



**Able Humber Ports Ltd
Marine Energy Park
Proposal to build a quay and associated development
on the south bank of the River Humber**

Planning Inspectorate Reference: TR030001

**Summary of oral representations made by
The Environment Agency
at the Issue Specific Hearings held on
11th, 12th & 13th September 2012
Unique Reference Number: 10015552**

24 September 2012

Issue Specific Hearing in respect of Cherry Cobb Sands HRA

At the hearing on 11 September 2012 Mrs Susan Manson made the following submissions on behalf of the Environment Agency (EA), when requested by the Panel to provide an update on the habitat compensation proposals at Cherry Cobb Sands.

Regulated Tidal Exchange proposal

The EA is pleased to see improvements to the proposed design of the compensation site, using the Regulated Tidal Exchange (RTE) scheme. The EA has no issues with the principle of using such a scheme.

We are aware of other projects that have utilised a RTE scheme and advise that the applicant considers information available in respect of these:

- Lippenbroek, on the River Scheldt
- KBR (Kruibeke Bazel Rupelmonde).

The Lippenbroek scheme has been intensively monitored since 2006 and has encountered higher levels of sedimentation than predicted. The purpose of this scheme was to provide compensation under the Birds and Habitats Directive using an experimental design. The River Scheldt has undergone more anthropogenic influences than the Humber, in particular in terms of much higher levels of dredging than those that take place on the Humber with a navigable channel having been dredged. Since 2002 dredging on the Scheldt has expanded, with the Port of Antwerp being located approximately 80km upstream from the estuary mouth. In 2010 deepening was initiated along the navigation channel to increase and maintain a minimum depth of 14.5m draft for boats. The Humber Estuary has higher sediment loads and hence is a more turbid estuary than the River Scheldt. These differences between the two systems need to be borne in mind when applying anything from the Scheldt to the Humber. For example, the Scheldt is a complex multi-channel river system where concentrations of suspended sediment are highly variable in place and time. The concentrations are in the range of a few hundreds mg/l (400 mg/l⁻¹).

We also advise the applicant undertakes further topographic survey work in order to ground truth their assessment and ensure the most up to date information available is used. We would not expect this to be undertaken for the whole site, but through a topographic survey to determine the degree of accuracy, confirm spot heights, understand the margin of error and any change since the LIDAR was acquired. This would include any change to the Cherry Cobb Sands Creek in the LIDAR data used. It would also be advisable to survey the Cherry Cobb Sands Creek, visible on the Google Earth image included in the Environmental Statement, Appendix 32.1 (Compensation Site Geomorphology) Figure 3. The EA has obtained new LIDAR data this summer, which may also be available to the applicant. If the applicant wants to pursue purchasing additional data for the site, we suggest they contact Geomatics directly.

It is the EA's opinion that a RTE scheme will deliver mudflat for a longer period than a managed realignment site alone, but without intervention in the

future there will still be accretion and salt marsh reversion. These two issues are ones that the EA is currently having to manage (in discussion with Natural England) in its own realignment programme for delivering compensation primarily for coastal squeeze.

Killingholme Marshes

The most up to date information that the EA holds in respect of long-term losses taking place within the estuary, including the Killingholme foreshore is that as set out in our Representations of 3rd August 2012 (Paragraphs 4.29-4.31), taken from the Humber Flood Risk Management Strategy Habitats Regulation Assessment (HFRMS HRA) as approved by Defra in July 2011 (See Appendix A attached). This information has not been used by the applicant in calculating the losses. The EA has not had the time to corroborate the applicant's assumption that the Killingholme foreshore accounts for 1.2% (EX 11.24, paragraph 16) of the Middle Estuary intertidal area (Middle Estuary shown on figure attached as Appendix B). With this proviso, accepting the 1.2% supplied by the applicant for these purposes the EA calculate that the loss that would take place on this frontage between 2000 and 2056 would be 6.12 ha +/- 1.88 ha. On this basis, a loss of 4.80 ha +/- 1.48 ha between 2013 and 2056.

Wet Grassland at Cherry Cobb Sands

The EA has only been made aware of this proposal this week and therefore we have no comments to make on it at the current time.

Stone Creek maintenance

The EA has been in long-term discussions with the Internal Drainage Boards (IDBs) in respect of this issue. The EA is responsible for managing flood risk, but not the land drainage. The result of recent discussion has resulted in the EA making a contribution to maintenance by the IDBs. (We would refer the Examining Authority to our response to the first written questions, in particular Q38, which also provides information in respect of maintenance at Stone Creek). The EA is able to confirm that the draft agreement for the transfer of the funds for this work has been agreed with Keyingham IDB, and the agreement has been signed by the EA. It is currently awaiting Keyingham IDB to sign the agreement. Mrs Manson referred to the work that was undertaken in 2010 by the EA looking at maintenance dredging. The results of this project (technical documents and appendices) are attached in Appendix C for information. Following this work and in response to local concerns we did look to establish trigger levels which would result in the EA undertaking dredging. The findings of this work have resulted in the EA making the contribution defined above.

Issue Specific Hearing in respect of Able Marine Energy Park HRA

At the hearing on 12 September 2012 Ms Carol Bolt, Mrs Susan Manson and Mrs Annette Hewitson made the following submissions on behalf of the EA.

In-combination effects

The EA supported the representations made by the Marine Management Organisation (MMO) in respect of the applicant's in-combination assessment for disposal of dredging material. Ms Bolt also flagged up the difficulties experienced in reviewing a large amount of supplementary information, which was submitted at the beginning of the summer holiday period during which EA officers were having to respond to numerous flooding incidents.

The EA has been raising concerns in respect of in-combination issues; Section 10 of our submission of 3rd August 2012 introduced these. The EA also has concerns in respect of the hydrodynamic assessments and these will be covered in more detail during the Hearing on 13 September 2012.

Our submission of 7th September 2012 to the Examining Authority's second round of questions set out the EA's current position on the in-combination issues. This is still our current understanding of the in-combination issues, as the applicant has not provided us with any further update on this matter. The main issues that need to be addressed are:

- Clear logical arguments to be presented with the appropriate cross referencing to alternative documents where necessary, when the justification for the view taken is not presented;
- Capital and maintenance dredging and dredge disposal;
- Hydrodynamic and morphological change.

We have been working with the applicant to seek to resolve these outstanding issues. We have held productive discussions with the applicant since the hearings were held. Mr Upton also asked if any of these issues were irresolvable. We are now awaiting a further formal response from the applicant before we can comment whether our matters are fully resolved.

