementation of the strategy will assist in meeting these objectives. Other RBMP objectives in relation to diffuse pollution and over-abstraction will not be impacted by the strategy.

- 1.4.6 A Strategic Environmental Assessment (SEA) has been carried out to document the environmental impacts of the strategy.
- 1.4.7 Natural England has confirmed that they think the proposal is likely to lead to an environmentally acceptable solution and is not likely to require an Appropriate Assessment.
- 1.4.8 The local community, statutory consultees and other interested parties have been consulted throughout the option appraisal; there is broad support for the strategy.

Benefits

- 1.4.9 The option selection process was carried out in accordance with FCERM-AG.
- 1.4.10 Property damage calculations were undertaken on a property level basis with threshold levels derived from LiDAR. Property damages have been capped at market value and a social equity factor applied; less than 10 properties were within deprived areas. Non residential market values were taken from the NPD3. Risk to Life damages and infrastructure damages were assessed. A critical infrastructure risk matrix has been produced for infrastructure within the study area which is considered to serve people outside the study area.
- 1.4.11 Agriculture is the main land use, the majority of which is high grade land used to produce high value crops, some of national importance; for example, it is the centre of UK red beet and celery production, and its organic salad production cannot be easily replaced elsewhere in the UK. Agricultural damages were assessed; in excess of 30,000 hectares of Grade 1 and Grade 2 agricultural land would be lost under the Do Nothing option. An agricultural damage study was produced by Cranfield University for the strategy which followed FCERM-AG; this justified higher land values than standard DEFRA values.

Costs

- 1.4.12 The cost estimates include all IDB and Environment Agency assets that contribute to managing flood risk in the Isle of Axholme and are shown in Table 1-2. In advance of approval of the strategy there are urgent MEICA repairs identified within the relevant SAMPs for a number of the Isle of Axholme pumping stations. There are also raised defence and outfall repairs identified in the Midlands MTP to address urgent repairs to a limited number of banks where the current condition is of concern. The capital costs for the implementation of the strategy in the later years will be approved using Project Appraisal Reports.

Table 1-2 Present Value (PV) Costs of Preferred Option

Cost	2013/14 (£k)	2014/15 (£k)	2015/16 (£k)	2016/17 (£k)	2017/18 (£k)	Future Years (£k)	Total (£k)
Capital	7,753	6,920	8,294	6,153	7,406	167,126	203,652
Non-Capital	2,323	2,167	2,077	2,007	1,973	58,635	69,182
Total	10,076	9,087	10,371	8,160	9,379	225,761	272,834

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- 1.4.13 The preferred option has a whole life cost saving of £49 million compared to maintaining the existing system (option 3). This cost saving is made up of optimisation of the pumping system and reduced future maintenance and capital works to defences; it is worth noting that pumping station maintenance costs reduce by 10%. In order to achieve the next highest SoP for the small number of assets at increased risk (option 5D) would require an extra £1.7 million in whole life costs. Table 1-3 shows the present value costs of options 3, 5C and 5D for comparison.

Table 1-3 PV costs for Preferred option, maintain option and a higher SoP option

Option	5C (Maintain existing pumping; defences at 1.33% SoP)	5D (Maintain existing pumping; defences at 1% SoP)	3 (Maintain existing pumping; defences at existing SoP)
PV Costs (£k)	272,834	274,554	322,220

Economic summary

- 1.4.14 Table 1-4 shows the economic summary of the preferred option. The catchment forms a single flood cell covering the whole of the study area under the Do Nothing; the Partnership Funding score is presented for this single flood cell.

Table 1-4 Summary of preferred strategy

	Preferred Option
Standard of Protection	1.3% (1 in 75 yr)
PV Costs (£k)	
Capital	204,000
Non-capital	69,000
Total PV Costs (£k)	273,000
PV Benefits (£k)	5,353,000
Average Benefit/Cost Ratio	19.6
Cash Costs (£k)	
Capital	595,000
Non-capital	228,000
Total Cash Costs (£k)	823,000
Partnership Funding Score	126.0%

Funding and contributions

- 1.4.15 The strategy is to be partly funded from the Flood Defence Grant in Aid (FDGiA) budget. Assessment against payments for outcomes shows a strong score which is in excess of 100% raw OM score level as per the Defra FDGiA calculator. The team have clearly articulated the need to all partners of the need to raise local contributions to reduce central government spending, without which it may not be possible to deliver this Strategy. Funding discussions have been held with North Lincolnshire Council and other key partners throughout the development of the strategy. North Lincolnshire Council have committed to supporting the preferred option and they are keen to show that their funding would provide improvements over and above what can be delivered through FDGiA. We have letters of support from the main Local Authority and their Cabinet have endorsed the principle of providing funding. The precise mechanisms for delivery are complicated by parallel discussions with the Authority on the need for funding of other work, in particular the adjacent Humber strategy. North Lincolnshire have made it clear that the Agency need to

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agree a combined funding package for all of our works (tidal Trent, Humber, Ancholme, Isle of Axholme), The approach will be confirmed in discussions that include these related projects.

Table 1-5 Summary of Contribution Status

Partner Organisations	Action	Trigger	Date
North Lincolnshire Council	Agreement on overall requirements for funding across the area	Conclusion of discussions with the LA	Autumn 2012
Internal Drainage Boards	Commence transfer of assets	First transfer approved by RFCC.	March 2012
Coal Authority	Coal Authority already contribute to 10 of the pumping stations. Work with the Coal Authority to seek efficiencies	Discussions commenced. We are providing access to modelling outputs	May 2012

- 1.4.16 The existing IDB land drainage charges will provide a potential method for collecting contributions. Transfer of the operation and maintenance of certain Environment Agency assets will form an important part of the longer term contributions being sought. All of the assets within the Isle of Axholme strategy area provide both land drainage and flood risk management functions. It would be possible to make an arbitrary split in the costs associated with the two functions, but the detail of this will be agreed as part of the on-going discussions with the IDBs on asset transfer and any split now could influence these discussions; as an indication, agriculture currently contributes 11% to the benefits of the strategy. The impact of these discussions will be to transfer a proportion of the whole life costs in the payment for outcomes calculation into an IDB contribution. This will improve the FDGiA position; it is unlikely that these arrangements could be in place before 2013.
- 1.4.17 Work is currently underway with Procurement to develop the Procurement Strategy which will allow it to take account of the new Water and Environment Management Framework which will commence in April 2013.

Key delivery risks (economic, social and environmental)

Table 1-6 Risks and mitigation

Risk	Key mitigation
Adequate financial resources not available	Good forward planning and programming.
Contributions for all FRM activities within the area not forthcoming; asset transfer unsuccessful	Discussions held with potential contributors; payment mechanisms identified. Discussions held about asset transfer.
Mitigation measures not approved/ delay in implementation	Detailed discussions with local communities on the likely scale of mitigation during strategy; consultation with landowners; good relationship with local MP and land owners.

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1.5 Status

- 1.5.1 The proposed Strategy has the support of the Local Authorities and Natural England. The majority of the area is within North Lincolnshire. The North Lincolnshire Council Cabinet has endorsed the strategy. Both groups of IDBs are supportive of the strategy
- 1.5.2 The recommendations of this Strategy are broadly aligned with the policies within the CFMP (sustain the current level of flood risk) for 99.9% of properties; a small number of properties (less than 20) and a small area of agricultural land (5%) will receive a lower SoP.

1.6 Recommendation

- 1.6.1 We recommend that the Isle of Axholme Flood Risk Management Strategy is approved. The Whole Life Cost of the recommendation is £823 million (rounded to 3 significant figures).

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1.7 Directors briefing paper

Region:	Midlands		Project executive:	Paul Stainer	
Function:	Flood Risk Management		Project manager:	John Pygott	
Strategy title:	Isle of Axholme Flood Risk Management Strategy		Code:	IMMI000778	
NEECA consultant:	Black & Veatch	NCF contractor:	-	Cost consultant:	-
The problem:	<p>The Isle of Axholme area depends on the operation of pumping stations and flood defences to discharge river flows and surface water. Axholme is below the mean level of tidal rivers draining the catchment; and unless the operation of pumps is continued and defences are maintained, the whole area would be permanently under 2m of floodwater. In a single flood, only a small number of properties (10-20) are typically affected as the major flood impacts are related to long term issues.</p>				
People at risk: Probability of exposure: Consequence of exposure:	<p>There are currently 28,000 properties at risk from the failure of the major pumping stations in the Isle of Axholme. Modelling indicates that single flooding events are less significant than the long term failure of the pumping stations and raised defences which would occur without continued maintenance and refurbishment.</p>				
Environmental resources at risk: Probability of exposure: Consequence of exposure:	<p>There are two internationally important Natura 2000 sites, fourteen SSSIs and more than one hundred and thirty locally important nature sites. The strategy area contains many listed buildings and archaeological sites. The Humber RBMP WFD issues relevant to the Strategy include: physical modification from land drainage, flood protection and recreation..</p>				
Assets at risk from flooding: Probability of exposure: Consequence of exposure:	<p>Sections of the M18 and M180 motorways, Keadby power station, two railway lines, gas and aviation fuel pipelines, more than 2000 businesses and 30,000 hectares of agricultural land would be lost</p>				
Description of proposed strategy:	<p>The Strategy proposes to implement a more efficient system of pumping (saving £49million in whole life costs) maintaining the standard of protection (SoP) for 99.9% of properties, with a lower SoP for less than 20 properties. Environment Agency assets will be transferred to the Internal Drainage Boards.</p>				
Outcome for people at risk:	<p>Around 28000 properties (residential and commercial) and 30,000 hectares of agricultural land will be protected against permanent inundation.</p>				
Outcome for environmental resources at risk:	<p>The options will be developed to ensure the SSSIs (inc the Natura 2000 sites) are protected or improved through floodplain reconnection in conjunction with Natural England. The WFD assessment concluded there would be no deterioration as a consequence of the implementation of our proposed Strategy and opportunities to improve on the WFD outcomes will be sought during implementation.</p>				
Outcome for assets at risk:	<p>A small number of properties and some areas of agricultural land will flood on a more frequent basis.</p>				
Costs (Pvc): (100 year life inc. maintenance)	£273M	Benefits: (PVb)	£5,353M	Ave. B: C ratio: (PVb/PVc)	19.6
NPV:	£5,080M	Incremental B:C ratio:	n/a	Whole life cost (cash value):	£823M
Choice of preferred option:	Option 5C was selected through the staged FCERM-AG process at stage 5.				
Total cost for which approval is sought:			£823M		
Delivery programme:	<p>Year 0 to 5 Detailed designs of defences and refurbishment of key assets in poorest condition. Transfer of assets to the IDBs. Year 6 to 100 Implementation of programme of refurbishment of all assets</p>				
Are funds available for the delivery of this programme?			Not confirmed		
External approvals:	Natural England – letter of support received				
Defra approval:					

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Key Plan

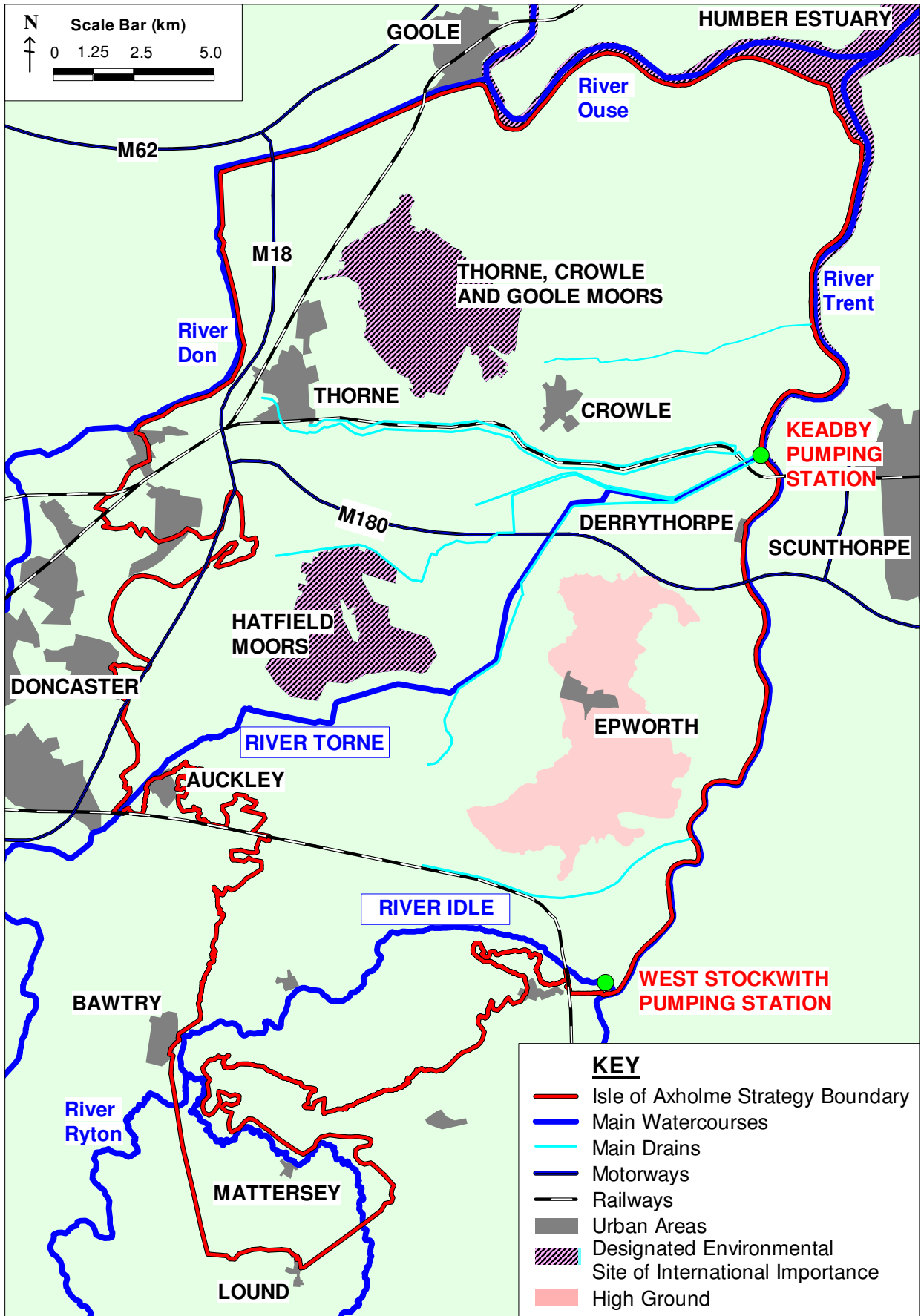


Figure 1-1 Key Plan

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2 Introduction and background

2.1 Purpose of this report

- 2.1.1 The aim of the Isle of Axholme (IOA) FRMS is to achieve long-term, sustainable and cost-effective solutions for managing flood risk whilst taking into consideration the natural and built environment, balancing the needs of competing land uses in an area that supports both high value agriculture and important environmental assets. The purpose of this Strategic Appraisal Report is to present the business case to justify the preferred option for achieving this. The strategy includes technical, economic and environmental assessments of the strategic options and selects a preferred option.
- 2.1.2 The appraisal has been carried out in accordance with the Environment Agency Flood and Coastal Erosion Risk Management appraisal guidance (FCERM-AG), published in March 2010.

2.2 Background

Strategic and legislative framework

River Trent Catchment Flood Management Plan

- 2.2.1 The approved River Trent Catchment Flood Management Plan (CFMP) (Environment Agency, 2010) establishes the long-term policies and action plans for managing flood risk in different geographic areas, or policy units, within the catchment.
- 2.2.2 The Isle of Axholme Study Area (study area) is part of Policy Unit 1 of the CFMP. The agreed CFMP Policy for this unit is to take further action to sustain the current level of flood risk into the future (responding to the potential increases in flood risk from urban development, land use change and climate change). Delivery of FRM activities is always subject to the guidance and funding mechanisms in force at the time.