Able Logistics Park

The applicant provided an outline of three options, which they are considering in respect of the Drax laydown area and its overlap with Mitigation Site A.

Option 1: Phasing the Marine Energy Park development, in a way that does not impact on the Drax proposal;

Option 2: Agree an alternative laydown area for the Drax proposal, which enables an amended layout for Mitigation Site A to proceed;

Option 3: Utilise the wet grassland area proposed at the Able Logistics Park (ALP) on a temporary basis until Drax finish using the laydown area. The original Mitigation Site A layout can then be developed into wet grassland to serve the Marine Energy Park.

The applicant confirmed that ALP does not yet have consent. North Lincolnshire Council is awaiting the completion of a Legal Agreement under s30 of the Anglian Water Act, in respect of future flood defence maintenance for the Halton Marshes frontage, between the applicant and the EA before consent can be granted.

Ms Bolt clarified the EA's position in respect of the ALP Legal Agreement as Mr Jones (the applicant's representative) had indicated that a response was

currently awaited from the EA. The Legal Agreement, was sent to the applicant in July in a draft format that the EA is prepared to sign up to. Prior to this the draft agreement had passed between the parties for over 4 years. It is the EA's intention to abandon the existing defences along the ALP frontage. The applicant is proposing to continue to maintain and improve the defences to facilitate ALP and the EA has proposed to make a contribution towards this. Unfortunately, the applicant has not yet been prepared to complete the agreement. A recent meeting scheduled to take place on 7 September 2012 between our organisations to discuss this issue was cancelled by the applicant.

The EA believes this is an important issue given the applicant is putting this forward as an option to potentially use the ALP site for wet grassland. The EA would like to highlight some concerns regarding this option:

1. As mentioned above, the EA has been in talks with the applicant in respect of the Legal Agreement to maintain the flood defences at Halton Marshes for more than 4 years. At the North Lincolnshire Planning Committee meeting held on 8th February 2012, it was resolved to grant permission for ALP subject to this agreement being completed by 30th June 2012. This date has now passed and the application may have to be referred back to the Planning Committee, which could cause further delays.
2. Even if permission is subsequently granted for ALP there are no fewer than 20 pre-commencement conditions that will need to be discharged before any development on site can commence.
3. A memorandum of understanding between the applicant, Natural England, and the Royal Society for the Protection of Birds, describes the first phase of the work at ALP to comprise "Flood defence and drainage works along the Halton Marshes frontage as agreed with the Environment Agency" alongside the provision of habitat described in 1.2, b) of the applicant's response to Examining Authority's 2nd questions. The need for defence improvements in this location is currently critical and will need undertaking in the immediate future.
4. Notwithstanding the above, proposed Condition 46, included in the North Lincolnshire Council's Committee report requires "The managed retreat works shown on submitted drawings KI-06029 D and KI-06030 D shall be carried out in their entirety before the commencement of any other floodbank works". This demonstrates a series of works that will be required before/alongside the development of the wet grassland mitigation.

As you will see, the potential to implement Option 3 is not without its difficulties. We would submit that it will not be immediately available as claimed by the applicant.

Notwithstanding the above, the defences in this location are reaching a critical condition. If the Legal Agreement is not completed in the immediate future and the required defence works undertaken, there is a strong likelihood that the EA will have to build a cross bank that intersects this mitigation area, in order to protect the wider flood cell, and the residential properties within it.

The plan attached at Appendix D shows the indicative location for the cross bank that the EA will need to construct, if essential maintenance is not undertaken by the applicant on the existing flood defences, in accordance with the draft Legal Agreement. Notwithstanding the above, it is a requirement of the draft Legal Agreement that the flood defence works are completed by 30th September 2014.

Ecological and Management and Monitoring Plans

The EA has experience of Ecological and Management and Monitoring Plans (EMMPs) for its own managed realignment sites at Paul Holme Strays and Alkborough. Paul Holme Strays has the equivalent of an EMMP which is named an Environmental Action Plan. This was secured through planning conditions and it was a requirement of the conditions that it was the subject of review after 5 years. Part of this review process included amending the frequency and number of parameters measured (both physical and ecological) in the light of the data gathered to date and the understanding of the manner in which the site was developing. The planning condition secures the EAP for a period of 10 years, however in terms of meeting the demands of the Birds and Habitats Directive the EA is in discussions with Natural England to understand when the EA will have met its obligations for the sites under the Directives.

The EMMP at Alkborough is slightly different because the site is jointly owned with Natural England, Associated British Ports and North Lincolnshire Council, and the whole site does not form compensatory habitat under the Habitat Regulations. The EA has an equivalent EMMP for the part of the site that the EA owns and is forming compensatory habitat.

An Environmental Steering Group exists for the Humber Estuary Managed Realignment sites. This Group meets twice a year, and the EA presents its monitoring data at these meetings and discusses how the sites are progressing towards the site objectives. Members of the steering group include the EA, Natural England, Humber INCA, Humber Management Scheme, RSPB, Associated British Ports (in their capacity as owners of realignment sites on the Humber), Lincolnshire Wildlife Trust, Yorkshire Wildlife Trust, and other specifically invited parties. For example, the site manager for the Alkborough realignment site attends to present data on the site's development and be involved in discussions about its future requirements.

Piling conditions

The EA provided clarification in respect of the alleged inconsistencies between the AMEP proposal and that at Green Port Hull. The proposed conditions are not only relevant for the EA for the protection of migratory salmon, but also the MMO and Natural England (NE) for the protection of marine mammals and lamprey. We have applied a consistent approach but there are differences between the two projects. These include the width of the estuary in the different locations and size of piles. The EA has reviewed the impact assessments provided by both applicants and concluded that the proposed conditions are appropriate to provide assurance that neither will

cause a greater impact by piling for longer periods or use larger piles than those that have been assessed.

The EA's position on this issue is set out in detail in our Written Representations (submission of 29 June 2012, paragraphs 4.48-4.73) and our comments on response to Relevant Representations (submission of 3 August 2012, paragraphs 3.1-3.17).

We concur with the MMO and NE that there are different receptors in these locations and the advice that the Examining Authority needs to note is that they are appropriate for this application. They also represent the common position of the government agencies and it is our collective advice that they will provide the protection required for the species of concern.

Issue Specific Hearing on Marine Matters

At the hearing on 13 September 2012 Ms Carol Bolt made the following submissions on behalf of the EA.