Internal Drainage Boards and the Doncaster Area Drainage Acts

- 2.2.3 Currently the pumping stations and watercourses are maintained and operated either by the Environment Agency or the Internal Drainage Boards. At the present time there are 14 individual IDBs which would make implementation of some of the proposals within the strategy relating to more efficient operation of the pumping stations difficult to achieve in a strategic manner. When current proposals for amalgamating Internal Drainage Boards are implemented fully, operational responsibility for some of the assets could be transferred to the two proposed new IDBs; this is likely to be a complex process which could take several years to complete. Ten of the pumping stations within the strategy area are covered by the requirements of the Doncaster Area Drainage Acts which provide for drainage in response to mining subsidence. Changes to these pumping stations may require amendments to the original legislation. The Coal Authority and Highways Agency currently contribute funding to support some of the pumping stations in the Isle of Axholme; currently they contribute per year to support 11 of the 57 pumping stations in the Isle of Axholme as well as other pumps in the Don catchment. We have involved both organisations throughout the work on the strategy and they are keen to work with us on efficiencies; they do however recognise the challenges imposed by primary legislation covering these activities.

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Legislation under which the Scheme would be Promoted

- 2.2.4 The works arising from the strategy would be undertaken by the Environment Agency under the powers of Section 165 of the Water Resources Act 1991: General Powers to carry out flood defence and drainage works. Some of the works proposed will be undertaken by the relevant Internal Drainage Boards under Section 14 of the Land Drainage Act 1991.

Planning Permission and Environmental Impact Assessment

- 2.2.5 The strategy will involve the construction of some new defences and the refurbishment and rebuilding of some existing flood defences. The construction of new defences will require planning permission under Section 57 of the Town and Country Planning Act 1990 (as amended). The modification of the existing defences should not require planning permission, but we will seek a screening opinion from the Local Planning Authority regarding this. Obtaining planning permission or screening opinions will be done at the project stage.
- 2.2.6 A Strategic Environmental Assessment (SEA) has been carried out to document the environmental impacts of the strategy.

Other Consents and Licences

- 2.2.7 Works proposed by the strategy are also likely require such consents and licences as those from the Environment Agency to carry out works adjacent to main rivers under the Water Resources Act 1991 The need for such consents will be confirmed at the project stage. Any works on pumping stations or outfalls now need to consider eel passage under these regulations. In practice this means in most situations an eel pass will be required adding additional cost to the works.

Previous Studies

- 2.2.8 Flooding to the study area from other sources (the Rivers Trent, Don and Humber) is being considered in strategies developed specifically for these rivers; we have maintained links to these strategies throughout the Isle of Axholme FRMS. Our plans for maintaining the tidal defences and taking account of climate change on the River Trent and other rivers are set out in the Trent Catchment Flood Management Plan, Tidal Trent Strategy and Humber Flood Risk Management Strategy; they are not part of the Isle of Axholme FRMS. The current ambition for the tidal Trent banks is to maintain and improve them in line with sea level rise to provide a 0.5% (1 in 200) year standard of protection; this will be reviewed as part of the Humber implementation review in 2012.

Social and political background

- 2.2.9 There is considerable local community pressure for the flood defences to be maintained at their current standard and from the local MP, the North Lincolnshire councillors and other local councillors support this view.
- 2.2.10 During the course of the Strategy, this pressure has been mitigated by convening eight meetings of a Steering Group chaired by the local MP and attended by representatives of relevant local authorities, Natural England, National Farmers Union, Internal Drainage Boards, Association of Drainage Authorities, local businesses and the Regional Flood and Coastal Committee chair.

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Location and designations

- 2.2.11 The Isle of Axholme is located across the boundaries of East Riding of Yorkshire, Doncaster, North Lincolnshire and Nottinghamshire. The IoA FRMS covers an area of approximately 520km², of which approximately 380km² is dependent on artificial drainage and pumping; without this it would be regularly flooded with ground levels of less than 3.0mOD which is less than tidal levels in the rivers that border it. In addition to this drainage system, the strategy concentrates on managing flood risk from the Rivers Torne and Idle where they flow across this low lying area. It is recognised that there is a clear link between land drainage and flood risk management activities in controlling flood risk. Most of this area is also at risk from tidal or fluvial flooding from the Rivers Trent, Ouse and Don and is protected from this flooding by large flood banks adjacent to these rivers. The study area is shown in Figure 1.1.
- 2.2.12 The area contains 28,000 properties including the towns of Crowle and Thorne, over 30,000 hectares of high-grade agricultural land (grades 1 and 2), significant infrastructure and many businesses. The area also contains nationally and internationally important habitats and is within the Humberhead Levels landscape character area, comprising flat low-lying land characterised by large river plains.
- 2.2.13 Within the study area are Hatfield and Thorne Moors, individually designated as Special Areas of Conservation (SACs) and Sites of Special Scientific Interest (SSSI). Hatfield and Thorne Moors combined are also designated as a Special Protection Area (SPA). These sites are also part of the Humberhead Peatlands National Nature Reserve (NNR). The Humber Estuary SAC, SPA, SSSI and Ramsar site is located just outside the northern boundary of the study area.
- 2.2.14 In addition there are a further fourteen SSSIs, over 130 Local Wildlife Sites and areas of Biodiversity Action Plan (BAP) Habitats within the study area.
- 2.2.15 The study area supports a variety of fauna, many species of which are either protected under national legislation or the subject of a number of UK or Local Biodiversity Action Plans (LBAPs).

History of the Flooding

- 2.2.16 There is a long history of flooding within the Isle of Axholme and the area has been subject to continued inputs to manage flood risk and improve land drainage from the 17th Century to the present day, particularly since the passing of the Land Drainage Act in 1930. During this time, a heavily engineered and complex network of pumps and drains/watercourses has been developed to manage water levels and drain the surrounding low lying areas.
- 2.2.17 The Rivers Torne and Idle, both high level carriers, discharge into the tidal River Trent at the terminal pumping stations at Keadby and West Stockwith. In total there are 14 inland pumping stations operated by the Environment Agency, a further 47 operated by Internal Drainage Boards (IDBs) and a small number operated by private landowners. In addition, water levels are managed by 93km of linear flood defences along the Torne and Idle and associated main drain channels. Adjacent to the River Idle there are significant lengths of minor embankments, designed to overtop at lower flood events and inundate the washland areas behind them.
- 2.2.18 Since the 18th century there have been a number of large floods recorded in the area, including some which lasted for several months. The most significant flooding events in recent times were in November 2000 and June 2007. (Table A1 in Appendix A of the Option Technical Assessment Report lists the flooding history of the area).

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- 2.2.19 On the River Torne the most significant flooding resulted from the breach of the embankment at Kilham in June 2007, including damage to a gas main. On the River Idle flooding was limited to the washlands. During both events surface water flooding was also experienced. North Lincolnshire Council are undertaking a Surface Water Management Plan to address these issues.

2.3 Current approach to flood risk management

Measures to manage the probability of flood risk

- 2.3.1 The activities currently undertaken by the Environment Agency and their partners to manage flood risk in the IoA Strategy area are listed below. Continuing to carry out these current flood risk management activities over the next 100 years would cost an estimated £606 million with annual costs between £4.3m and £11m.
- 2.3.2 Pumping - Maintaining and operating the large Keadby and West Stockwith Pumping Stations and the smaller inland pumping stations. This includes general maintenance works and major capital repairs and replacement when required. Regular inspections are undertaken to evaluate asset condition and prioritised recommendations implemented. There are a total of 64 pumping stations in study area.
- 2.3.3 Internal flood defences - Management of 93km of flood embankment and 1km of flood wall. Staff regularly inspect defences and carry out general maintenance requirements and minor repairs.
- 2.3.4 Channel maintenance - Maintenance of river/ditch channels and banks. This includes vegetation cutting, tree clearance and removal of debris and vegetation where they increase local flood risk or reduce land drainage capacity.
- 2.3.5 Development control - Advice on new developments as statutory consultees in accordance with Planning Policy Statement 25 (Development and Flood Risk).
- 2.3.6 Perimeter defences - Management of the perimeter flood defences that provide protection from the Rivers Trent, Ouse and Don.
- 2.3.7 Further details of the condition of FRM assets are contained in Table 2-1 and

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Table 2-2.

Table 2-1 Summary of Pumping Station Condition

Operator	Condition			Total
	Good	Fair	Poor	
Environment Agency	9	4	3	16
Shire Group of IDBs	20	4	1	25
Lindsey Marsh Group of IDBs	8	8	3	19
Other IDBs	1	1	0	2
TOTAL	38	17	7	62

Notes: – Grange Farm pumping station decommissioned (Lindsey Marsh group of IDBs)
– Keadby Grange pumping station privately owned

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Table 2-2 Summary of Flood Defence Condition

Watercourse	NFCDD Condition Grade (km)			Total Length (km)
	2	3	4	
River Torne	8.6	16.3	0	24.9
North Soak Drain	1.8	1.2	0	3.0
South Soak Drain	5.4	0.4	0.1	5.9
Hatfield Waste Drain	8.3	1.1	0	9.4
North Engine Drain	3.6	0	0	3.6
South Engine Drain	7.6	< 0.1	0	7.7
River Idle	23.1	8.8	6.1	38.0
Total Length (km)	58.4	27.9	6.2	92.5

Notes: – No flood defences in study area have been assigned a condition Grade 1 or 5.

Measures to manage the consequences of flood risk

- 2.3.8 At present, a flood forecasting and warning service is available for residents in the area. This delivers warnings to those organisations, businesses and the general public within the existing flood warning areas, on the River Idle from Bawtry to West Stockwith and the Trent from West Stockwith to the Humber Estuary. This service has been promoted during our public consultation on the scheme.

3 Problem definition and objectives

3.1 Outline of the problem

- 3.1.1 The Isle of Axholme study area is low lying and depends on the operation of pumping stations and flood defences to discharge river flows and surface water (particularly the terminal pumping stations at Keadby and West Stockwith). The loss of discharge through a cessation of pumping leads to a progressive increase in flood volume (and level); this poses the greatest flood risk to assets in the study area; the impacts of this are discussed further in Section 3.2.
- 3.1.2 Dependence on the operation of flood defence assets, particularly pumps, makes the area vulnerable to changes in their condition and failure. Within the 100yr appraisal period all pumping stations and linear flood defences will need to be refurbished or replaced; this makes it very expensive to maintain the same standard of protection that the area currently experiences.
- 3.1.3 The Isle of Axholme receives a higher standard of protection than would usually be provided to such an area. Over the majority of its length, the River Torne defences have a high standard of protection; the River Idle defences also have a high standard of protection along its length. Across the majority of the defences on the Idle and Torne, the current standard of protection is in excess of 0.5% (1 in 200 chance of happening each year). There are several localised areas where the linear flood defences are in poor condition. Should these defences be overtopped experience shows it will lead to a breach and flooding. However, extreme river flows that cause channels to overtop and breach only result in localised flooding of a small number of properties. This suggests that defence standards are not optimised and there may be scope to lower defence levels.
- 3.1.4 The Humber River Basin Management Plan (RBMP) identifies measures and actions needed to bring all water bodies in the study area to 'good' overall status under the Water framework Directive (WFD). Issues include: physical modification as a result of land drainage, flood protection, recreation, diffuse pollution and over-abstraction.

3.2 Consequences of doing nothing

- 3.2.1 The implications of Do Nothing were agreed at a Do Nothing workshop attended by representatives of both the Environment Agency (Operations and Project Team) and Internal Drainage Boards to draw on the operational experience of both.
- 3.2.2 The workshop concluded that ceasing maintenance and operation of the complex network of existing flood defences, pumping stations other assets and flood risk management practices would have a significant impact on the existing land drainage and flood risk management regime. Walking away from the pump stations would mean that they would effectively act to form a blockage across river and drainage channels. Significantly, if operation of the terminal pumping stations at Keadby and West Stockwith ceased the Rivers Torne and Idle would no longer be able to discharge to the River Trent; this leads to a progressive increase in flood volume (and level). In addition to the loss of pumping, gravity discharge would be lost due to siltation.
- 3.2.3 Subsequent modelling of the 'Do Nothing' option has identified that water levels could reach a maximum level of 5.25mOD (the height of the lowest defences on the River Trent) over an

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estimated five year period. The modelling is detailed in the Do Nothing Hydraulic Modelling Report. This would have a massive impact on the area, resulting in the permanent flooding of the following:

- 27,771 residential properties; of which 17,920 are directly affected and 9,851 are isolated by the flooding
- 2,627 non residential properties
- Permanent flooding of agricultural land as follows: 7,922 hectares of Grade 1; 23,300 hectares of Grade 2; 11,184 hectares of Grade 3; 932 hectares of Grade 4; and 3,262 hectares of Grade 5
- 36 kilometres of motorway

3.2.4 Other critical infrastructure including high pressure gas pipelines, aviation fuel pipelines, Keadby Power Station and railway lines.

3.2.5 This flood level would also flood the area to the north of the Isle of Axholme through overtopping of the Keadby canal, also referred to as Flood Cell 13 of the Humber Flood Risk Management Strategy. This area and the associated impacts of flooding have therefore been included within the Isle of Axholme strategic study area.

3.2.6 In addition to the significant direct impacts of flooding on assets within the strategic study area above, there are several communities that, although above the flood level, would become isolated due to flood water. For this analysis, we have only considered Epworth, Belton, Haxey, Westwoodside and Crowle as these would be the largest villages affected; together adding up to 9,851 properties. Being permanently isolated from the surrounding area would have serious effects on the socio-economic activities within these communities and they would cease to be sustainable. There are several much smaller villages or hamlets that would also be affected; however, we have not quantified damages associated with these as they were considered to be insignificant and highly unlikely to affect the option choice.

3.2.7 The key environmental impacts of the 'Do Nothing' option have also been examined and further detail is provided in the Strategic Environmental Appraisal Report in Appendix N. The most notable impact would be the loss of two internationally designated sites which are the two largest remaining raised bogs in lowland England: Hatfield Moors, and Thorne, Crowle and Goole Moors. Although not protected, the unique fenland landscape created in the mid 17th century by the Dutch engineer Vermuyden would also be lost. To present a balanced case, we have looked at the environmental benefits of the 'Do Nothing' option through the potential creation of habitat and incorporated this into our assessment.

3.3 Strategic issues

3.3.1 The agreed policy for the Isle of Axholme FRMS study area according to the River Trent Catchment Flood Management Plan is to sustain the current level of flood risk into the future.

3.3.2 Under the Do Nothing, the area forms a single flood cell which includes area to the north of our original study area, referred to as Flood Cell 13 (FC13). This confirms the need for a strategic approach.

3.3.3 The majority of the area currently receives a much higher level of protection than a rural area would generally receive and options were included to assess the strategic impacts of reducing the level of protection.

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- 3.3.4 The Isle of Axholme FRMS is bounded by three other strategies. To avoid taking benefits without costs, the costs associated with the Rivers Ouse, Don and Trent perimeter defences have been included in the Isle of Axholme FRMS. Flooding from the Rivers Ouse, Don and Trent has not been considered as part of the Isle of Axholme FRMS; it is being considered in the respective strategies.

3.4 Key constraints

Nature Designations

- 3.4.1 The study area is an important site for wildlife and includes a number of internationally designated sites including:
- Thorne and Hatfield Moors SAC and Thorne Moor SACs are the largest remaining naturally regenerating raised bogs within the UK: both moors are also designated as SPAs.
 - The Humber Estuary SAC, SPA and Ramsar is located on the north eastern boundary of the Study Area. We are required under the Habitats Directive to protect and maintain the favourable condition status of these habitats and species.
- 3.4.2 Many sites within the study area are also designated at a national level as part of the national network of SSSIs and any favourable condition status will need to be protected.
- 3.4.3 Any impacts on internationally or nationally designated sites as a result of implementing the FRMS will need to be avoided or mitigated.
- 3.4.4 There are also 136 Local Wildlife Sites within the study area; many of which are ditches which rely on the existing flood risk management and land drainage to maintain their conservation status.
- 3.4.5 The presence of protected and rare species adds to the biodiversity of the study area. Many habitats and species are either protected under national legislation or the subject of a number of UK or Local Biodiversity Action Plans.
- 3.4.6 Part of the protection on the Idle is provided by the River Idle Washlands SSSI which provide storage under flood events in excess of 50% (1 in 2) chance of happening each year.