The EA requests clarification from the applicant in respect of EX8.6, Table 8 (page 7) in respect of the difference in actual returned disposal quantities and the predicted range of maintenance requirements as defined in paragraphs 4.11-4.12 of our response of 3rd August 2012. We await the applicant's written response to this point. We are able to confirm that subsequent to the Hearings we have been in discussion with the applicant regarding this point. Verbal clarification was provided (on 18 September 2012), and we were informed a written response on this matter will follow in due course.

The EA expressed similar concerns to those expressed by the MMO and NE in respect of dredging and dredge disposal and its impact on the hydrodynamic and sedimentary regime. The EA expects to be included in further discussion with the applicant on this issue and will forward details of the outcome of these in due course.

The MMO raised the issue of the materials intended to be disposed of at HU080 by the applicant. In particular, the gravel size (between 2mm and 10mm) exceeding the threshold of what is normally considered to be fine muddy gravel (up to 2mm). This is an issue as it is unlikely to disperse and modelling has not been provided in respect of changes on benthic communities likely to result from this. The EA recently received (5th September 2012) the Gravel Dispersion Note provided by the applicant (JBA, 28 August 2012) and we are currently considering this. Any change in the benthic community caused by this will need to be included in the Water Framework Directive assessment. The Written Representation of Peter Whitehead in the ABP submission was also drawn to our attention during the Hearing. The EA will be reviewing this representation in the light of Mr Whitehead's comments at the Hearing regarding the change in material type to be disposed at HU080. If there is a potential change to habitat type as a consequence of this activity, we will require the applicant to assess this impact under the Water Framework Directive.

The EA also requested it is included in any further dredging discussions that take place in respect of the in-combination assessment.

Additional Information Requested by the Examining Authority

In response to Mr Upton and Mr Gibb's requests for further information on the following matters, please find below details of the information held by the EA in relation to:

- The characteristics of the mud at Killingholme foreshore;
- Any information on the distribution of mud within the middle estuary, and any characterisation of mud within the middle estuary, with particular interest in the East Halton foreshore and the south bank of the Humber;
- Any update on Black-tailed Godwits since the data for 2009 contained in the ES;
- Any information on the balance between proximity to roost and the characteristics of mud;
- Any other information of locations around the UK where there are large concentrations of birds.

The EA does have information on the foreshore in the vicinity of the foreshore at East Halton from 2003. This includes ecological data and data on the characteristics of the mud, including moisture content, plasticity index and particle size distribution. This information has been recalled from our archives in order to assist the Examining Authority in making its recommendation. We will forward this information as soon as it comes back from our archiving system.

The EA piece of work looking at estuary habitat distribution within the Humber Estuary is currently running behind schedule, and is not expected to be completed until late September or early October due to pressures on staff resources arising from this application. It does present some information on mudflat extent within the middle estuary, but is not location specific. In addition, the EA is involved in a project with other European North Sea estuaries called Tidal River Development, which has undertaken some historical and present day mapping of biotopes within the estuary, including specific reference to mudflat distribution. Unfortunately, this information is not due to be completed until between December 2012 and March 2013, and so at present is unpublished draft material. If at any point there is a change in the examination programme for this project, the EA can provide an update on the progress with this work.

In response to the above request the EA encloses the HRA for the HFRMS (2011) (see Appendix A (HRA Volume 2 Appendix D) attached). Appendix D of the HRA contains a detailed report on bird distributions and locations within the middle estuary.

APPENDIX A

**Humber Flood Risk Management Strategy
Habitats Regulation Assessment – Volume 1**

enhancing... improving... cleaning... restoring...
changing... tackling... protecting... reducing...
create a better place... influencing... inspiring...
advising... managing... adapting...

Humber Flood Risk Management Strategy Habitats Regulations Assessment Volume One (Stages One, Two & Three)

28th February 2011 - FINAL

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Published by:

Environment Agency
Rio House
Waterside Drive, Aztec West
Almondsbury, Bristol BS32 4UD
Tel: 0870 8506506
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

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Environment Agency

Humber Flood Risk Management Strategy

Habitats Regulations Assessment

Volume One (Stages One, Two & Three)

Contents Amendment Record

This report has been issued and amended as follows:

Issue	Rev	Description	Date	Signed Author/ Reviewer
1 - 5	0	Various Drafts for information and consultation.	June 2005- Sept 2008	Richard Ashby-Crane
6	0	Draft for consultation with Natural England	April 2009	Katie Born / Richard Ashby-Crane
7	0	Draft for consultation with Natural England, incorporating clarifications of Strategy and outcomes of ongoing discussions.	Jan 2011	Katie Born / Richard Ashby-Crane
8	0	DRAFT Final	Feb 2011	Katie Born / Richard Ashby-Crane
8	1	DRAFT Final	Feb 2011	Katie Born / Richard Ashby-Crane
8	2	FINAL with Environment Agency sign-off from Phillip Winn (Humber Strategies Manager) and Sue Manson (Technical Specialist Humber Strategies)	28 Feb 2011	Katie Born / Richard Ashby-Crane

Halcrow Group Limited
 Burderop Park Swindon Wiltshire SN4 0QD
 Tel +44 (0)1793 812479 Fax +44 (0)1793 812089
 www.halcrow.com

Project Reference: CEFAXA

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1 Introduction

1.1 *Purpose of this Document*

The Environment Agency (generally referred to as ‘we’ or ‘us’ throughout this document) has responsibility for managing flood risk within the Humber Estuary. The Humber Flood Risk Management (FRM) Strategy¹ which was adopted in March 2008, hereafter called ‘the Strategy’, describes how flood risk will be managed in the estuary for the next 100 years. The Humber Estuary is of international importance for nature conservation. This is reflected in its European or Natura 2000 site designations as a Special Protection Area (SPA), Special Area of Conservation (SAC) and international designation as a Ramsar Site.

This Habitats Regulations Assessment (HRA) for the first 50 years of the Humber FRM Strategy comprises:

- Volume One – a record of HRA Stages One, Two and Three, which includes a) whether the regulations apply to the Strategy, b) whether there is a likely significant effect on the interest features of the Natura 2000 site, c) an ‘appropriate assessment’ and the results of that ‘appropriate assessment’ (i.e. whether the Strategy will have an ‘adverse effect on the integrity’ of the International/Natura 2000 sites present, either alone or in combination with other plans, permissions and projects).
- Volume Two – a record of HRA Stage Four – the ‘Statement of Case’ which records the examination of alternatives, imperative reasons of overriding public interest and provisions for compensation.