Infrastructure and Transport

- 3.4.7 The study area supports a growing human population served by important regional infrastructure including roads, railways, power stations, prisons and wastewater treatment works which are vulnerable to flood risk.
- 3.4.8 The M18 and M180 motorways provide important transport links to the major UK trading gateways of Immingham and Grimsby, as well as the general industry and commerce of Scunthorpe and North Lincs.
- 3.4.9 Rights of navigation exist on Stainforth and Keadby Canal and the River Idle.

Agriculture

- 3.4.10 Agriculture is the main land use within the Study Area, the majority of which is high grade land used to produce high value crops, some of national importance; the Study Area is the centre of UK red beet and celery production, whilst Organic vegetable production cannot be

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easily replaced elsewhere in the UK agricultural sector. These crops rely heavily on land drainage and flood risk management.

Water

- 3.4.11 Surface water quality within the study area varies between poor to moderate, whilst groundwater quality varies from poor to good.
- 3.4.12 The Humber River Basin Management Plan (RBMP) identifies measures and actions needed to bring all water bodies to 'good' overall status under the Water framework Directive (WFD). Issues relevant to the Strategy include: point source pollution on the River Idle and the River Torne from sewage treatment works leading to high levels of nutrients; physical modification as a result of land drainage issues, flood protection and recreation; abstraction from the Sherwood Sandstone aquifer reducing water quality; diffuse pollution from agricultural run-off (notably pesticides, ammonia and nitrates).
- 3.4.13 There is significant pressure on water resources within the study area. The study area contains a NVZ and potable water is protected in some areas. Previous studies in the area have demonstrated that there is no connection between the sandstone aquifer which is used for water supply and the surface water drainage.

Natural Resources

- 3.4.14 The study area contains a number of valuable natural resources including sand, gravel and peat.

Recreation

- 3.4.15 Recreational facilities and public footpaths associated with watercourses in the study area provide access to the countryside and important public amenities.

Archaeology

- 3.4.16 There are 12 Scheduled Monuments, 5 Built Conservation Areas and 332 Listed Buildings within the study area.
- 3.4.17 There may be significant buried archaeological features within the existing floodplains which could be uncovered during construction of FRM Schemes and may be susceptible to changes in water levels. None of these potential features are currently identified and so the potential impact on future schemes is unknown.

Other Constraints:

- 3.4.18 There are key historic settlements and surrounding remnant field systems as well as Built Conservation Areas.
- 3.4.19 The study area contains seven Regionally Important Geological and Geomorphological Sites.
- 3.4.20 The character of the landscape such as the extensive long distance views, the overall sense of 'openness' and the significance of areas of trees and hedgerows in a relatively featureless landscape is important.

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3.5 Objectives

- 3.5.1 The aim of the IoA FRMS is to achieve long-term, sustainable and cost-effective solutions for managing flood risk whilst taking into consideration the natural and built environment, balancing the needs of competing land uses in an area that supports both high value agriculture and important environmental assets. The strategy includes technical, economic and environmental assessments of the strategic options in accordance with the Environment Agency Flood and Coastal Erosion Risk Management Appraisal Guidance¹ (FCERM-AG).
- 3.5.2 The objectives of the IoA FRMS were set and agreed by the Strategy Board at an early stage in the development of the strategy as:
- to provide the most cost effective approach for land drainage and flood risk management;
 - to demonstrate resilience in the face of extreme events and/or future change;
 - to maximise the overall carbon efficiency and sustainability of the options considered;
 - to improve the management of existing biodiversity and incorporate gains where possible;
 - to ensure that the strategy is understood and supported by key partners and the wider community.
 - to fulfil the requirements of the WFD, specifically the Humber RBMP.

¹ Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM-AG), *Environment Agency, March 2010.*

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4 Options for managing flood risk

4.1 Potential FCRM measures

4.1.1 Initially the Foresight Future Flooding Report was used to ensure that a full range of potential response measures was considered. These response measures were not mutually exclusive and it was anticipated that several would be combined to form an option which would meet the flood risk management requirements of the study area. A public consultation was subsequently undertaken; the results of which informed the selection of a long list of options for further assessment.

4.2 Long list of options

4.2.1 A long list of options was developed based on options and response measures listed in the Foresight Report on Flooding; adapted to be appropriate for the Strategy. Combinations of the potential response measures formed the long list of options and are included in Table 4-2.

Table 4-1 Description of Do Nothing and Do Minimum options

Option	Description
Do Nothing	Cease all operation and maintenance of all flood and drainage assets within study area
Do Minimum	Maintenance and operation of existing flood defences continues, as does flood warning until capital investment is required, then all investment stops.

4.2.2 In addition to the measures listed in Table 4-2, a range of potential ways for how best to manage the flood risk management system in a sustainable and cost effective manner were identified. These additional non-engineering measures included a consideration of aspects such as:

- determining which organisation is best placed to operate the asset;
- what is the most carbon efficient method of operation;
- what is the most appropriate technology;

4.2.3 Opportunities for environmental and biodiversity enhancements have also been considered throughout the development of the options.

Table 4-2 Foresight Report Intervention Option and Response Measures considered

Foresight Report Intervention Option	Response Measures
Non-engineering Measures & Other Activities	Development Control, Preparing for Flooding, Flood Warning, Mining Legislation requirements, Operational Responsibility
River Conveyance - Channels	Change existing channels, restore channels, create channels, change existing maintenance, silt management, vegetation management, Additional channels
Engineered Flood Storage – Floodplain/Wetland Storage	Use areas of land adjacent to the river to store water during floods, floodplain restoration and associated environmental enhancements such as BAP habitat creation.
Floodwater Transfer - Outfalls	Replace existing structures possibly with a pumping station, increase/decrease capacity or remove outfalls.
Floodwater Transfer – Pumping Stations	Changes to the existing pumping stations (inland and/or terminal, either individually or in combination), reduce overcapacity (reduce pump size), reduce overcapacity (combine pumping stations), increase/decrease standard of service, replace with gravity outfalls, modify pump operating regime, standardise plant and equipment, changes to operational responsibility, carbon reduction
River Defences – Linear Flood Defences	Construct new linear defences, improving existing flood walls or embankments, improve Standard of Protection, reduce Standard of Protection, set back flood defences, managed realignment with potential for BAP habitat creation and the improvement of existing designated sites.

4.3 Options rejected at preliminary stage

4.3.1 After a high level review had been undertaken, a number of measures were discounted as they did not provide a significant (strategic level) technical, economic or environmental flood risk management benefit.

Table 4-3 Response Measures that have been discounted

Intervention option and response measure	Technical Assessment Method	Option Suitability
River Conveyance – Additional Channels	Reviewed existing channel layout and potential opportunities for FRM benefits through making strategic scale changes.	Existing high Standard of Protection means that providing additional capacity or changing the layout of the river / drainage system is not technically feasible at a reasonable cost.
River Conveyance - Combining Channels	Reviewed existing channel layout. LiDAR and survey data used to inform whether it was feasible to combine the channels based on bed levels.	No significant flood risk management benefits of combining channels were identified.

Intervention option and response measure	Technical Assessment Method	Option Suitability
Inland Pumping Station -Do Nothing	Assessment of combined Do Nothing Option carried out under Stage 1 of the Strategy. Hydraulic modelling assessment to identify impacts of turning off all inland pumping stations. This was considered in isolation and in combination with Do Nothing for other flood risk management assets	Do Nothing assessment for entire system shows significant impacts and justification for continuing FRM. Option shown to result in significant losses of agricultural land and/or a reduction of agricultural grade, and therefore discounted on economic grounds. Sufficient strategic level economic justification to continue to manage pumping. <i>Option discounted but taken forward as economic baseline. Potential localised changes to pumping system should be explored post strategy.</i>
Inland Pumping Station -Do Minimum	The Do Nothing option hydraulic assessment provided the basis for the technical evaluation due to the similarity of the options.	Over time, this option results in similar impacts as those under the Do Nothing option and hence the same conclusion. <i>Option discounted but taken forward as economic baseline. Potential localised changes to pumping system should be explored post strategy.</i>
Terminal Pumping Station -Do Nothing	Hydraulic assessment of turning off Keadby and West Stockwith carried out under Stage 1 of Strategy.	Similar impacts as do nothing for internal pumping stations; thus same <i>Option discounted for terminal pumping stations, but taken forward as economic baseline.</i>
Terminal Pumping Station -Do Minimum	The Do Nothing option hydraulic assessment provided the basis for the technical evaluation due to the similarity of the options.	Similar impacts as for Do minimum for internal pumps; thus same conclusion. <i>Option discounted for terminal pumping stations, but taken forward as economic baseline.</i>
Internal linear defences -Do Nothing	Assessment of combined Do Nothing Option carried out under Stage 1 of the Strategy. At Stage 2 additional hydraulic modelling undertaken to identify the impact of breaches in the defences. High level review of potential impact of breakdown of internal defence system	Assessment of Do Nothing for entire system shows significant impacts and justification for continuing FRM. Consideration of Do Nothing to inland defences whilst maintaining the remainder of system indicates that progressive failure of inland banks may result in a significant risk of an unmanaged breakdown of the river system. This could result in permanent inundation of low lying areas. There is uncertainty that the Terminal Pumping Stations could continue to operate due to changes in river channel alignment, and hence there is a risk of the overall Do Nothing impacts being realised. <i>Option discounted but taken forward as economic baseline</i>

Intervention option and response measure	Technical Assessment Method	Option Suitability
Internal linear defences -Do Minimum	The Do Nothing option hydraulic assessment provided the basis for the technical evaluation due to the similarity of the options.	Over time results in similar significant impacts as would occur under the Do Nothing option; thus same conclusion. <i>Option discounted for internal raised flood defences, but taken forward as economic.</i>
Internal linear defences - Additional flood defences and/or raised standard of defence	Assessment of the existing Standard of Protection indicates that it is very high; additional defences are not required	No significant strategic flood risk management benefits for providing additional defences within the existing system
Engineered Flood Storage – Floodplain/Wetland Storage	Reviewed study area for suitable storage area and identified several areas which were modelled.	None of areas identified provided a significant reduction in water levels. Due to the low lying nature of the land, most required a large length of flood defences to form storage area and all required very significant costs in relation to purchase of land or a right to flood. Discounted on technical and cost grounds.

4.4 Options short-listed for appraisal

- 4.4.1 The remaining measures were subjected to more detailed studies, including an assessment of: Technical feasibility; economic impacts and mitigation requirements; environmental impacts; cost (initial assessment of capital and maintenance costs subsequently refined at the short list stage).
- 4.4.2 In addition to the Do Nothing and Do Minimum options, we have considered eight further options shown in Table 4-4. The Do Nothing option forms the baseline for the economic appraisal; due to the severe impacts it is not considered to be an implementable option. The Do Minimum prolongs the life of the system but only serves to delay the onset of the Do nothing impacts; it should also be considered non implementable. All other options provide the current high SoP to all but a small number of properties (less than 20) and a small area of agricultural land (5%); the SoP is reduced for these properties and this land.
- 4.4.3 Further external consultation was carried out to allow stakeholders to comment on the range of options being considered, identify their preferred option and provide additional information to support the assessment. This consultation included options 1 to 6.
- 4.4.4 Option 7 was added in response to representations made during consultation on the Strategy in early 2011 by environmental consultees. This option (a combination of Options 5 and 6) examined the feasibility of reverting to gravity at West Stockwith and modifying the inland defence Standard of Protection on the River Torne. A single defence standard of 1.33% (1 in 75) or greater chance of happening each year, on the River Torne was assessed under Option 7.
- 4.4.5 In addition, a number of engineering and non engineering flood risk management measures are considered suitable for inclusion in the overall preferred option (summarised in Table 4-5) and therefore are integral to Option 4 onwards. Further information on these measures is included in Appendix C of the Options Technical Report and section 4.2 of the StAR.

Table 4-4 Options Descriptions

Title	Isle of Axholme Flood Risk Management Strategy					
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No	Option Description
3	Maintain (maintain existing flood defence and pumping system) – continue to operate the existing flood defence system (including pumps), with refurbishment and replacement of assets as needed over the 100year life.
4	Maintain with Kilham Flood Storage Area and optimised inland pumps – As option 3 but with the addition of a flood storage scheme where overtopping already occurs in an uncontrolled way and the removal of redundancy in the internal pumps; this option provides the same standard of protection as option 3.
5	As option 4 but with lowered internal defences. Four sub options as follows: 5A – Lower to a 10% (1in 10) or greater chance of happening each year 5B – Lower to a 2.5% (1in 25) or greater chance of happening each year 5C – Lower to a 1.33% (1in 75) or greater chance of happening each year 5D – Lower to a 0.1% (1in 100) or greater chance of happening each year
6	Gravity at Terminal Pumping Stations, option 4 for the internal pumps and defences – Stop pumping and rely on gravity outfalls at both Keadby and West Stockwith pumping stations; current internal defence levels to be maintained.
7	Lower existing raised defences on the River Torne system to 1.33% (1 in 75). On the River Idle system pumping would be stopped and West Stockwith Pumping Station would revert to a gravity outfall (Option recommended by Environmental Consultees) – a combination of option 5C on the Torne and option 6 on the Idle.

Table 4-5 Flood Risk Management Measures included in Short List Options

Measure	Description
Operational responsibility	Continue to assess opportunities associated with transferring operational responsibility; this is most significantly associated with ongoing discussions with the IDBs which could result in a significant transfer of costs associated with these assets.
Silt management	Continue current management, identifying need to monitor silt levels around channel structures and clear build-ups as appropriate by taking a risk based approach. This would need to correlate with sediment management strategies required under the implementation of the Humber River Basin Management Plan. Further assessment of impacts on land drainage appropriate at a post strategy stage.
Vegetation management	Continue current management. Reducing current regime has potential to impact on both flood risk and land drainage and further detailed assessment would be required if changes to current activities were proposed.
Reduce overcapacity of inland pumping stations	Assess potential benefits of reducing overcapacity (without increasing flood risk) as part of future assessments of inland pumping station system. Assess benefits of localised changes to inland pumping system.
Replace individual inland pumping stations by gravity drainage	Investigate potential benefits of gravity drainage as part of future assessments of inland pumping station system.
Modify pumping regime	Investigate potential benefits as part of future assessments of inland pumping station system.
Standardise plant & equipment.	Investigate potential benefits as part of future assessments of inland pumping station system.
Carbon reduction	Future replacement of assets to consider ways in which carbon footprint of the system can be reduced
Flood warning	Continue to provide a flood warning system with further improvements only being made where appropriate
Land use & development control	Continue to work with Local Planning Authorities and Developers to ensure the appropriateness of development in areas at risk of flooding, in line with current planning policy.

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Measure	Description
Preparing for flooding	Continue to work with local communities to continue to raise awareness of residual flood risk and ways in which the consequences of this risk can be reduced.
Mining requirements	Continue to work with stakeholders to confirm requirements in relation to legal requirements under the Doncaster Area Drainage Acts.
Working with others	Work with others to identify opportunities for financial contributions that may assist in providing additional environmental or flood risk management benefits.
Eel Pass Regulations Requirements	In terms of legal requirements, for any high priority obstructions identified within the Study Area under the Eels Regulations we will look to identify costed passage and screening solutions by May 2012 and implementation by December 2015 for our own structures. For third party structures we will be contacting relevant owners in order to provide detail of the prioritisation of their structure and the eel pass requirements.

4.4.6 In addition, a number of non FRM measures, which offer environmental improvements are considered; these are shown in Table 4-6.