1.2 *Background*

A ‘shadow’ Appropriate Assessment² (AA) was produced in May 2005 to support the draft Strategy³ (for consultation) and its associated Strategic Environmental Assessment (SEA)⁴. The aim of the ‘shadow’ AA was to gain initial support from English Nature (now Natural England) and the Local Planning Authorities for the Strategy, and more specifically, for the package of works that was proposed in the first five years, at a time when ‘appropriate assessment’ of strategies and plans of this kind was not considered mandatory.

However, since the issue of the ‘shadow’ AA, our approach to HRA of Strategies/Plans and has changed, notably,

- following judicial review by the European Court of Justice in October 2005, the UK Government was found lacking in its implementation of the Habitats Directive with respect to the AA of ‘land-use plans’,

¹ Humber Flood Risk Management Strategy March 2008, Environment Agency (2008)

² ‘Shadow’ Appropriate Assessment for the Humber FRM Strategy, May 2005, Environment Agency (2005)

³ Draft Humber Flood Risk Management Strategy, Environment Agency (2005)

⁴ Strategic Environmental Assessment of the Draft Humber Flood Risk Management Strategy, Environment Agency (2005)

- the Environment Agency has formalised its policy towards HRA of FRM Strategies and Plans and produced an Operational Instruction (16 October 2007) providing guidance on this. It is Environment Agency policy that they should be subject to HRA under Article 6(3) of the Habitats Directive;
- new guidance has been produced on sea level rise, and the predictions of habitat losses through coastal squeeze within the Humber Estuary have changed as a result of a review of the Coastal Habitat Management Plan (CHaMP); and
- data is now available from the monitoring of actual inter-tidal habitat gains and losses from schemes and sea level change as part of the Environment Agency's mitigation and compensation package.

As a result, there is a need to take account of these changes by revising the HRA (including 'appropriate assessment') of the Strategy. This document therefore supersedes the 2005 'shadow' AA and describes our current understanding of the Humber FRM Strategy and its impacts on the internationally and European designated sites concerned.

1.3 *Flood Risk within the Humber Estuary*

1.3.1 *Existing Defences*

Currently flood protection in the Humber Estuary is provided by approximately 235km of defences largely comprising grassed, earth embankments or heavier rock/stone protected banks with some lengths of quay walls and sheet-piled walls, mainly in the urban areas. The defences are generally in reasonable condition, but the standard of protection is low in places where insufficient height of defence could lead to damage through overtopping, or where the condition of the defence itself results in an unacceptable risk of breaching/destabilisation through wave action.

1.3.2 *Sea Level Rise, Coastal Squeeze and the CHaMP*

Records show that water levels in the Humber Estuary have been rising historically, relative to the land levels, at a rate of c. 2mm per year. This rate is increasing as a result of climate change and, unless action is taken, will increase flood risk in many areas to unacceptable levels. In addition to the increased risk to people, property and land uses, the rising sea levels are causing loss of inter-tidal habitats within the estuary; these habitats are prevented from migrating inland by the existing flood defences (a process known as 'coastal squeeze').

We produced a Coastal Habitat Management Plan (CHaMP)⁵ in 2005 that assumed a rate of 6mm/year over the period 2000 – 2050. A recent review of the CHaMP revised this rate to 4mm/year (as recommended by Defra for use in flood risk planning). The review also allowed a revision of calculations of coastal squeeze habitat losses based on improved data sets.

⁵ Environment Agency (2004). Humber Estuary Coastal Habitat Management Plan (CHaMP). Black & Veatch Consulting Ltd, March 2004.

Coastal Habitat Management Plans (CHaMPs) provide a framework for managing sites of European importance and Ramsar sites that are located on or adjacent to dynamic coastlines. The primary functions of the Humber Estuary CHaMP are to:

- provide a clear and agreed record of predicted habitat losses and gains, and other potential impacts on the habitats and species of European or international importance subject to shoreline change; and
- set the direction for habitat conservation measures to address net losses.

The Humber Estuary CHaMP commits the Environment Agency to compensate for the loss of inter-tidal habitat on the following basis (unless agreed otherwise on a site by site basis or as a result of future Strategy / CHaMP reviews):

- 1:1 replacement for coastal squeeze and temporary disturbance from FRM schemes, and
- 3:1 replacement for permanent loss due to flood defence works (this is the currently agreed ratio, but may be subject to alteration in the future).

1.3.3 Humber Estuary Coastal Authorities Group, Shoreline Management Plan

Since the publication of the Humber FRM Strategy, the Humber Estuary Coastal Authorities Group (HECAG) has prepared a second generation Shoreline Management Plan (SMP2) for the coast between Flamborough Head and Gibraltar Point, including the outer Humber Estuary. HECAG is a partnership between the coastal local authorities responsible for shoreline management policy in the area. The four councils are the East Riding of Yorkshire Council, North East Lincolnshire Council, East Lindsey District Council and Lincolnshire County Council. The HECAG SMP and associated HRA has taken the Humber FRM Strategy appropriately into account. It deals with the outer and outer middle estuary at a higher 'policy' level than the FRM Strategy.

1.4 The Humber Estuary Flood Risk Management Strategy

1.4.1 Development of the Strategy

A strategic approach to the long-term management of flood risk within the Humber Estuary has been developed. The aim is to provide an integrated and consistent approach to the provision of defence standards within the estuary. In turn, this allows us to appraise each scheme in the context of the Strategy and take into consideration the potential cumulative and synergistic impacts of the programme of schemes, and third party proposals, on the European sites.

In 2000, the Humber Estuary Shoreline Management Plan (HESMP) was produced (Environment Agency 2000). The HESMP identified a long-term policy plan for managing the flood defences surrounding the Humber Estuary, including the lower, tidal reaches of the Rivers Ouse and Trent.

Further studies have included the development of the Strategy, published in March 2008, which outlines how the policies in the HESMP will be implemented over the next 100 years. The first 25 years of the Strategy has been approved by Defra, and it will be refreshed

through a 5-year rolling programme of reviews. The first packages of work under the Strategy are underway and some schemes have already been completed including managed realignment/habitat creation schemes at Alkborough and Paull Holme Strays, which contribute to compensatory habitat provision for anticipated coastal squeeze (and direct) losses in the estuary.

Figure 1 illustrates the Strategy study area, management units and flood cells referred to within this report. Appendix A outlines the flood risk management proposals within the Strategy and a summary of these is also shown in Figure 2.