Table 4-6 Environmental Benefits Measures Included in Short List Options

Measure	Description
Channel restoration	Implement opportunities for biodiversity gains at a more detailed local level under a post strategy assessment. This would need to correlate with any relevant actions and mitigation measures in the Humber River Basin Management Plan.
Channel Reprofiling	Implement opportunities for biodiversity gains as part of future defence / river works. This could incorporate two stage channels or channel widening works. This would need to correlate with any relevant actions and mitigation measures in the Humber River Basin Management Plan.
River Idle Washlands SSSI Improvements	<p>During consultation with landowners we identified opportunities for increasing the area of wetlands adjacent to the SSSI. We will work with landowners at Newington to link opportunities for gravel quarry restoration with the removal of sections of the minor embankments, with a potential habitat gain of 80 to 140ha. Elsewhere we will work with landowners to assess the potential for further wetland creation.</p> <p>However, we recognise that this is likely to be a complex process requiring further assessment and work with the landowners. We have costed for the provision of a project officer to work with landowners.</p>
Set back defences	Assess potential ecological and other benefits of locally setting back defences as part of any future defence works.

Option 1 Do Nothing

4.4.7 This option involves all flood risk management partners stopping maintenance, repairs and all other activities in the study area including the immediate cessation of pumping station operations. The Do Nothing option forms the baseline for the economic appraisal. For health and safety reasons, it may be necessary to take minimal steps to make abandoned works safe. This could be a range of measures from making the sites inaccessible to undertaking full decommissioning and demolition. Current Project Appraisal Guidance allows these costs to be considered within the 'Do Nothing' option as additional damages; however, these costs are likely to be very small compared with the overall flood damages and therefore have not been included in this assessment.

Option 2 Do Minimum

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4.4.8 In effect, the Do Minimum option is a delayed Do Nothing. In the short term the current standard of protection (in excess of 0.5% across the majority of the area) would be maintained as all maintenance and operation activities would continue. However, when a failure occurs requiring capital investment this would not be carried out. Do Minimum involves maintenance and minor repair but does not include major capital works so may mean that Do Minimum reverts to Do Nothing when it is no longer feasible to continue maintaining the defences. It has been estimated that within ten years the terminal pumping stations at Keadby and West Stockwith would have lost their discharge capacity and that the gradual filling up of the study area would begin.

Key benefits include: Low cost associated with maintenance only activities.

Key disadvantages include: Within 15 years the same disadvantages as occur in the Do Nothing option would result.

Option 3 Maintain (maintain existing flood defence and pumping system)

4.4.9 This option would involve the continuation of all current flood risk management activities required to provide the existing Standard of Protection. Future works are limited to providing the same defence heights or pumping regime that are currently in place when an asset fails. This option does not allow for improvements (either defence raising or additional pumping) that may be required due to climate change. The existing SoP is unusually high for a rural area. The impacts of climate change are minimal and a maintain SoP option would be a significant increase in costs with minimal additional benefits.

Key benefits include: The majority of properties benefit from protection against long term inundation through continued operation of the pumped drainage system (including defended channels). A small number of properties (less than 20) remain at risk from (overtopping) flooding; their SoP varies.

Key disadvantages include: High costs.

Option 4 Maintain with Kilham Flood Storage Area and Optimised Inland Pumps

4.4.10 This option is the same as Option 3 but includes the works required to formalise the Kilham Flood Storage Area at Auckley on the River Torne. Land at Kilham already floods but overtopping of the banks risks damage and some engineering work is needed to mitigate this. It also allows for future works to reduce the overcapacity of the inland pumping stations (without increasing flood risk).

Key benefits include:
The majority of properties benefit from protection against long term inundation through continued operation of the pumped drainage system (including defended channels). A small number of properties (less than 20) remain at risk from (overtopping) flooding; their SoP varies); increased efficiency of operation with associated cost savings.

Key disadvantages include: High costs.

Options 5A to D Maintain Pumping System with Lower Existing Raised Flood Defences to Provide a Reduced Standard of Protection

4.4.11 The majority of properties benefit from protection against long term inundation through continued operation of the pumped drainage system (including defended channels). A small number of properties (less than 20) remain at risk from (overtopping) flooding; their SoP varies; the majority of defences will need to be replaced over the 100 year appraisal period and Option 5 assesses the feasibility of replacing them with defences providing a lower standard of protection to these small number of properties. This option includes the same Kilham flood storage and optimised inland pumps as option 4. Option 5 has been

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sub-divided to appraise a range of lower standards and optimise the level of protection provided:

Option 5A - 10% (1 in 10), Option 5B - 4% (1 in 25), Option 5C - 1.33% (1 in 75), Option 5D - 1% (1 in 100)

Key benefits include: Optimised costs, reduced future capital works.

Key disadvantages include: increased flood risk to a few assets.

Option 6 Terminal Pumping Stations – Stop Pumping and rely on Gravity Outfalls

4.4.12 This option includes the same Kilham flood storage and optimised inland pumps elements as Option 4 but includes ceasing pumping and reverting to gravity drainage at both Keadby and West Stockwith Terminal Pumping Stations.

Key benefits include: Reduced reliance on pumping, increased sustainability; enhanced environmental habitat.

Key disadvantages include: Increased flood risk.

Option 7 River Torne: Modify Existing Raised Flood Defences to Provide Modified Standard of Protection. River Idle: Stop Pumping and Rely on Gravity Outfalls at West Stockwith Terminal Pumping Station.

4.4.13 Option 7 consists of Option 5C for the River Torne (modify existing raised defences) and Option 6 on the Idle (revert to gravity). Option 5C was chosen to ensure that properties continued to receive a Standard of Protection equivalent to the 1.33% (1 in 75) or greater chance of happening each year.

Key benefits include: Reduced reliance on pumping, increased sustainability; enhanced environmental habitat.

Key disadvantages include: Increased flood risk.

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5 Options appraisal and comparison

5.1.1 The options selected for the short list were subjected to more detailed studies, including an assessment of:

- technical feasibility;
- impacts and mitigation requirements;
- environmental suitability (high level assessment);
- cost a refined version of the initial estimates;
- benefits.

5.2 Technical issues

5.2.1 Technical Issues identified during the option appraisal have been highlighted in Table 5-1. Further details can be found in the Option Selection - Technical Report and its Appendix C.

5.2.2 An assessment of the impact of climate change on 1.33% and 1% flows was carried out. Existing modelling shows for both flows that the change factor for the 2080s and its upper end estimate are less than or comparable to the existing 0.1% (1 in 1000) flow. An assessment of the property numbers affected by the 0.1% flood shows the impact to be insignificant.

Table 5-1 Option Appraisal Technical Issues

Option No	Abbreviated Description	Option	Technical Issues
1	Do Nothing		No technical issues
2	Do Minimum		No technical issues
3	Maintain		No allowance was made for improvements required as a result of climate change; hydraulic modelling indicates future changes in flood risk due to increased river flows have a limited impact across the study area.
4	Maintain with Kilham FSA and optimised internal pumps		<u>As for Option 3 plus</u> improvement and raising a short length of cross embankment required for Kilham FSA. Reduced maintenance due to reducing existing overcapacity in internal pumping station network.
5A	Lower defences to a 10% (1 in 10) or greater chance of happening each year		<u>As for Option 4 plus</u> hydraulic modelling was used to assess the impacts of lowering the existing defences when their condition deteriorated and they needed replacing. More detailed assessments would be required before any of these options were implemented. As active steps to reduce the Standard of Protection (SoP) provided would increase flood risk to some assets and property, mitigation measures would be required. Mitigation works are limited to maintaining the current SoP to Newington Road (access to the village of Mission).
5B	Lower defences to a 4% (1 in 25) or greater chance of happening each year		
5C	Lower defences to a 1.33% (1 in 75) or greater chance of happening each year		
5D	Lower defences to a 1% (1 in 100) or greater chance of happening each year		
6	Terminal Pumping Stations – revert to gravity		Hydraulic modelling was undertaken to assess the impact of changing the existing pumping regime to gravity drainage. This action would be taken when the terminal pumping stations required capital investment, estimated to

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Option No	Abbreviated Description	Option	Technical Issues
			be in ten years. Upstream water levels would increase at both pumping stations and mitigation works would therefore be required. On the Torne embankments will be required to protect the A18, ring banks will be required to protect two sewage treatment works and a group of affected properties and some road raising in the Keadby Grange area. On the Idle works to protect the A631 Bawtry to Gainsborough road would be required.
7	River Torne 1.33% (1 in 75) defences; River Idle gravity		Hydraulic modelling was undertaken to assess this combination of Option 5C (River Torne) and Option 6 (River Idle). More detailed assessments would be required before this option was implemented. The replacement defences along the Torne would start to be constructed within the next ten years. On the River Idle upstream water levels would be increased as West Stockwith pumping station reverted to gravity drainage requiring works to protect the A631 Bawtry to Gainsborough road.

5.3 Environmental assessment

- 5.3.1 A Strategic Environmental Assessment (SEA) was undertaken to assess the environmental impacts of options. The Environmental Issues associated with the short listed options presented in Table 5-2 have been considerably abbreviated. Full details on all the Environmental Issues can be found the SEA (Appendix N to the StAR).
- 5.3.2 The Humber River Basin Management Plan (RBMP) identifies measures and actions needed to bring all water bodies to 'good' overall status under the Water framework Directive (WFD). Issues relevant to the Strategy include: physical modification as a result of land drainage issues and flood protection and recreation. Implementation of the strategy will assist in meeting these objectives. Other RBMP objectives in relation to diffuse pollution and over-abstraction will not be impacted by the strategy. Table 5-2 includes a summary of the positive and negative impacts relative to the WFD objectives.

Table 5-2 Option Appraisal Environmental Issues

Option No	Abbreviated Description	Option	Environmental Impacts
1	Do Nothing		<p>Negatives: Loss of significant areas of protected habitats, e.g. SSSI, NNR, SPA and LWS. Loss of large areas of agricultural land resulting in job losses and reduction in UK food security. Current landscape character would be lost. Conservation Areas, Scheduled Monuments and Listed Building would be flooded or isolated.</p> <p>Positives: Long term reduction in energy use and emissions as a result of stopping pumping regime and no or few functioning properties or agriculture. May lead to carbon sequestration in anaerobic underwater sediment.</p> <p>These options were not assessed for compliance under the Water Framework Directive (WFD) as they were only used to provide an economic baseline.</p>
2	Do Minimum		
3	Maintain		<p>Negatives: Continued degradation and wastage of peat based soils. Lost opportunity to revert Rivers Torne and Idle systems towards a more natural regime. Lost opportunity to improve condition of River Idle Washland SSSI. Continued use of energy resources through pumping regime. Limited opportunities to</p>

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Option No	Abbreviated Description	Option	Environmental Impacts
			<p>help achieve good ecological status of water bodies under the WFD.</p> <p><u>Positives:</u> Continued protection for all habitats protected under statute protected habitats. Continued protection for towns, villages and agricultural land. Continued protection of all landscape character areas. Continued protection of Scheduled Monuments, Built Conservation Areas and Listed Buildings. Compliant with the environmental objectives of the WFD (i.e. no adverse changes).</p>
4	Maintain with Kilham FSA and optimised internal pumps		<p><u>As for Option 3 plus</u></p> <p><u>Negatives:</u> No additional negatives.</p> <p><u>Positives:</u> Reduction in flood risk to agricultural land adjacent to the River Torne downstream of Kilham Farm. Compliant with the WFD, subject to appropriate design of Kilham FSA and mitigation during sediment control activities. Opportunities to help achieve good ecological status of water bodies under the WFD during optimisation and refurbishment of pumps; channel re-profiling and setting back embankments during works to flood defences; working with landowners to increase the overall area of wetlands adjacent to the River Idle Washlands SSSI.</p>
5A	Modify defences to a 10% (1 in 10) or greater chance of happening each year		<p><u>Negatives:</u> Increased flood risk to maximum of 2 residential properties and 1 commercial asset. Potential impact on human health as a result of reduced SoP for the area. Potential loss of farming related employment due to increased flood risk leading to reduction in productivity. Increased flood risk to A18 to the west of Derrythorpe. Continued degradation and wastage of peat based soils. Lost opportunity to revert Rivers Torne and Idle systems towards a more natural regime. Lost opportunity to improve condition of River Idle Washland SSSI. Continued use of energy resources through pumping regime.</p> <p><u>Positives:</u> Continued protection for all habitats protected under statute protected habitats. Continued protection for towns, villages and agricultural land. Continued protection of all landscape character areas. Continued protection of Scheduled Monuments, Built Conservation Areas and Listed Buildings. Reduction in flood risk to agricultural land adjacent to the River Torne downstream of Kilham Farm. Reduction in flood embankment height leading to increased visual and landscape openness. Compliant with the WFD, subject to appropriate design of Kilham FSA and mitigation during sediment control activities. Opportunities to help achieve good ecological status of water bodies under the WFD during optimisation and refurbishment of pumps; channel re-profiling and setting back embankments during raising or lowering works; working with landowners to increase the overall area of wetlands adjacent to the River Idle Washlands SSSI.</p> <p>*Only applicable to Option 5A.</p>
5B	Modify defences to a 4% (1 in 25) or greater chance of happening each year		
5C	Modify defences to a 1.33% (1 in 75) or greater chance of happening each year		
5D	Modify defences to a 1% (1 in 100) or greater chance of happening each year		

Option No	Abbreviated Option Description	Environmental Impacts
6	Terminal Pumping Stations – revert to gravity	<p><u>Negatives:</u> Increased flood risk to 4 residential properties. Limited impact on human health as a result of reduced SoP for the 4 properties. Potential loss of farming related employment due to decreased land drainage capacity leading to reduction in productivity. Continued degradation and wastage of peat based soils. Majority of River Idle Washland SSSI will be permanently inundated over 50% of the time leading to loss of feeding, breeding and roosting habitat for a number of protected bird species. Loss of 559 hectares of agricultural land through being waterlogged. Potential impact on Pilfrey Bridge Listed Building as a result of embankments along A18. Potential non-compliance with the WFD due to increased flood risk and alterations in drainage of agricultural land causing short term increases in nutrient, chemical and sediment content of water that drains into water bodies. Detailed assessment needed.</p> <p><u>Positives:</u> Continued protection from flood risk for majority of properties, towns, villages and agricultural land. Alteration of flow regime on the River Torne and River Idle systems towards more natural conditions. Continued protection for all protected habitats. Potential for improvement to the River Idle Washlands SSSI as a result of inundation. Decreased land drainage capacity along the Torne and Idle may lead to conditions suitable for formation of inland marsh habitat which may improve habitats for certain protected species. Reduction in flood risk to agricultural land adjacent to the River Torne downstream of Kilham Farm. Reduction in energy use as a result of reversion to gravity drainage at terminal pumping stations. Continued protection of majority of landscape character areas. Continued protection of Scheduled Monuments, Built Conservation Areas and Listed Buildings. Opportunities to help achieve good ecological status of water bodies under the WFD from: improved continuity between the Torne and Idle systems and the River Trent and reversion to a more natural flow regime; optimisation and refurbishment of pumps; channel re-profiling and setting back embankments as part of works to flood defences.</p>

Option No	Abbreviated Description	Option	Environmental Impacts
7	River Torne 1.33% (1 in 75) defences; River Idle gravity		<p>Negatives: Increased flood risk to Study Area as lowering of SoP and associated impacts on human health. Potential loss of farming related employment due to decreased land drainage capacity leading to reduction in productivity. Continued degradation and wastage of peat based soils. Lost opportunity to revert River Torne system to a more natural flow regime. Majority of River Idle Washland SSSI will be permanently inundated over 50% of the time leading to loss of feeding, breeding and roosting habitat for a number of protected bird species. Loss of 437 hectares of agricultural land through being waterlogged. Potential non-compliance with the WFD due to increased flood risk and alterations in drainage of agricultural land causing short term increases in nutrient, chemical and sediment content of water that drains into water bodies. Detailed assessment needed.</p> <p>Positives: Continued protection from flood risk for majority of properties, towns, villages and agricultural land. Alteration of flow regime on the River Idle systems towards more natural conditions. Continued protection for all protected habitats. Potential for improvement to the River Idle Washlands SSSI as a result of inundation. Decreased land drainage capacity along the Torne and Idle may lead to conditions suitable for formation of inland marsh habitat which may improve habitats for certain protected species. Reduction in flood risk to agricultural land adjacent to the River Torne downstream of Kilham Farm. Reduction in energy use as a result of reversion to gravity drainage at West Stockwith. Continued protection of majority of landscape character areas. Continued protection of Scheduled Monuments, Built Conservation Areas and Listed Buildings. Opportunities to help achieve good ecological status of water bodies under the WFD from: improved continuity between the River Idle and the River Trent and reversion to a more natural flow regime; optimisation and refurbishment of pumps; channel re-profiling and setting back embankments during raising or lowering works.</p>

5.4 Social and community impacts

- 5.4.1 The impacts of the short listed options on social and community aspects are shown in Table 5-3. They have been considerably abbreviated but further details on these issues can be found in the Strategic Environmental Assessment (Appendix N to the StAR).