1.4.2 *The Overall Approach*

Figure 2 and Appendix A describe the key elements of the Strategy, which can be summarised in the following three points:

1. We will manage flood risk around the estuary to protect people and property by:
 - continuing to maintain, and improve, existing defences where this is sustainable;
 - identifying and providing Local Authorities with advice regarding potentially unsuitable development in the floodplain;
 - providing targeted and timely flood warnings.

Over the majority of the estuary the current defence line will be held, to a suitable standard, through maintenance or improvement works as appropriate. Our ability to maintain and improve these defences will depend upon available funding.

2. There are also significant lengths where we anticipate that there will be funding difficulties in the future. We will withdraw public investment in maintenance of these defences as they become uneconomic, but will examine other ways of protecting people and property where this happens, including:
 - building secondary lines of defence, or new lines of defence, in both cases to protect more valuable areas; and
 - advising people on how to prepare for flooding.

Defences where we anticipate withdrawing maintenance at some time in the future are shown as the 'red line' reaches in Figure 2. This will happen to specific defences as and when maintenance becomes uneconomic; current assessments indicate that this is unlikely within the next 10 years. However, when we identify this as a course of action, we will ensure that our intentions are communicated to land owners in a timely manner so that they are able to prepare and make other plans for their frontages.

3. Where justified we may move or set defences back where doing so will:
 - provide flood storage to help manage water levels during serious floods and so benefit adjacent areas;
 - allow us to stop maintaining other defences that are uneconomic; and
 - create new inter-tidal habitat to compensate for that being lost because of the Strategy (i.e. coastal squeeze against fixed defences).

Areas where we anticipate (or have already completed) schemes to set-back or breach defences to allow development of new inter-tidal habitat are shown in orange on Figure 2. Proposed areas for future flood storage or controlled overtopping of defences are shown in blue on Figure 2.

1.4.3 *Clarification of 'Withdrawal of Maintenance' with Regard to the HRA*

Figure 2 identifies potential funding difficulties in many areas; these reaches are denoted by red lines on Figure 2. As, and when maintenance of these reaches becomes uneconomic, we plan to withdraw investment in conjunction with investigating other ways to protect people and property, such as building secondary lines of defences and advising people on how to prepare for flooding. However, currently this is anticipated to be more than 30 years away for many reaches and at least 10 for most. We will endeavour to give landowners more than two years notice and a minimum of six months of our intention to cease maintenance. There are complex 'human rights' issues surrounding the legitimate expectation that such landowners may have with regard to continued maintenance of their defences. Because of this and the uncertainty regarding when/if withdrawal will occur, our CHaMP (and the calculation of habitat losses through coastal squeeze) and this HRA assume that these defences will continue to be maintained (by ourselves or by third party intervention) over the life of the Strategy. This also means that where third parties choose to maintain these defences, this will be consistent with the Strategy, and the requirements for compensatory habitat (for coastal squeeze losses only) will be met through the Strategy's habitat creation programme.

Maintenance of defences in this context is described in an agreed protocol between the Environment Agency, Natural England and Defra, an extract from which follows:

1. *Examples of work that could be classed by the Environment Agency as 'maintenance' include:*
 - (a) *vegetation management and tree removal;*
 - (b) *replacing block-work;*
 - (c) *raising a low part of an embankment or wall to the level of the adjacent bank or wall;*
 - (d) *repairing slips or erosion of an earth embankment;*
 - (e) *small scale repairs to damaged bank revetments;*
 - (f) *repairs to footpaths on top of banks;*
 - (g) *maintenance and repairs to sluice doors, hinges, seals, and so on.*
2. *There is no expectation that where the Environment Agency proposes discontinuing maintenance that the landowner would need to 'allow' the sea wall to fail in order to create new habitats to offset coastal squeeze.*
3. *Maintenance can include the reinstatement of low parts of a defence caused, for example, by erosion or other damage. Reinstatement to the level of the adjacent defence or to the highest level of the defence at the time of handover will normally be allowed under a maintenance consent but this will be subject to the length over which this can occur being agreed with the local Environment Agency team who need to be satisfied that the interests of other parties are not unreasonably affected by the work. The raising of defences above the highest point for substantial lengths will require consent for development and possibly planning approval.*

4. *Proposals to change the footprint, overall level or composition of the defence are classed as improvement (development) work.*

It should be noted that the maintenance approach described here will result in a gradual reduction in the ‘standard of defence’ due to the anticipated rise in sea levels. Environment Agency or third party work to maintain defences under the Strategy may, like any project, still require HRA to show that impacts are not greater than those assumed within the Strategy approval. The compensatory habitat requirement for coastal squeeze losses associated with Environment Agency or third party works to maintain defences are met by the compensatory habitat creation programme identified in the Strategy.

Environment Agency or third party works to improve defences may also require HRA especially in consideration of any impacts that are additional to those assumed for the ‘hold the line through maintenance’ approach provided by the Strategy. If the improvement works are consented then compensation for coastal squeeze impacts would be covered by the Strategy’s habitat creation programme. However increased footprint of the defence within the designated site or other impacts on interst features of the site (not described in the Strategy) would not.

The requirement for compensatory habitat (which is calculated as the worst case scenario on the basis of a ‘hold the line’ approach throughout the estuary) and the programme of habitat creation to meet this requirement are described in more detail in Volume 2 of this HRA.

1.4.4 *Future Reviews of the Strategy*

The Strategy and its key supporting documents (e.g. the CHaMP) will be reviewed on a regular basis approximately every five years to ensure that new monitoring data and best practices inform improved management, and to ensure that the works planned, the coastal squeeze loss calculations and the compensatory habitat provision are still aligned with the predictions.

1.5 ***European Nature Conservation Designations***

1.5.1 *Overview*

The Humber Estuary is important for nature conservation. The whole estuary falls under two European designations that form part of the Natura 2000 network::

- Special Area of Conservation (SAC) under the EU Habitats Directive⁶; and
- Special Protection Area (SPA) under the EU Wild Birds Directive⁷.

The whole estuary is also designated as a wetland of international importance:

- Ramsar Site under the Ramsar Convention on Wetlands⁸.

⁶ Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora.

⁷ Council Directive 79/409/EEC on the Conservation of wild birds.

⁸ The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, Iran, 1971)

Furthermore, some of the terrestrial habitats landward of the flood banks are also designated as SPA and Ramsar Site.

Key nature conservation features within the estuary are shown on Figure 3. This provides an indication of their distribution according to our current understanding, but it is likely to change with time (particularly for the more mobile species) and will need to be updated during the Strategy's review process.

SACs represent the range and variety within the European Union of habitats and (non-bird) species listed on Annexes I and II to the Habitats Directive. SPAs support rare and vulnerable birds listed in Annex I to the Birds Directive and/or for regularly occurring migratory species and/or for being regularly used by over 20,000 waterbirds. SPAs and SACs collectively form the Natura 2000 Network. Ramsar Sites protect internationally important wetland habitat.

1.5.2 *Humber Estuary SAC*

The Humber Estuary is designated as a SAC because of the following qualifying and interest features:

(a) Annex I habitats that are a primary reason for selection of this site⁹:

- Estuaries: The Humber is the second largest coastal plain estuary in the UK, and the largest coastal plain estuary on the east coast of Britain. It is a muddy, macrotidal estuary, fed by the Rivers Ouse, Trent and Hull and Ancholme. Suspended sediment concentrations are high, and are derived from a variety of sources, including marine sediments and eroding boulder clay along the Holderness coast. This is the northernmost of the English east coast estuaries whose structure and function is intimately linked with soft eroding shorelines. Habitats within the Humber Estuary include Atlantic salt meadows and a range of sand dune types in the outer estuary, together with subtidal sandbanks (sandbanks which are slightly covered by sea water all the time), extensive intertidal mudflats (mudflats and sandflats not covered by seawater at low tide), glasswort beds (*Salicornia* and other annuals colonising mud and sand), and coastal lagoons. As salinity declines upstream, reedbeds and brackish saltmarsh communities fringe the estuary. These are best-represented at the confluence of the Rivers Ouse and Trent at Blacktoft Sands. Upstream from the Humber Bridge, the navigation channel undergoes occasional major shifts from north to south banks. This section of the estuary is also noteworthy for extensive mud and sand bars, which in places form semi-permanent islands. Significant fish species include river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus*, which breed in the tributaries of the River Ouse including the River Derwent.
- Mudflats and sandflats not covered by seawater at low tide: The Humber Estuary includes extensive intertidal mudflats and sandflats not covered by seawater at low

⁹ <http://www.jncc.gov.uk/ProtectedSites/SACselection> (accessed 20/02/08)

tide. Upstream from the Humber Bridge, extensive mud and sand bars in places form semi-permanent islands.

(b) Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site:

- Sandbanks which are slightly covered by sea water all the time
- Coastal lagoons * Priority feature
- *Salicornia* and other annuals colonising mud and sand
- Atlantic salt meadows (*Glauco-Puccinellietalia maritima*)
- Embryonic shifting dunes
- Shifting dunes along the shoreline with *Ammophila arenaria* ('white dunes')
- Fixed dunes with herbaceous vegetation ('grey dunes')* Priority feature
- Dunes with *Hippophae rhamnoides*

(c) Annex II species present as a qualifying feature, but not a primary reason for site selection:

- Sea lamprey *Petromyzon marinus*
- River lamprey *Lampetra fluviatilis*
- Grey seal *Halichoerus grypus*

Conservation Objectives have not been revised for the Humber Estuary SAC since changes to the citation in 2004. However, the following conservation objectives are taken from *The Humber Estuary European Marine Site: English Nature's Interim advice given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994, April 2003, (the 'Regulation 33 package')*:

- Subject to natural change, maintain the **estuary** in favourable condition.
- Subject to natural change, maintain the **coastal lagoons** in favourable condition.
- Subject to natural change, maintain the **Atlantic salt meadows** in favourable condition.
- Subject to natural change, maintain the ***Salicornia* and other annuals colonising mud and sand** in favourable condition.
- Subject to natural change, maintain the **mudflats and sandflats not covered by seawater at low tide** in favourable condition.
- Subject to natural change, maintain the **sandbanks which are slightly covered by seawater all of the time** in favourable condition.
- Subject to natural change, maintain the habitats of ***Lampetra fluviatilis* (river lamprey)** in favourable condition.
- Subject to natural change, maintain the habitats of ***Petromyzon marinus* (sea lamprey)** in favourable condition.

(Where maintain implies restoration if the feature is currently not in favourable condition.)

1.5.3 Humber Estuary SPA

The Humber Estuary is designated as a SPA because of the following qualifying features:

(a) SPA qualifying species (article 4.1) regularly used by 1% or more of the GB populations of:

- Avocet *Recurvirostra avosetta* (wintering & breeding)
- Bittern *Botaurus stellaris* (wintering & breeding)
- Hen harrier *Circus cyaneus* (wintering)
- Golden plover *Pluvialis apricaria* (wintering)
- Bar-tailed godwit *Limosa lapponica* (wintering)
- Ruff *Philomachus pugnax* (passage)
- Marsh harrier *Circus aeruginosus* (breeding)
- Little tern *Sterna albifrons* (breeding)

(b) SPA qualifying species (article 4.2) regularly used by 1% or more of population of the following migratory species:

- Shelduck *Tadorna tadorna* (wintering)
- Knot *Calidris canutus* (wintering & passage)
- Dunlin *Calidris alpina* (wintering & passage)
- Black-tailed godwit *Limosa limosa* (wintering & passage)
- Redshank *Tringa totanus* (wintering & passage)
- Sanderling *Calidris alba*

(c) Other SPA qualifying features:

- Used regularly by over 20,000 waterbirds. In addition to the species listed above, the assemblage includes: dark-bellied brent geese *Branta bernicla bernicla*, wigeon *Anas penelope*, teal *Anas crecca*, mallard *Anas platyrhynchos*, pochard *Aythya ferina*, scaup *Aythya marila*, goldeneye *Bucephala clangula*, cormorant *Phalacrocorax carbo*, oystercatcher *Haematopus ostralegus*, ringed plover *Charadrius hiaticula*, grey plover *Pluvialis squatarola*, lapwing *Vanellus vanellus*, sanderling *Calidris alba*, whimbrel *Numenius phaeopus*, curlew *Numenius arquata*, greenshank *Tringa nebularia* and turnstone *Arenaria interpres*.