Table 5-3 Option Appraisal Social and Community Impacts

Option No	Abbreviated Description	Option	Social and Community Impacts
1	Do Nothing		<p>Negatives: total loss of the character of the area with the abandonment of nearly 30,000 properties, agricultural land and associated employment. Total breakdown of current community structure and dispersal of thousands of residents. Recreation, regional economy and infrastructure would be significantly affected. Positives: None.</p>
2	Do Minimum		
3	Maintain		<p>Negatives: None. Positives: Continued protection from surface water flooding and flood events for communities, agricultural land, regional economy, recreational pursuits and critical regional infrastructure.</p>
4	Maintain with Kilham FSA and optimised internal pumps		

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Option No	Abbreviated Option Description	Social and Community Impacts
5A	Modify defences to a 10% (1 in 10) or greater chance of happening each year	<u>Negatives:</u> Increased flood risk to 5 residential and 2 non-residential properties and associated stress for those property owners. Increased flood risk to small areas of agricultural land with possible impacts on productivity and employment. <u>Positives:</u> continued protection for the majority of communities and agricultural land, albeit at a lower standard than is received currently. Critical regional infrastructure, recreational pursuits and regional economy protected.
5B	Modify defences to a 4% (1 in 25) or greater chance of happening each year	<u>Negatives:</u> As for Option 5A but increased flood risk to 2 residential and 1 non-residential properties and associated stress for those property owners. <u>Positives:</u> as for Option 5A.
5C	Modify defences to a 1.33% (1 in 75) or greater chance of happening each year	<u>Negatives:</u> As for Option 5A but increased flood risk to 2 residential and 1 non-residential properties and associated stress for those property owners. <u>Positives:</u> as for Option 5A.
5D	Modify defences to a 1% (1 in 100) or greater chance of happening each year	<u>Negatives:</u> As for Option 5A but increased flood risk to 2 residential and 1 non-residential properties and associated stress for those property owners. <u>Positives:</u> as for Option 5A.
6	Terminal Pumping Stations – revert to gravity	<u>Negatives:</u> Increased flood risk to 4 residential properties and associated stress for those property owners. Increased flood risk to approximately 559 hectares of agricultural land with possible impacts on productivity and employment. <u>Positives:</u> continued protection for the majority of communities and agricultural land, albeit at a lower standard than is received currently. Potential for current agricultural land to become habitat, although there are known obstacles to implementation from land owners. Critical regional infrastructure, recreational pursuits and regional economy protected.
7	Option recommended by Consultees – modify defences on the River Torne and revert to gravity on the River Idle	<u>Negatives:</u> Increased flood risk to approximately 470 hectares of agricultural land with possible impacts on productivity and employment. <u>Positives:</u> continued protection for all communities and majority of agricultural land, albeit at a lower standard than is received currently. Potential for current agricultural land to become habitat, although there are known obstacles to implementation from land owners. Critical regional infrastructure, recreational pursuits and regional economy protected.

5.5 Option costs

- 5.5.1 The cost estimates include all Internal Drainage Board and Environment Agency assets that contribute to managing flood risk in the Isle of Axholme. This includes inland flood defences, perimeter flood defences, outfalls and inland and terminal pumping stations. All of the assets within the Isle of Axholme strategy area provide both land drainage and flood risk management functions. It would be possible to make an arbitrary split in the costs associated with the two functions, but the detail of this will be agreed as part of the on-going discussions with the IDBs on asset transfer and any split now could influence these discussions. The impact of these discussions will be to transfer a proportion of the whole life costs into an IDB contribution. This will improve the FDGiA position.

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- 5.5.2 For options which result in a reduction to the existing Standard of Protection engineering mitigation costs were also included.
- 5.5.3 Option costs were developed using a variety of sources and approaches in order to provide a robust estimate of future investment requirements under each option. At the Medium List assessment stage, the costs provided an initial comparison between the various options and generally conform to an assessment date of 2010. The main exceptions to this are the costs for inland flood defences (which were initially assessed at Quarter 1 2009) and the perimeter flood defences (which had earlier assessment dates relating to the specific strategies).
- 5.5.4 These costs were subsequently refined at the Short List stage based on more in depth assessment. In addition, where it was considered appropriate with reference to the timing and robustness of the initial cost estimates, certain elements of the Short Listed option costs were updated (to fourth Quarter 2010) using the BIS Output Price Index for New Construction (2010): Public Non-Housing.
- 5.5.5 The Asset Technical Assessment Report describes the development of the replacement/refurbishment programme for the inland pumping stations and associated costs. Condition information was used to develop a regular programme of work for mechanical, electrical and civil elements of each pumping station. Allowances have also been made for major inspections, refurbishments and overhauls. The costs and implementation programme were developed by mechanical and electrical engineers with experience in pumping station design.
- 5.5.6 The Asset Technical Assessment Report contains details of the replacement costs for each inland flood defence asset. The Environment Agency Unit Cost Database was used and an approach of completely replacing each section of flood defence has been taken. This is considered to be conservative; in reality improvement works may not be required along the entire defence length. Principal quantities have been estimated, assuming that a completely new bank will be reconstructed. This again may be a conservative approach; in reality it may be possible to improve the existing bank in situ. It is assumed that flood defence walls would also be replaced to match the existing structures.
- 5.5.7 The four main components that combine to give the total cost of the options are shown in Table 5-4:

Table 5-4 Option Cost Components

Component	Description
Capital Costs	The capital expenditure associated with each implementation approach. For the purposes of this assessment, operation and maintenance costs are included under the capital cost heading.
Engineered Mitigation Costs	Applied to options where the costs associated with protecting key infrastructure are less than the resulting damages if the mitigation was not provided. Includes works to protect agricultural land, properties and infrastructure/highways and the repair of breaches caused by increased overtopping related defence failures.
Optimism Bias Adjustment	An Optimism Bias of 60% has been applied to items which involve significant design and therefore uncertainty at this stage; this includes flood defence works and mitigation costs. A 20% Optimism Bias applies to works to existing assets where there is more certainty; this includes pumps and outfall structures.

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Component	Description

Mitigation Costs

5.5.8 For the Do Something options which make the situation worse (i.e. 5A to 5D reduce Standard of Protection and 6 and 7 Gravity options) the Environment Agency will need to undertake mitigation works to protect landowners from the increased risk of flooding. We have considered the increased flooding risk to property and to agricultural land. The increased flooding to property is minimal and adds only minor costs. Agricultural land is the major cause of mitigation work costs and is affected either by an increase in surface flooding or changes to the land drainage network; we have considered both. Increased frequency of surface flooding would occur in the reduced SoP options and gravity options, whilst changes to the land drainage network would only occur in the gravity options. Mitigation costs account for between 0.5% and 7.5% of PV costs in options 5A to 5D; in options 6 and 7 they account for less than 3%, in spite of this all options are cheaper than the maintain option (3). Further details are included in Appendix G.

5.5.9 A summary of option present value costs can be seen in Table 5-5.

Table 5-5 Summary of options present value (PV) costs

	Initial implementation cost (Year 0-5)		Sub Total (£k)	Future Costs (Year 6-100)		Sub Total (£k)	Total PV Cost (£k)
	Capital (£k)	Non-capital (£k)		Capital (£k)	Non-capital (£k)		
Option 1	0	0	0	0	0	0	0
Option 2	10,115	9,553	19,668	54,416	11,965	66,381	86,049
Option 3	46,760	10,595	57,355	208,907	55,958	264,865	322,220
Option 4	48,310	10,546	58,856	206,158	53,833	259,991	318,847
Option 5A	32,854	10,546	43,400	154,561	88,082	242,643	286,043
Option 5B	34,271	10,546	44,817	160,080	68,021	228,101	272,918
Option 5C	36,526	10,546	47,072	167,126	58,636	225,762	272,834
Option 5D	37,125	10,546	47,671	169,376	57,507	226,883	274,554
Option 6	48,534	11,121	59,655	198,494	62,594	261,088	320,743
Option 7	39,151	11,121	50,272	175,028	60,252	235,281	285,553

Note: An Optimism Bias of 60% has been applied to items which involve significant design and therefore uncertainty at this stage; this includes flood defence works and mitigation costs. A 20% Optimism Bias applies to works to existing assets where there is more certainty; this includes pumps and outfall structures.

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5.6 Options benefits (Damages avoided)

5.6.1 The economic appraisal was undertaken in accordance with FCERM-AG.

Property Damages

5.6.2 Property benefit calculations were undertaken on a property level basis and threshold levels were derived from LiDAR survey. Property damages have been capped at market value.

5.6.3 Non residential market values have been taken from the NPD3 where available. Where no value was available we used the average per m² values taken from the study area data and multiplied this value by the property area. Residential market values have been obtained from the Land Registry; county values have been used to reduce any negative effect of flood risk. Missing valuations have been replaced with suitable averages.

5.6.4 Further details of the methodology used are included in Appendix G.

Isolated Communities

5.6.5 As part of the 'Do Nothing' option assessment we considered villages that whilst not being directly affected by flooding would be isolated by the flood water. As this is not acceptable for health and safety and quality of life these isolated properties were deemed uninhabitable in the 'Do Nothing' option. In line with current FCERM-AG we defined a least cost option for the economic damages associated with these isolated communities; we considered the cost of writing-off the properties and compared this to the cost of maintaining a safe and reliable access route into the villages. We have included costs for raising both the east and west sections of the M180; this maintains the current major forms of access to the affected communities. We have also included the costs associated with raising the A161 to the villages. The available cost data indicates that raising the access roads would be the least cost option for both Crowle and the Belton, Epworth, Haxey and Westwoodside areas; £730 million has been included for this. We have not included for any changes required in services to the communities (such as water supply and sewerage) under such a scenario. None of the Do Something options will result in properties or villages being isolated in this way.

Risk to Life

5.6.6 The Flood Risks to People guidance sets out how allowances should be made to account for injuries and deaths during a flood event. Although considerable flooding would occur during the 'Do Nothing' option it would not be sudden, rather a slow build-up of water taking many months, with an estimated average velocity of 0.008m/s, from the Rivers Torne and Idle. In the Do Minimum and Do Something options only a very small number of properties would be affected; in comparison to the damages resulting from the flooding to agricultural land and properties the risk to life damages would be insignificant. For these reasons Risk to Life damages have not been assessed for any options.

Infrastructure

5.6.7 The Environment Agency's Receptors Vulnerable to Flooding layer has been plotted to identify the location of major infrastructure such as hospitals, power and sub-stations, pylons, pumping stations, gas storage facilities, communication depots, sewage treatment works etc.

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- 5.6.8 A critical infrastructure risk matrix has been produced to identify infrastructure within the strategic study area which is considered to serve a significant number of people outside the strategic study area and would need to be replaced or maintained. We included the following key infrastructure within the economic assessment.
- 5.6.9 There would be a loss of electricity distribution in the Do Nothing option; we have assumed that all the pylons that currently pass through the strategic study area will be moved at a cost of £0.75M/km (the average of the range given in Regulatory Impact Assessment URN 06/1929/A1). This £91.1 million cost has been included within the analysis.
- 5.6.10 Major Accident Hazard (MAH) pipelines and High Pressure Gas Pipelines pass through the strategic study area. The estimated length of pipelines that would be affected is 138km and £159 million has been included within the analysis. The gas storage facility at Hatfield is the fourth largest of the nine major gas storage facilities in the UK (2003). It is not known what effect the 'Do Nothing' option would have beyond that on the pipelines that are part of its infrastructure; therefore we have not included any further costs.
- 5.6.11 Two prisons (HMP Lindholme and HMP Moorland) would need replacing under the Do Nothing; £215 million has been included.
- 5.6.12 Smaller infrastructure such as care homes, electricity sub-stations, schools within the strategic study area would no longer be required during the 'Do Nothing' option and therefore they have been written off with all other property; none of this infrastructure floods in the Do Something options.
- 5.6.13 Further information is contained within Appendix G.

Social Equity

- 5.6.14 In accordance with the current Defra guidance a social equity factor was calculated and applied for each residential property affected. Virtually all of the property is within the 60% least deprived areas.

Agricultural Damages

- 5.6.15 In excess of 30,000 hectares of Grade 1 and Grade 2 agricultural land would be lost under the Do Nothing option. A study specific to the Isle of Axholme was carried out by Cranfield University to confirm write off values and losses according to MCM guidance. Significant areas of good quality agricultural land would also be affected, either by an increase in surface flooding or changes to the land drainage network, under the Do Minimum and Do Something options; these damages have been assessed in accordance with MCM guidance dependent on whether the damage would be permanent or intermittent. Full details on the agricultural damage assessment for the Do Minimum and Do Something are included in Appendix G.
- 5.6.16 It is also of note that the number of people in the Isle of Axholme area that are employed in the agriculture and fishing sector is five times the English average² and at least twice the Yorkshire average; economic impacts related to flooding have not been quantified.

² Yorkshire Forward Renaissance Market Towns Isle of Axholme – Economic Needs Analysis Final Report August 2004

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Transport Damages

- 5.6.17 Transport damages followed MCM guidance; in the Do Nothing option only damages due to the loss of sections of the M180 and M18 were assessed; This approach was taken as the use of the A grade and other local roads in the study area was limited primarily to local residents whose homes would be permanently flooded. The damages were capped at the lower cost (£880 million) associated for raising the motorway out of the flood plain.
- 5.6.18 We have included £640 million to rebuild 32 miles of railway line around the strategy study area edge in the Do Nothing option.
- 5.6.19 The Do Minimum and Do Something options did not lead to significant road flooding so no further assessment was made.

Environmental Damages

- 5.6.20 The 'Do Nothing' option would result in the permanent loss of Thorne, Crowle and Goole Moors and Hatfield Moors. Between them these internationally protected areas make up approximately 3,000 hectares of the remaining 10,000 hectares of raised bog in lowland England.
- 5.6.21 The permanent flooding of land below the 5.25m level would result in the potential for the natural development of 3,006 hectares of swamp habitat in water less than 0.4m deep.
- 5.6.22 Although it is not appropriate to suggest that the loss of the raised lowland bog can be balanced ecologically with the possible creation of the same area of swamp habitat: in monetary terms it is unlikely that there would be a significant cost difference. For this reason no environmental damages or benefits have been quantified within the Do Nothing assessment.

Environmental Benefits

- 5.6.23 The positive change in environmental value associated with the potential creation of new habitats resulting from the gravity options (6 and 7) have been estimated using the FCERM-AG Economic Valuation of Environmental Effects – Handbook. Resulting values are included within the economic appraisal as benefits.
- 5.6.24 Further details of the economic environmental assessment carried out as part of the strategy are included in Appendix G.