Conservation Objectives have not been revised for the Humber Estuary SPA since changes to the citation in 2004. However, the following conservation objectives are taken from *The Humber Estuary European Marine Site: English Nature's Interim advice given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994, April 2003, (the 'Regulation 33 package')*:

- Subject to natural change, maintain in favourable condition the habitats for the internationally important populations of the **regularly occurring Annex I species**, in particular:
 - Intertidal mudflats and sandflats
 - Saltmarsh communities
 - Tidal reedbeds
 - Coastal lagoons
 - Unvegetated sand and shingle

- Subject to natural change, maintain in favourable condition the habitats for the internationally important populations of the **regularly occurring migratory bird species and assemblage of waterfowl**, in particular:
 - Intertidal mudflats and sandflats
 - Saltmarsh communities
 - Tidal reedbeds
 - Coastal lagoons

(Where maintain implies restoration if the feature is currently not in favourable condition.)

1.5.4 Humber Estuary Ramsar Site

The Humber Estuary is designated as a Ramsar Site because it satisfies the following criteria under the Ramsar Convention on Wetlands:

(a) Ramsar criterion 1: The site is a representative example of a near-natural estuary with the following component habitats: dune systems and humid dune slacks, estuarine waters, intertidal mud and sand flats, saltmarshes, and coastal brackish/saline lagoons. It is a large macro-tidal coastal plain estuary with high suspended sediment loads, which feed a dynamic and rapidly changing system of accreting and eroding intertidal and subtidal mudflats, sandflats, saltmarsh and reedbeds. Within the Humber Estuary Ramsar Site, there are good examples of four of the five physiographic types of saline lagoon.

(b) Ramsar criterion 3: The site supports a breeding colony of grey seals *Halichoerus grypus* at Donna Nook. It is the second largest grey seal colony in England and the furthest south regular breeding site on the east coast. The dune slacks at Saltfleetby-Theddlethorpe on the southern extremity of the Ramsar Site are the most north-easterly breeding site in Great Britain of the natterjack toad *Epidalia calamita*.

(c) Ramsar criterion 5: Assemblages of international importance: 153,934 waterfowl, non-breeding season (5-year peak mean 1996/97-2000/2001).

(d) Ramsar criterion 6: Species/populations occurring at levels of international importance:

- Eurasian golden plover *Pluvialis apricaria altifrons* subspecies (passage)
- Red knot *Calidris canutus islandica* subspecies (passage)
- Dunlin *Calidris alpina alpina* subspecies (passage)
- Black-tailed godwit *Limosa limosa islandica* subspecies (passage)
- Common redshank *Tringa totanus brittanica* subspecies (passage)
- Common shelduck *Tadorna tadorna* (wintering)
- Eurasian golden plover *Pluvialis apricaria altifrons* subspecies (wintering)
- Red knot *Calidris canutus islandica* (wintering)
- Dunlin *Calidris alpina alpina* subspecies (wintering)
- Black-tailed godwit *Limosa limosa islandica* subspecies (wintering)
- Bar-tailed godwit *Limosa lapponica lapponica* subspecies (wintering)
- Common redshank *Tringa totanus brittanica* subspecies (wintering).

(e) Ramsar criterion 8: The Humber Estuary acts as an important migration route for both river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus* between coastal waters and their spawning areas.

The following conservation objectives are taken from *The Humber Estuary European Marine Site: English Nature's Interim advice given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994, April 2003, (the 'Regulation 33 package')*:

- Subject to natural change, maintain wetland hosting an assemblage of **threatened coastal and wetland invertebrates** in favourable condition, in particular:
 - Saltmarsh communities
 - Coastal lagoons
- Subject to natural change, maintain the **wetland hosting a breeding colony of grey seals** and **wetland regularly supporting 20,000 or more waterfowl** in favourable condition, in particular:
 - Intertidal mudflats and sandflats
- Subject to natural change, maintain the **wetland regularly supporting 1% or more of the individuals in a population of one species or sub-species of waterfowl** in favourable condition, in particular:
 - Intertidal mudflats and sandflats
 - Saltmarsh communities
 - Tidal reedbeds
 - Coastal lagoons

(Where maintain implies restoration if the feature is currently not in favourable condition.)

1.6 Implications of the Habitat Regulations

In accordance with these designations and the Conservation of Habitats and Species Regulations 2010, Competent Authorities are required to make an AA where there is likely to be a significant effect on a European site as a result of plans or projects that are not considered to be necessary for the management of the site for nature conservation.

Development that has an adverse effect on the integrity of European sites may only be approved by the Secretary of State if there are no alternatives, if there are imperative reasons of overriding public interest for the development and if compensation for the adverse effect is provided (generally in the form of habitat creation).

Also, it is apparent that the UK Government is under obligation to provide compensatory habitat to replace that being lost to 'coastal squeeze' in order to maintain the coherence of the Natura 2000 network. The 'Strategy' seeks to fulfil UK Government obligations in this respect by laying out a programme of 'managed realignment' of defences at selected locations to provide compensatory habitat for that which is being lost through both coastal squeeze a direct losses resulting from implementation of the Strategy..

2 Approach to Habitats Regulations Assessment

2.1 *The Approach to this Assessment*

The following section describes the approach taken to Stages One to Three of the HRA in considering the first 50 years of the Humber FRM Strategy.

The conclusions of AA Stage Four are given in Volume 2.

2.1.1 *Study area*

The Strategy study area (see Figures 1, 2 and 3) has been divided into the following three sections on the basis of the geomorphological and ecological characteristics of the estuary:

- outer estuary which has also been divided into Outer North (Spurn Head to Hawkins Point) and Outer South (Saltfleetby to Grimsby) sub-sections in the recent review of the CHaMP;
- middle estuary (Grimsby/Hawkins Point to Humber Bridge); and
- inner estuary (upstream of Humber Bridge).

These broadly defined sections provide a basis by which the location of habitat losses (especially through coastal squeeze) and the associated need for replacement and/or compensatory inter-tidal habitat can be identified, alongside other factors such as sediment type, especially in the outer estuary.

2.1.2 *'Top down' 50 year assessment and 50 year 'balance sheet'*

A 'top down' approach has been taken to concentrate on the long-term impacts of implementing the Strategy as a whole. Although the timescale for the implementation of the Strategy is 100 years, this HRA only considers the impacts of the first 50 years. This is because of the uncertainty associated with both the delivery of the plan, and of the effects of sea level rise, over the longer period.

A 50 year 'balance sheet' of the anticipated habitat gains and losses throughout the estuary is provided in Appendix B. Estimates of the potential inter-tidal habitat changes resulting directly from the works and from coastal squeeze have been based on best available information. Information sources included: outline designs for the frontages in the first 5-year programme of works, the Strategy appendices (Detailed Appraisal Reports, Key Issues Assessments, and the Engineering Report), the Humber Estuary CHaMP and the recent unpublished review of this in 2009/2010. It is anticipated that the 'balance sheet' will be a 'live' document and it will be regularly updated (as a minimum at the 5-yearly Strategy reviews) as better predictions or 'actual' figures become available.