Breakdown of Damages

Figure 5-1 Breakdown of Do Nothing Damages

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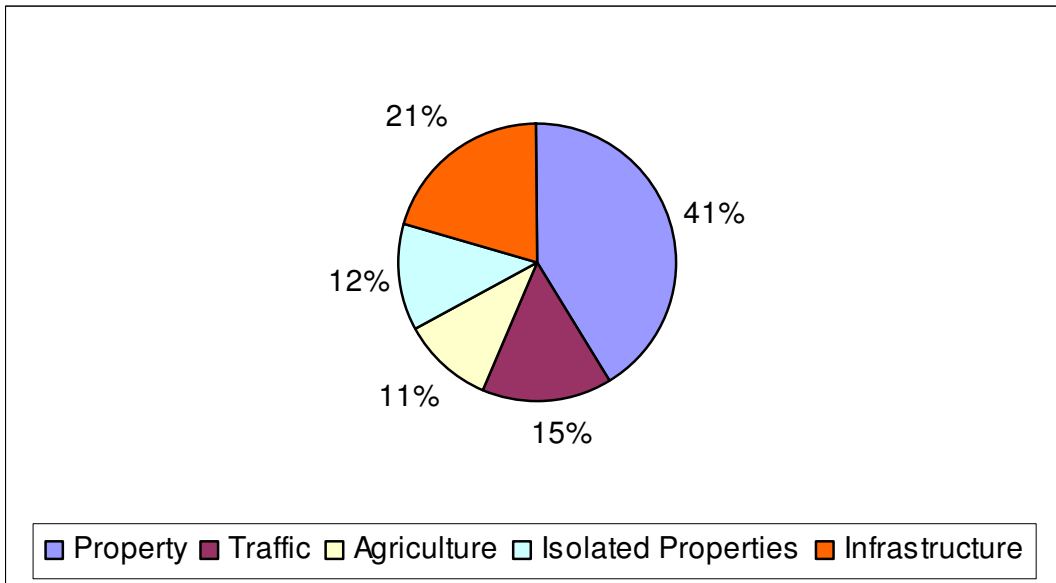


Table 5-6 Summary of options present value (PV) damages and benefits (£k)

Option	Damage (PVd)	Benefits (PVb)	Key non-monetised benefits
Option 1	5,356,415	0	
Option 2	3,797,929	1,558,486	
Option 3	3,615	5,352,800	Prevention of negative impacts to the local economy through loss of agricultural jobs
Option 4	3,540	5,352,875	
Option 5A	4,541	5,351,874	
Option 5B	3,883	5,352,532	
Option 5C	3,632	5,352,783	
Option 5D	3,631	5,352,784	
Option 6	21,592	*5,349,872	
Option 7	15,401	*5,353,225	

*Includes ecosystem services benefits.

5.7 Consultation

- 5.7.1 Between January 2011 and March 2011, interested parties were consulted on a variety of options.
- 5.7.2 In summary, the results of this consultation were:
- 5.7.3 The local residents, the National Farmers Union (NFU) and local farmers support the maintain option.
- 5.7.4 The Royal Society for the Protection of Birds (RSPB), Yorkshire Wildlife Trust, Nottinghamshire Wildlife Trust and Natural England do not support the Maintain Option believing it would miss opportunities for improving the environment.
- 5.7.5 Local Authorities and residents confirmed their commitment to supporting the strategy implementation through contributions.

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6 Selection and details of the preferred option

6.1 Selecting the preferred option

Table 6-1 Benefit-cost assessment

	PV Costs (£k)	PV Benefits (£k)	Av. Benefit/Cost Ratio	Incremental BCR	Option Rank
Option 1	-	-	-	-	-
Option 2	86,049	1,558,486	18.11	N/A	6
Option 3	322,220	5,352,800	16.61	N/A	9
Option 4	318,847	5,352,875	16.79	N/A	7
Option 5A	286,043	5,351,874	18.71	N/A	5
Option 5B	272,918	5,352,532	19.61	N/A	2
Option 5C	272,834	5,352,783	19.62	N/A	1
Option 5D	274,554	5,352,784	19.50	N/A	3
Option 6	320,743	5,349,872*	16.68	N/A	8
Option 7	285,553	5,353,225*	18.75	N/A	4

* Figures include ecosystem services benefits of £15,049k and £12,211k for Options 6 and 7 respectively.

- 6.1.1 This economic assessment follows the decision process set out in the Environment Agency's Flood and Coastal Erosion Risk Management Appraisal Guidance The Do Nothing report demonstrated that it was possible for the benefits of an option to exceed its costs. This is due to the large (circa £5,000Million) Do Nothing damages. All the shortlisted options have benefits that exceed their costs by a ratio of 16 to 1 or more.
- 6.1.2 The major flood risk to the area is from long term loss of the pumping system leading to permanent inundation; this only occurs in the Do Nothing and Do Minimum. In comparison, due to the high standard of the existing inland river defences and pumps across the system, all other options have relatively small residual damages. These residual damages are dwarfed by the Do Nothing damages; the result is several options very close together in terms of benefits. The options were ranked by Average Benefit Cost Ratio to select the leading option. All these options have benefits that exceed their costs by a ratio of 16 to 1 or more. The ranking is shown in Table 6-1.
- 6.1.3 During the preferred option consultations, many consultees were open to the possibility of external contributions. If such contributions were forthcoming, it is possible that the leading option might change. For instance, a contribution towards Option 5D of £60k per year over the 100 years would change the leading Option from 5C to 5D.
- 6.1.4 The scheme is to be partly funded from the Flood Defence Grant in Aid (FDGiA) budget. Assessment against payments for outcomes shows a strong score which is in excess of 100% raw OM score level as per the Defra FDGiA calculator. The strategy team have clearly articulated the need to all partners of the need to raise local contributions to reduce central government spending, without which it may not be possible to deliver this Strategy. Discussions with the IDBs and local community have revealed a willingness to contribute to the option to achieve a slightly higher standard of 1% (1 in 100) chance in any year. The existing IDB land drainage charges provide a potential method for collecting contributions. Transfer of the operation and maintenance of certain Environment Agency assets will form an important part of the longer term contributions being sought and these will be defined in more detail with the local community and other partners during the implementation of specific elements of the strategy at a project level.

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- 6.1.5 The benefits of several of the options in contention are similar; the options are therefore separated on costs and environmental issues/ opportunities. Due to the limited differences between the options' costs and due to the inherent inaccuracy of strategic costing, uncertainty is significant. Thus, a small (circa 5%) change in costs could change the leading option and such a change is well within the expected uncertainty of the costs. However, the uncertainty of costs applies similarly to all options considered; no one option has more certain costs than the others. It is therefore, not appropriate to change the leading option from Option 5C due to uncertainty.
- 6.1.6 From examination of the options against the strategic objectives and the views expressed during the preferred option consultation, it is clear that different options provide different outcomes against the wider objectives. For instance, some provide greater ecological benefits whilst others provide better outcomes for agricultural land and communities. However, no one option provides a better outcome to all these wider objectives and therefore there is no obvious alternative option to the leading option (option 5C).
- 6.1.7 Consultation has shown that reverting to gravity at West Stockwith; whilst environmentally preferred by some consultees, cannot be reasonably implemented as there are strong indications that landowners and others would not accept the reduced Standard of Protection that would be provided and the associated impacts on land drainage due to effects on outfalls. These stakeholders might install additional pumps to ensure the continued land drainage.
- 6.1.8 Option 5C has been identified as the preferred option.

6.2 Sensitivity testing

- 6.2.1 The option selection results have been tested for sensitivity to the issues listed below. Tests have been carried out on the strategic costs and the strategic benefits:

Climate Change

- 6.2.2 The impacts of climate change have been examined in line with the latest 2011 guidance. Due to the mechanism of the damages occurring under the Do Nothing option, the increased fluvial peak flows will not change the magnitude of the Do Nothing damages. As the residual damages for the options considered are so tiny when compared to the Do Nothing damages (i.e. in the region of 0.05% of the Do Nothing damages), the impact of climate change on all options is just to increase the costs and hence decrease the BCR of each option. However, an assessment of the impact of climate change on 1.33% and 1% flows was carried out. Existing modelling shows for both flows that the change factor for the 2080s and its upper end estimate are less than or comparable to the existing 0.1% (1 in 1000) flow. An assessment of the property numbers affected by the 0.1% flood shows the impact to be insignificant. These climate change impacts will have a similar effect on all shortlisted options. Therefore, a more detailed quantified assessment of climate change has not been undertaken as this would not have been proportionate to the strategy objectives. This climate change assessment applies to the strategy area; it does not consider the tidal rivers which are covered by separate strategies.

Increased costs:

- 6.2.3 Our cost estimates are based on the best information presently available. If they are too high, the scheme will provide better value than was anticipated. If they are too low, the business case could be untenable. To test this, we have assumed the preferred option costs would increase by an arbitrary 20%, with the same economic benefits. Result - BCR reduces from 19.6 to 16.3; option 5c is still the preferred option. Option choice is sensitive to changing cost as described in paragraph 6.1.5; however as explained in 6.1.5, as the basis for deriving cost is similar for all options, the uncertainty in cost is seen to apply equally.

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Removing the northern (FC13) area from costs and benefits:

- 6.2.4 The Do Nothing option floods the majority of the FC13 study area so costs for protecting the area were included to avoid including benefits of the options but not the costs. As none of the Do Something options caused flooding in FC13 we tested the sensitivity of the options to removing the FC13 Do Nothing damages and FC13 perimeter defence costs from the economic assessment. Result - BCR reduces from 19.6 to 12.0; option 5c is still robustly cost beneficial.

Environmental Effects:

- 6.2.5 The Eftec 'First Cut' Assessment' was used to provide an indication of the value of ecosystem services under options that include reversion to gravity flow at the terminal pumping stations (options 6 and 7). The outcomes of the first cut assessments were incorporated into the economic analysis of the options, being input as PV Benefits. The 'First Cut' analysis suggests a maximum ~£51 million benefit under Option 6 (full gravity) compared with the total benefits of maintaining defences for the study area of ~£5,353 million.
- 6.2.6 The relatively small benefits from ecosystem services, even at the maximum level, do not have an influence on the preferred option from a cost-benefit perspective. For Option 6 the value of ecosystem service would need to increase to a little over £1,000 million to have an influence on the preferred option: this would represent a greater than 20-fold increase in the value of ecosystem services when compared to the maximum value from the First Cut assessment. For Option 7, the value of ecosystem services would need to increase to around £350 million: a greater than 8-fold increase in the value of ecosystem services when compared to the maximum value from the First Cut assessment.
- 6.2.7 Options 4 to 7 all include the potential to carry out channel re-profiling and to set back embankments during works to flood defences, and to increase the overall area of wetlands adjacent to the River Idle Washlands SSSI (see Tables 4-6 and 5-2). Therefore these habitat improvement measures, and the ecosystem services they could provide, are not a way of distinguishing between options.
- 6.2.8 Ecosystem services do not influence the preferred option from a cost-benefit perspective. Even if the Environment Agency was pro-active in carrying out works to maximise the benefits that could be achieved from reversion to gravity flow and also considered other schemes the influence is unchanged. Therefore further analysis, e.g. 'Second Cut' or similar, was not carried out.

Agricultural Land Values

- 6.2.9 Do Nothing damages are very large (circa £5,000 million) and residual damages are approximately £3 million; agricultural damages are 11% of the Do Nothing damages. A change in the Do Nothing damages is likely to affect all options similarly; it would take a large change in residual damages to affect the option choice;.
- 6.2.10 The Do Nothing damages are the result of permanent inundation and agricultural land is written off at market value. A separate study was commissioned to assess land value; this can be seen as Appendix B of the economic report. Potential variances in land values discussed in the report under a business as usual situation could vary by +/- 15%. This would not affect the option choice.
- 6.2.11 The residual damages in the Do Something options do not involve permanent inundation and thus the land values adopted are not significant in the benefits of options; land values would not affect the option choice.

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6.3 Details of the preferred option

Technical aspects

- 6.3.1 The appraisal (technical, environmental and economic) concludes that Option 5C is the preferred option; this involves maintaining pumping at the terminal pumping stations combined with lowering the inland flood defences to provide protection against flood events with a 1.33% (1 in 75) or greater chance of happening each year.
- 6.3.2 Overall, this option is technically and environmentally acceptable and meets the strategic objectives. It is the most economically viable of the options considered; however, it is recognised that the option choice is sensitive to costs and additional contributions could change the option.
- 6.3.3 In addition, we will implement a scheme to create a formal Flood Storage Area on land at Kilham that already floods. This scheme will reduce flooding to approximately 112ha of agricultural land between Kilham Farm and Tunnel Pits Pumping Station. This scheme is economically acceptable with limited environmental impacts.
- 6.3.4 It is also recommended that the range of additional engineering and non-engineering flood risk management activities should form part of the preferred option as follows:

Operational responsibility - *Review future operational responsibility to identify potential efficiencies* - currently the pumping stations and watercourses are maintained and operated either by the Environment Agency or the Internal Drainage Boards. When current proposals for amalgamating Internal Drainage Boards are implemented fully, operational responsibility for a good proportion of the current Environment Agency assets could be transferred, potentially delivering significant savings. However, this is likely to be a complex process which could take several years to complete. Initially it is likely that the Environment Agency would contract the IDBs to provide the services which we currently undertake ourselves. Pilot exercise for trialling the contracting out of operational and maintenance responsibilities to the Isle of Axholme ID for Snow Sewer is already planned to take place in April 2012. Alongside this we would commence the legal process which will eventually lead to the formal transfer of assets. These discussions are at a positive early stage and the full extent is not yet determined. However, there is the potential to eventually transfer all of the Environment Agency assets apart from the tidal banks and the two terminal pumping stations. Transfer of responsibility to the IDBs could potentially provide a ready-made mechanism for securing contributions for maintaining a higher standard of protection. As part of the process of asset transfer we would seek to establish a more robust basis for the split between land drainage and flood risk management costs for individual assets

Reducing Overcapacity - *Adjust inland pumping stations capacity and layout without increasing flood risk or reducing land drainage capabilities* – currently there is significant redundancy in the capacity of the pumping station network. By reducing this redundancy, costs can be reduced and environmental improvements such as better fish and eel passage achieved without increasing the flood risk both now and in the future. The cost reduction can be achieved in a number of ways; we have identified up to 18 pumping stations which can either have lower capacity pumps installed when the pumps need replacing or be combined with another pumping station; by reducing the operating regime of the pumping stations costs may be reduced and standardising equipment used in the pumping stations could potentially provide a more cost-effective approach to management of the pumping network.

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Environmentally, such a solution will reduce energy consumption and contribute to a smaller carbon footprint.

Flood Storage - *Provide flood storage to hold water in times of flood, reducing pressure on the defences elsewhere* – existing flood storage areas on the River Idle should be maintained and an area downstream of Kilham Farm should be formalised as a flood storage area. This will reduce the volume of water available to flood properties and agricultural land. We will look to manage the storage areas to provide maximum biodiversity benefits.

Flood Warning - *Continue to provide flood warning services, seeking improvements as appropriate* – This draft strategy concentrates on fluvial flood risk from the Rivers Torne and Idle. Flood warning associated with flood risk from the surrounding tidal Rivers Trent, Don and Ouse will continue in line with the recommendations of the strategies for these watercourses.

Land use and development control - *We will continue to influence planning proposals* – by working with Local Planning Authorities and developers to ensure the appropriateness of development in areas at risk from flooding, in line with current planning policy.

Preparing for Flooding - *We will work with local communities to manage the remaining risk from flooding* – no flood risk management activities can totally remove the risk of an extreme event or failure causing a flood. We will continue to work with local communities to provide advice on ways that they can reduce the consequence of remaining flood risks by applying suitable resilience measures.

Improvement of pumping station plant and equipment - *Standardize plant and equipment to provide future efficiencies* – this would offer a more cost-effective procurement approach and will allow equipment to be interchangeable between the different pumping stations.

The carbon emitted while operating the pumping system is directly linked to energy consumption of the system and is a major contributor to the carbon emissions from the system as a whole. The Energy Hierarchy below shows how improvements to the system can target carbon savings most effectively, the first being most effective:

- Reduce Energy Demand – achieved by reducing the number of pumps or changes in operational rules.
- Increase Energy Efficiency – achieved through replacement pumps or modifications.
- Use of Renewable Energy - e.g. solar and direct wind power.
- Use a mix of renewable and non-renewable energy
- Carry on as at present with minor improvements.

This thinking should be applied during all future asset refurbishment, replacement and maintenance activities. These activities can also provide opportunities to improve fish and eel passage in line with the requirements of the Eel Regulations and the WFD.

Pumping stations as mining subsidence mitigation - Review current requirements relating to pumping stations legally required as mitigation for mining subsidence – we have not been able to recommend an approach to these pumping stations funded by the Coal Authority under statute. We understand that the statute is under review which may make future potential savings possible.

River channel improvements - *Channel Profile Improvements* - on a project-level basis, when defence or channel work is required, further investigation will be carried out into the feasibility of channel realignment or improvement in order to achieve

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environmental gains. This may include the construction of a two-tiered channel with appropriate vegetation planting to provide better habitat during low flow conditions or the re-profiling of an existing engineered channel to provide a more natural profile. We will also seek to implement WFD mitigation measures for areas impacted by capital works as we start to do significant works to defences.

Seeking opportunities to improve wetland habitat - River Idle Washlands SSSI - during consultation with landowners we have identified opportunities for increasing the overall area of wetlands adjacent to the SSSI. We have recognised that there is a major opportunity to extend the wetland area adjacent to Unit 2 Misson West, which is currently in Unfavourable Recovering condition. We will be working with Hanson Quarries and Nottinghamshire Wildlife Trust to link opportunities for gravel quarry restoration with the removal of sections of the minor embankments. Elsewhere we will work with landowners to assess the potential for further wetland creation, potentially linked to improving irrigation water supply by further removal of the minor banks.

Setting back of defences - further assessment of the potential to set back existing flood defences during improvement works. In addition we are investigating the potential to either reduce pumping capacity or remove pumps altogether at a number of locations by providing storage capacity in enlarged channels. This will be subject to a detailed appraisal at a project level, landowner agreement and obtaining the appropriate funding. Setting back of defences is likely to provide ecological benefits by creating new washland areas and wetland habitats.

Legal compliance –Eel Regulations - under these Regulations we will look to implement screening and passage solutions on our own structures by 2015. We will also be contacting owners of third party structures to provide details of what is required to comply with the regulations. The Isle of Axholme strategy area is being developed as one of a small number of pilot areas looking at the implications of implementation of the Eel Regulations.

Environmental aspects

- 6.3.5 The strategy will involve the construction of some new defences and the refurbishment and rebuilding of some existing flood defences. The construction of new defences may require planning permission under Section 57 of the Town and Country Planning Act 1990 (as amended). The modification of the existing defences should not require planning permission, but we will seek a screening opinion from the Local Planning Authority regarding this. Obtaining planning permission or screening opinions will be done at the project stage.
- 6.3.6 A Strategic Environmental Assessment (SEA) has been carried out to document the environmental impacts of the strategy.
- 6.3.7 The Humber River Basin Management Plan (RBMP) identifies measures and actions needed to bring all water bodies to 'good' overall status under the Water Framework Directive (WFD). Issues relevant to the Strategy include: physical modification as a result of land drainage issues and flood protection and recreation. Implementation of the strategy will assist in meeting these objectives. Other RBMP objectives in relation to diffuse pollution and over-abstraction will not be impacted by the strategy.
- 6.3.8 The strategy has been assessed against the requirements of the Habitats Regulations 2010. The assessment concluded that the strategy is not likely to have a significant effect on a European site. Further details are available in the separate Technical Note and HR01

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form. Natural England has confirmed that they think the proposal is likely to lead to an environmentally acceptable solution and is not likely to require an appropriate assessment.

6.3.9 The preferred option has been assessed as compliant with the WFD. Further details are available in the separate compliance report.

6.3.10 The environmental risks of the strategy to existing conditions are limited to potential localised changes in landscape character from the Kilham Flood Storage Area and optimisation of the inland pumping regime, and potential impacts on human health as a result of a reduced overall SoP increasing stress. The strategy will, however, result in a continuance of the following existing environmental risks: degradation and wastage of peat based soils as a result of the use of a pumped system; continued use of energy resources for the pumping regime; and, a lost opportunity to revert the River Torne and River Idle systems towards a more natural flow regime including improvements to the condition of the River Idle Washlands SSSI.

6.3.11 The Environment Agency has a statutory duty to protect and enhance the local environment wherever possible. In addition to the objectives of the Strategy, the consultation and option development processes have helped identify a number of additional benefits that the Strategy can deliver.

6.3.12 Environmental benefits are measures that improve the existing environment. These measures are in addition to any mitigation or off-setting measures. Furthermore, in developing engineering elements, good environmental design is expected. This is also distinct from environmental benefits.

6.3.13 We have identified benefits to access, landscape, recreation or conservation that could be gained as part of future schemes that will be developed from this strategy; these are summarised below. Technical details can be seen in Section 6.3.4.

6.3.14 Opportunities for environmental enhancement:

- Channel restoration
- Channel Re-profiling
- River Idle Washlands SSSI Improvements
- Set back defences

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Costs of the preferred option

Table 6-2 PV Costs of Preferred Option

Cost	2013/14 (£k)	2014/15 (£k)	2015/16 (£k)	2016/17 (£k)	2017/18 (£k)	Future Year (£k)	Total (£k)
Capital	7,753	6,920	8,294	6,153	7,406	167,126	203,652
Non-Capital	2,323	2,167	2,077	2,007	1,973	58,635	69,182
Total	10,076	9,087	10,371	8,160	9,379	225,761	272,834

Contributions and funding

- 6.3.15 Work is currently underway with Procurement to develop the Procurement Strategy which will take account of the new Water and Environment Management Framework which will commence in April 2013.
- 6.3.16 The scheme is to be partly funded from the Flood Defence Grant in Aid (FDGiA) budget. Assessment against payments for outcomes shows a strong score which is in excess of 100% raw OM score level as per the Defra FDGiA calculator. The team have clearly articulated the need to all partners of the need to raise local contributions to reduce central government spending, without which it may not be possible to deliver this Strategy. Discussions with the IDBs, North Lincolnshire Council and the local community have revealed a willingness to contribute to the option to achieve a slightly higher standard of 1% (1 in 100 yr) chance in any year. We have letters of support from the main Local Authority and their Cabinet have endorsed the principle of providing funding. The precise mechanisms for delivery are complicated by parallel discussions with the Local Authority on the need for funding of other work, in particular the adjacent Humber strategy. North Lincolnshire have made it clear that the Agency need to agree a combined funding package for all of our works (tidal Trent, Humber, Ancholme, Isle of Axholme), so the approach will be confirmed with these related projects.
- 6.3.17 The existing IDB land drainage charges provide a potential method for collecting contributions. Transfer of the operation and maintenance of certain Environment Agency assets will form an important part of the longer term contributions being sought and these will be defined in more detail with the local community and other partners during the implementation of specific elements of the strategy at a project level. These transferred costs would reduce the FDGiA costs and increase the raw OM score; it is unlikely that these arrangements could be in place before 2013.
- 6.3.18 Currently there are 11 pumping stations funded by the Coal Authority and Highways Agency. The costs of maintenance and replacement of these pumping stations within the strategy is £16.94m. We have involved both organisations throughout the work on the strategy and they are keen to work with us on efficiencies; they do however recognise the challenges imposed by primary legislation covering these activities.

Other aspects

- 6.3.19 We are currently in the process of setting up a pilot trial for the transfer of the operation and maintenance of a section of pumped drainage at Snow Sewer to the Isle of Axholme and North Nottinghamshire Water Level Management Board. The IDBs have been involved at board level throughout the strategy and will be key to the future implementation of the strategy.

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6.4 Summary of preferred strategy

Table 6-3 Summary of preferred strategy

	Preferred Option
Standard of Protection	1.3% (1 in 75 yr)
PV Costs (£k)	
Capital	204,000
Non-capital	69,000
Total PV Costs (£k)	273,000
PV Benefits (£k)	5,353,000
Average Benefit/Cost Ratio	19.6
Cash Costs (£k)	
Capital	595,000
Non-capital	228,000
Total Cash Costs (£k)	823,000
Partnership Funding Score	126.0%

6.5 Consultation

- 6.5.1 Between 10th October 2011 and 10th November 2011, interested parties were consulted on the preferred option. In summary, the results of this consultation were:
- 6.5.2 The local residents, the National Farmers Union (NFU) and local farmers are opposed to any reduction in the Standard of Protection afforded to valuable agricultural land. They have indicated that they are willing to provide contributions to support the highest possible SoP.
- 6.5.3 The Royal Society for the Protection of Birds (RSPB), Yorkshire Wildlife Trust, Nottinghamshire Wildlife Trust and Natural England do not support the Maintain Option believing it would miss opportunities for improving the environment. However they accept that in preparing the strategy we have achieved a reasonable balance between the various stakeholders. The Agency has agreed to continue to work with the environmental groups and landowners to seek to build on work already underway around the River Idle to restore the Idle Washlands SSSI. There are a number of wider initiatives currently underway in the area, in particular the new Nature Improvement Area which will assist in delivery of the environmental objectives.

7 Implementation

7.1 Project planning

Phasing and approach

7.1.1 We have identified an initial programme of refurbishment of existing defences and pumping stations which includes the following works in the short-term (first 10 years):

- Seven sections of raised defences, with a total length of almost 27km, require refurbishment in the next five years.

River Torne – on the right bank downstream of Tunnel Pits Pumping Station (PS)

South Soak Drain – on the right bank upstream of Crook o Moor Bridge and Goodnow Bridges and downstream of Thorne

North Soak Drain – on the left bank upstream of Crook o Moor Bridge

Hatfield Waste Drain – left bank downstream of Wood Carr Farm

North Engine Drain – right bank downstream of Dirtness Bridge

South Level Engine Drain – right bank between Greenholme PS and Stockholes Turbary and downstream of Bull Hassocks PS and Greenholme PS

River Idle – on the left and right banks of the Idle, including in the Newington and Everton areas

- All inland pumping stations will be subject to a rolling programme of refurbishment. Pumping stations in the poorest condition are likely to require the earliest works. This includes refurbishment works to the following 11 inland pumping stations: Armthorpe; Dirtness; Snow Sewer Drain Head; Woodcarr; Cross Drain; Bewcarrs; Black Dyke; Greenholme; Heckdyke; Trentside and Four Bridges. Improvement schemes will take account of potential opportunities to reduce capacity and/or combine pumping stations. This will be subject to more detailed studies in the short-term. These more in-depth localised studies will also assess opportunities for biodiversity improvements associated with the pumping system. This programme of refurbishment will be affected by the proposed asset transfer from the Environment Agency to the IDBs; this will affect who funds the works and the timings of the work.
- The terminal pumping stations at Keadby and West Stockwith will be subject to a rolling programme of refurbishment with each asset requiring improvements. In the short-term works are likely to include refurbishment of penstocks, flood gates and valves, works to mechanical and electrical systems and replacement of the diesel engines at Keadby.
- Kilham Flood Storage Area involves improvement works to the existing cross embankment upstream of Kilham Farm to formalise the upstream flood storage area.
- Works to defences along the Rivers Trent, Ouse and Don will continue in line with the recommendations of the strategies developed specifically for these rivers.
- Approximately six outfalls will require works within the short- to medium-term.
- The wetland area adjacent to Unit 2 Misson West, currently in Unfavourable Recovering condition, will be extended as we work with Hanson Quarries and Nottinghamshire Wildlife Trust to provide environmental improvement in this area.

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7.1.2 Costs for these works are shown in Table 7-1 and Table 7-2

Table 7-1 First ten years of flood defences costs

Description	Cost of improvement / reconstruction (£k)	Cost of Investigation (£k)
River Torne: Improvement / reconstruction to a total of 1800m of embankment on the right bank downstream of Tunnel Pits Pumping Station. Investigation to 3300m of embankment on left bank downstream of Auckley.		30
South Soak Drain: Improvements / reconstruction to a total of 2900m of embankment on the right bank upstream of Crook o Moor Bridge & 100m of flood wall on right bank upstream of Goodnow Bridge. SoP improvement to 50m of embankment upstream of Goodnow Bridge. Investigation and localised repairs to 1900m of embankment on the right bank downstream of Thorne.	4,990	80
North Soak Drain: Improvement / reconstruction to a total of 1100m of embankment on the left bank upstream of Crook o Moor Bridge.	683	0
Hatfield Waste Drain: Improvement / reconstruction to a total of 300m of embankment on the left bank downstream of Wood Carr Farm. Further investigate a 400m length in the same area where, although the strategy indicates a poor defence condition, the adjacent ground levels appear high enough to provide the 1.33% (1 in 75) Standard of Protection. Similar investigation of a total of 1500m of embankment on the right bank in the Sandtoft Grange area.	88	0
North Engine Drain: Investigation of adjacent ground levels and defence requirements of 50m of embankment on the left bank upstream of A161 road bridge. Improvement / reconstruction of 3400m of embankment on the right bank downstream of Dirtness Bridge.	4,632	0
South Level Engine Drain: Improvement / reconstruction to a total of 2200m of right bank embankment between the areas of Greenholme Pumping Station and Stockholes Turbary. SoP improvement to 2700m of embankment downstream of Bull Hassocks pumping station and 30m of right bank floodwall downstream of Greenholme Pumping Station.	7,145	0
River Idle: Improvement / reconstruction to a total of 1400m of embankment on the right bank and 6100m of minor embankments on left bank of the River Idle. Investigation and localised repairs to 1100m of embankment on the left bank in the Newington area and 1800m of embankment in the Everton area.	19,599	130
Kilham Farm Flood Storage: Involves construction of 150m new embankment	530	0
TOTAL	37,667	240

- Notes: 1) Costs included 60% optimism bias
2) As part of programming of strategy was to achieve even annual programme, timing of works can be changed to address local needs
3) For more detail, see Appendix K

Table 7-2 First ten years of pumping station costs

Description	Costs (£M)	Stations requiring work in first 5 years	
Mechanical, electrical or building refurbishment of Environment Agency pumping stations in first 10 years	5.30	<ul style="list-style-type: none"> • Armthorpe • Dirtness 	<ul style="list-style-type: none"> • Snow Sewer Drain Head • West Stockwith
Mechanical, electrical or building refurbishment of Isle of Axholme and North Nottinghamshire Water Level Management Board pumping stations in first 10 years	5.80	<ul style="list-style-type: none"> • Bewcarrs • Black Dyke • Derrythorpe • Greenholme • Hecdyke • Old River (Godnow) 	<ul style="list-style-type: none"> • Rushcarr • Southfields • South Street • Trentside • Common Carrs • Four Bridges
Mechanical, electrical or building refurbishment of Shire Group of IDBs pumping stations in first 10 years	2.63	<ul style="list-style-type: none"> • Blaxton Quarry • Cadmans • Franklins • Elmhurst • Cross Drain 	<ul style="list-style-type: none"> • High Levels South (Askerns) • South Thorn Bank
Mechanical, electrical or building refurbishment of other IDB and private pumping stations in first 10 years	0.16		
TOTAL	13.89		

- Notes:
- 1) Costs included 60% optimism bias and 20% for engineering/management costs
 - 2) As part of programming of strategy was to achieve even annual programme, timing of refurbishment can be changed to address local needs
 - 3) For more detail, see Appendix K
 - 4) As certain MEICA items need refurbishment or replacement every 10 years, most if not all pump stations require work in the first 10 years.
 - 5) The split of expenditure between the Environment Agency and IDBs will depend on how the proposed asset transfer progresses, however this process offers the opportunity to secure a more robust split between the costs of providing land drainage and flood risk management functions.

7.1.3 Once the initial works have been undertaken implementation of the draft strategy will continue. We will carry out further works required in addition to reviews of the final strategy every five years. Some of these future works will require further study as follows:

- Review of the Idle Washlands SSSI Water Level Management Plan (WLMP). This is due for a major review starting in 2012. We will be re-engaging with landowners and other key stakeholders to review the work which has been undertaken to date and to plan future works to meet the objectives of the WLMP. Elsewhere we recognise that there are more complex impacts on existing land use which would need to be resolved as part of the review of the WLMP.
- Minor banks – linked to the WLMP we are keen to work with farmers and landowners to assess the potential for a transfer of responsibility for the minor banks which provide a low standard of protection to agricultural land along the River Idle. This would allow considerable cost savings to be made on future refurbishment, but we need to understand the implications for the areas of land which are protected and for the Environment Agency's obligations under the Reservoirs Act.

Programme and spend profile

Table 7-3 Annualised spend profile and OM priority score

Costs (£k)	2013/14 (£k)	2014/15 (£k)	2015/16 (£k)	2016/17 (£k)	2017/18 (£k)	Future Year	Total
Preferred Option							
Adjusted OM Score = 125.98%							
Capital	7,753	6,920	8,294	6,153	7,406	167,126	203,652
Non-capital	2,323	2,167	2,077	2,007	1,973	58,635	69,182

Note* Figures do not include inflation

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Outcome measures contributions

Table 7-4 Medium Term Outcome Measures Contributions

Outcome Measures						
1 Scheme Details						
Pv whole life costs (k)	£272,834					
Pv whole life benefits (k)	£5,352,783					
Benefit to cost ratio	19.62					
FDGiA Contribution (k)	£343,890					
Raw score	125.98%					
OM 2 households better protected against flood risk						
	Before			After		
	Moderate risk	Significant risk	Very significant risk	Moderate risk	Significant risk	Very significant risk
Number of households in:						
20% most deprived areas	0	20	0	0	0	0
21-40% most deprived areas	0	25	0	0	0	0
60% least deprived areas	0	17,876	0	6	0	0
OM 3 households better protected against coastal erosion						
						None
OM 4 Statutory environmental obligations met						
						None

Note: Outcome measures not separated into various components as the component parts work together, i.e. all are required to achieve the benefits.

7.2 Procurement strategy

- 7.2.1 Work is currently underway with Procurement to develop the Procurement Strategy. This will allow it to take account of the new Water and Environment Management Framework which will commence in April 2013.
- 7.2.2 A wide range of opportunities such as how the new frameworks may be used, opportunities for wider packaging and different contractual arrangements, potential joint work with the IDBs, picking up some previous discussions with specialist suppliers on standardisation of pumping station technology, looking at increased maintenance efforts to defer capital improvements will be considered. In the short term the Area are progressing the most urgent work as part of the re-conditioning programme and work identified by the regional MEICA team.
- 7.2.3 The Procurement Strategy will be devised to allow initial use of our existing frameworks with flexibility to align the approach dependant on any future overarching recommendations from our Engineering Procurement Strategy.
- 7.2.4 As part of the Procurement Strategy we will look for phasing and packaging opportunities in developing schemes. We will be seeking to work closely with both IDB and Local Authority partners as they progress schemes. This will enable other procurement opportunities to be

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developed with economies of scale, reduction of project risks and improved team performance.

7.3 Delivery risks

High level risk register

Table 7-5 High level risk schedule and mitigation

Key Strategy risks	Adopted mitigation measure
Failure to secure all required approvals (internal and external)	<ul style="list-style-type: none"> • Good quality report; key technical staff available for queries; continued communication with wider team and project board. Commitment to formal external endorsement of the strategy – full support for preferred option has been secured from both IDBs and North Lincolnshire Council.
Mitigation measures not approved/ delay in implementation	<ul style="list-style-type: none"> • Legal advice obtained during strategy; consultation with landowners; good relationship with local MP and land owners.
Adequate financial resources not available	<ul style="list-style-type: none"> • Good forward planning and programming.
Contributions for all FRM activities within the area not forthcoming; asset transfer not successful	<ul style="list-style-type: none"> • Discussions held with potential contributors; payment mechanisms identified. Discussions held about asset transfer.
Missing opportunity to add potential environmental benefits	<ul style="list-style-type: none"> • Thorough SEA process; early Idle Washlands work. Opportunities for WFD and eels regulations improvements also identified.

Safety plan

- 7.3.1 Health and safety is integral to the strategic development process. Within the strategy the consideration of options is limited to concept or outline design; however, it is recognised that decisions that are made at this level can impact on later implementation stages. Therefore, ensuring the proposed future works are designed to be safely constructed and operated, with low residual risk to construction operatives, operational staff and members of the public is an important consideration.
- 7.3.2 In preparing this strategy, no strategic level health and safety issues have been identified as a reason to select one option over another. There are residual risks with each option, however through good practice these can be mitigated to an acceptable level.
- 7.3.3 It could be argued that providing a reduced SoP could result in an increased strategic level health and safety risk due to the increased likelihood of flooding. However, given the nature of the flooding impacts, the increased health and safety risk is considered to be relatively low. The replacement of assets will include associated construction and operational risks.
- 7.3.4 Implementing future works to the flood risk management system does provide an opportunity to reduce the residual risk through the application of a number of general principles and practices. These can be applied to the design, construction and operational stages of strategy implementation. To assist with the identification of these we have prepared a high level RAG health and safety register. The register lists those activities which should be encouraged (green activities) or avoided (red activities) during the subsequent implementation stages of the strategy. The list illustrates the principals of the strategic option development and highlights activities that should be considered at the individual scheme level.
- 7.3.5 The list should be read in conjunction with the current Environment Agency generic RAG list. The HSE have also prepared a RAG list which provides further guidance on aspects to consider. The strategy specific and generic Environment Agency RAG register forms the

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basis of the recommended activities. The lists consider both strategic level and more specific detailed aspects. They are designed to provide guidance as to best practice and do not replace the need for individual health and safety assessments at the project level. In preparing the list we have undertaken a preliminary assessment of the hazards associated with the key components of the preferred option (raised flood defences, pumping stations and other flood risk management structures) and have indicated whether the requirements primarily relate to the reduction of hazards that would be encountered during the construction or operation/maintenance stages.

7.3.6 Further details can be seen in the Options Technical Report in Appendix K.

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Appendix A Project appraisal report data sheet

Entries required in clear boxes, as appropriate.

GENERAL DETAILS

Authority Project Ref. (as in forward plan):	
Project Name (60 characters max.):	Isle of Axholme Flood Risk Management Strategy
Promoting Authority: Defra ref (if known)	
Name	Environment Agency (Midland Region)
Emergency Works:	<input type="checkbox"/> No <input type="checkbox"/> Yes/No
Strategy Plan Reference:	N/A
River Basin Management Plan	Humber RBMP
System Asset Management Plan	Various
Shoreline Management Plan:	N/A
Project Type:	Strategy Plan
Shoreline Management Study/ Preliminary Study/ Strategy Plan/Prelim. Works to Strategy/ Project within Strategy/Stand-alone Project/ Strategy Implementation/Sustain SOS. Coast Protection/Sea Defence/Tidal Flood Defence/Non-Tidal Flood Defence/Flood Warning Tidal/Flood Warning - Fluvial/Special	

CONTRACT DETAILS

Estimated start date of works/study:	2013
Estimated duration in months:	1200
Contract type*	Various

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

COSTS

	APPLICATION (£000's)
Appraisal:	tbc
Costs for Agency approval:	823,000
Total Whole Life Costs (cash):	823,000

For breakdown of costs see Table in Section 2.4

CONTRIBUTIONS

Windfall Contributions:	0 – contributions to be sought after approval
Deductible Contributions:	0
ERDF Grant:	0
Other Ineligible Items:	0

LOCATION - to be completed for all projects

EA Region/Area of project site (all projects):	Midland
Name of watercourse (fluvial projects only):	Rivers Idle and Torne
District Council Area of project (all projects):	East Riding of Yorkshire Council, Doncaster Metropolitan Borough Council, North Lincolnshire Council and Bassetlaw District Council
EA Asset Management System Reference:	Various
Grid Reference (all projects):	SE 750 080

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

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DESCRIPTION

Specific town/district to benefit:	Isle of Axholme
Brief project description including essential elements of proposed project/study (Maximum 3 lines each of 80 characters)	Strategy plan for Isle of Axholme area covering future FRM activities over next 100 years. Option is to use existing EA and IDB assets (about 100km of flood defences and 60 pumping stations) to maintain 1 in 75 SoP for area

DETAILS

Design standard (chance per year):	1 in 75	yrs
Existing standard of protection (chance per year)	Varies from 1 in 100 - 1000 in places	yrs
Design life of project:	100	yrs
Fluvial design flow (fluvial projects only):	Various	m ³ /s
Tidal design level (coastal/tidal projects only):	n/a	m
Length of river bank or shoreline improved:	100,000	m
Number of groynes (coastal projects only):	n/a	
Total length of groynes* (coastal projects only):	n/a	m
Beach Management Project?	No	Yes/No
Water Level Management (Env) Project?	No	Yes/No
Defence type (embankment, walls, storage etc)	Various	

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

ADDITIONAL AGREEMENTS:

Maintenance Agreement(s):	Not applicable	Not Applicable/Received/Awaited
EA Region Consent (LA Projects only):	Not applicable	Not Applicable/Received/Awaited
Non Statutory Objectors:	N/A	Yes/No
Date Objections Cleared:	N/A	
Other:	Not applicable	Not Applicable/Received/Awaited

ENVIRONMENTAL CONSIDERATIONS

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

SITES OF INTERNATIONAL IMPORTANCE

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

Special Protection Area (SPA):	Yes	Yes/No
Special Area of Conservation (SAC):	Yes	Yes/No
Ramsar Site	Yes	Yes/No
World Heritage Site	No	Yes/No
Other (Biosphere Reserve etc)	No	Yes/No

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

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

OTHER ENVIRONMENTAL CONSIDERATIONS

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

COMPATIBILITY WITH OTHER PLANS

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

SEA/ENVIRONMENTAL IMPACT ASSESSMENT

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

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

Costs, benefits and scoring data

(Apportion to this phase if part of a strategy)

Local authorities only: For projects done under Coast Protection Act 1949, please separately identify: FRM = Benefits from reduction of asset flooding risk; CERM = Benefits from reduction of asset erosion risk

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

DEF

LAND AREA

Total area of land to benefit:			Ha
of which present use is:	FRM	CERM	
Agricultural:	46,600	N/A	Ha
Developed:	2,330	N/A	Ha
Environmental/Amenity:	3,600	N/A	Ha
Scheduled for development			Ha

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PROPERTY & INFRASTRUCTURE PROTECTED

	Number		Value (£'000s)	
	FRM	CERM	FRM	CERM
¹ Residential	27,771	N/A	2,591,848	N/A
Commercial/industrial	2,627	N/A	245,176	N/A
Critical Infrastructure	See Appnd G	N/A		N/A
Key Civic Sites		N/A		N/A
Other (description below):	See Appnd G	N/A		N/A
Description:	See Appnd G			

costs and Benefits

¹ Present value of total project whole life costs (£'000s):	272,977	
Project to meet statutory requirement? Y/N	N	
	Value (£'000s)	
	FRM	CERM
Present value of residential benefits:	2,591,848	N/A
Present value of commercial/industrial benefits:	245,176	N/A
Present value of public infrastructure benefits:	1,927,035	N/A
Present value of agricultural benefits:	588,724	N/A
Present value of environmental/amenity benefits:		N/A
¹ Present value of total benefits (FRM & CERM)	5,352,783	
Net present value:	5,079,949	
Benefit/cost ratio:	19.62	
Base date for estimate:	May 2011	
FCERM-AG Decision Rule stage 3 applied	Yes	Yes/No
FCERM-AG Decision Rule stage 4 applied	Yes	Yes/No

OTHER OUTCOME MEASURE SCORING DETAILS

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

Exemption Details (if exempt from OM scoring system)

Exempt from Scoring:		Yes/No
Reason (max 100 chars):		

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FDGiA Calculator, based on interim funding arrangements announced 23rd May 2011

ePublications Catalogue Product Code - FLHO0511BTXS-E-E

Project Name/ref: Axholme 1:75yr option

Key	Input cells
	Calculated cells

Summary: prospect of FDGiA funding

"FDGiA Contribution":	£ 343,889,719		
"Raw OM Score":	125.98%	Scheme Benefit to Cost Ratio:	19.62 to 1
Cost saving and/or external contribution required:	£ -	Effective return to taxpayer:	19.62 to 1
Less scheme contributions secured:	£ -	Effective return to area:	n/a to 1
"Adjusted OM Score":	125.98%		
Result:	Potential candidate for FDGiA funding dependant upon funding availability		
FDGiA required for next phase(s):	£ 272,979,000		

1. Scheme details

Who will maintain asset?	EA
PV Whole-Life Costs:	£ 272,8340 million
PV Whole-Life Benefits:	£ 5,352,7830 million
Cash cost of next phase(s):	£ 272,9790 million
Duration of Benefits:	100 years
Average flood damages:	£ 30,000 per household
Construction phase?	Yes - costs for approval include construction

2. Qualifying benefits under Outcome Measure 2: households better protected against flood risk

Number of households in:	Before			After			Change due to scheme		
	Moderate risk	Significant risk	Very significant risk	Moderate risk	Significant risk	Very significant risk	Moderate risk	Significant risk	Very significant risk
20% most deprived areas	-	20	-	-	-	-	0	-20	0
21-40% most deprived areas	-	25	-	-	-	-	0	-25	0
60% least deprived areas	-	17,876	-	6	-	-	6	-17,876	0
Annual damages avoided, compared with a household at low risk									
	£ 150	£ 600	£ 1,350						

Change in household damages, in:	Per year		Over lifetime of scheme		Qual. benefits (discounted)	
	£		£			£
20% most deprived areas	-£ 12,000		-£ 1,200,000		OM2 (20%)	£ 358,360
21-40% most deprived areas	-£ 15,000		-£ 1,500,000		OM2 (21-40%)	£ 447,950
60% least deprived areas	-£ 10,724,700		-£ 1,072,470,000		OM2 (60%)	£ 320,275,613

3. Qualifying benefits under Outcome Measure 3: households better protected against coastal erosion

Number of households in:	Before		Damages per household avoided:	
	Long-term loss	Medium-term loss	Annual damages avoided	Loss expected in
20% most deprived areas	-	-	£ 6,000	£ 6,000
21-40% most deprived areas	-	-	50	20 years
60% least deprived areas	-	-	£ 1,184	£ 3,015
Present value of Year 1 loss (i.e. first year damages, discounted based on when loss is expected)				
	Long-term loss	Medium-term loss		

Change in household damages, in:	Year 1 loss avoided:		Over lifetime of scheme:		Qual. benefits (discounted):	
	£		£			£
20% most deprived areas	£ -		£ -		OM3 (20%)	£ -
21-40% most deprived areas	£ -		£ -		OM3 (21-40%)	£ -
60% least deprived areas	£ -		£ -		OM3 (60%)	£ -

4. Qualifying benefits under Outcome Measure 4: statutory environmental obligations met

Payments under:	Assumed benefits per unit:		Qual. benefits (discounted):	
	£		£	
OM4a Hectares of net water-dependent habitat created	£ 15,000		OM4a	£ -
OM4b Hectares of net intertidal habitat created	£ 50,000		OM4b	£ -
OM4c Kilometres of protected river improved	£ 80,000		OM4c	£ -
			OM4	£ -

5. Qualifying benefits arising from the overall scheme, for entry into the Medium-Term Plan

OM, deprivation:	Qual. benefits:	Payment rate:	FDGiA contribution:	
OM1	£ 5,031,793,076	5.56 p in the £1	£ 279,544,060	
OM2	20% most	£ 358,360	45.0	£ 161,262
	21-40%	£ 447,950	30.0	£ 134,385
	Least 60%	£ 320,275,613	20.0	£ 64,055,123
OM3	20% most	£ -	45.0	£ -
	21-40%	£ -	30.0	£ -
	Least 60%	£ -	20.0	£ -
OM4	£ -	100.0	£ -	
Total	£ 5,352,875,000		£ 343,894,830	

The "FDGiA Contribution" towards the scheme's whole-life benefits

Sensitivity Testing. It is important that users of this calculator appreciate the implications on funding from changes to input data which may become necessary as the project develops and better information is available. Three typical tests are provided below. Users should consider how appropriate these are to their project, what other tests may be appropriate and how best to use the information with all those that may be involved in the project.

Revised:	FDGiA Contribution	Raw OM Score
1. Change in PV Whole Life Cost (30% increase)	£ 343,894,830	96.91%
2. Change in OM2 - 50% of households in Very Significant (Before) risk may already be in Significant Risk band	£ 343,894,830	125.98%
3. Change in OM3 - 50% of households in Medium Term loss (Before) may already be in Long Term loss	£ 343,894,830	125.98%