Note: With regard to the calculation of habitat losses and gains that feed into the 'Balance Sheet':

- *actual areas are used for completed managed realignment gains from Paull Holme Strays and Alkborough*

- likely case scenarios from preliminary designs are used for the habitat gains predicted from future realignment schemes
- the original CHaMP used a long-term sea level and intertidal area (charts etc) dataset from 1936 to 2000 to develop a trend analysis used to predict future intertidal areas within the inner, middle and outer sectors of the estuary
- The recent CHaMP review has integrated recalculated intertidal areas based on measured bathymetries from the period 2000 to 2007 with the historic data and new sea level rise guidance to provide an enhanced trend analysis to predict future intertidal areas within the inner, middle, outer (N) and outer (S) sectors.

Both actual and predicted / modelled figures are subject to a range of sources of 'uncertainty' many of which combine to express themselves as the 'prediction intervals' associated with the predictions. Actual measured data is subject to a range of uncertainty sources from error and precision in measurement, use of mean or transformed data. Predictions of future trends are subject to additional sources of uncertainty inherent in modelling and trend analyses.

2.1.3 *Competent Authority and Secretary of State*

For the purposes of this HRA, the Environment Agency acts as the Competent Authority, as the producer of FRM plans and because planning permissions are not yet being sought. Defra represents the Secretary of State (SoS).

2.1.4 *Approval of the 50 year Strategy*

It is the intention that following this HRA, approval of the 50 year Strategy under the Habitat Regulations is taken to mean the approval of the long-term package of flood risk management schemes that includes the integral managed realignment schemes. The Strategy will be reviewed every five years and the 50 year 'balance sheet' will be regularly updated using the results of monitoring and the updated CHaMP. The nature of the coastal squeeze habitat loss predictions combined with changing estuary processes (or our current understanding of them) mean that there is considerable uncertainty associated with the losses defined in the balance sheet. Our Strategy and our compensation package must remain flexible and thus this review process will allow any agreed changes to be documented.

2.1.5 *Approval of the component schemes*

During the 5-yearly review of the Strategy, a new programme of component schemes ("the 5-year package of works") will be developed for planning and other approvals as necessary. Each scheme has been/will be subject to a specific HRA, as required, when planning or other approvals are being sought. For each specific scheme, the HRA Stage Two assessment will be carried out with two possible outcomes:

- 'no likely significant effect' – with agreement from Natural England the scheme may be consented by the normal routes; or
- 'likely significant effect' – the scheme will require an 'appropriate assessment' (HRA Stage Three assessment).

Where an HRA Stage Three assessment (an 'appropriate assessment') is needed, there are three possible outcomes that the Competent Authority might reach:

- ‘no adverse effect on site integrity’ – the scheme may then be consented by the normal routes;
- ‘adverse effect on site integrity’, but no adverse effects additional to those identified (and mitigated/compensated) in the HRA of the approved Strategy - with Natural England agreement to the aforementioned, the scheme may then be approved by the normal routes; or
- ‘adverse effect on site integrity’ with adverse effects *in addition* to those identified (and therefore mitigated/compensated) in the HRA of the approved Strategy - the scheme will either need to be redesigned to remove or mitigate the additional adverse effects on site integrity, or imperative reasons of overriding public interest will need to be proven and the necessary compensation secured. In the latter case, HRA Stage Four will be required and the Competent Authority would need approval from the Secretary of State to consent the scheme. Third party developers carrying out work under the Strategy would be required to fulfil these requirements also.

2.2 **Consultation**

2.2.1 *Consultation on the Strategy*

Consultation has been central to the development of the HESMP and the Strategy in order to arrive at a solution that meets the needs of as wide a range of stakeholders as possible and to engage them in the development and appraisal process. Various formal consultation documents have been produced since 1999, and consultation on the Strategy is described in full in the SEA Environmental Report⁴.

Key consultation groups involved in the development of the Strategy (and any future iterations) include:

- the Steering Group – approximately 25 key organisations drawn from relevant statutory and non-statutory consultees, set up to allow consultation on and review of documentation and progress etc;
- the Liaison Panel – a smaller group of key organisations, comprising a subset of the Steering Group, set up to help make decisions on approaches to consultation etc;
- landowners and tenants – specific consultation exercises and documents were aimed at this group, mainly in connection with the potential managed realignment and flood storage sites; and
- other organisations and the wider community – organisations not represented on the Steering Group and Liaison Panel were consulted at ‘formal stages’, including the public/wider community, as summarised in the SEA.

2.2.2 *Consultation on the HRA*

During the development of the ‘Shadow AA’, key consultees included Natural England, Local Planning Authorities, RSPB and Defra. Natural England confirmed the scope of the ‘shadow AA’ in their *letter of comfort* to the Environment Agency in July 2005 and confirmed

that the Strategy represents the best environmental option for long-term management of flood risk in the Estuary.

In 2007-8, Natural England and RSPB have been integral to establishing the best approach to this HRA and have been closely consulted over the amendments made to update the 'Shadow AA' in order to produce this document (see Section 1.2 for background behind the changes). Their comments on the draft HRAs in December 2007/ January 2008, and April 2008 and those of Natural England and Defra in April 2009 have been incorporated into this document.

Issues that were raised during consultation with Natural England and RSPB between 2005 and 2008, and how these have been dealt with in this assessment are listed below.

1. Comment: The 'Likely Significant Effect' assessment considers the scheme design. If mitigation measures are in place as an integral part of the scheme design, then the resulting residual impacts should be considered in the likely significant effect assessment. [Our assessment has taken this approach.];
2. Comment: The programme of managed realignment should be considered as compensation for habitat lost due to the proposed works and coastal squeeze rather than benefiting the integrity of the European Sites in the long-term.[Our assessment has taken this approach.];
3. Comment: Any sporadic, unplanned intertidal habitat creation following unmanaged realignment due to the withdrawal of maintenance should not be included in the compensatory habitat calculations, but could be seen as additional benefits. [Our assessment has taken this approach.];
4. Comment: Clarification is required about what additional impacts will be outside the scope of this assessment and what magnitude would trigger a separate scheme AA is needed. [We have provided some clarification and we anticipate that a separate scheme AA will be required where additional impacts are significant e.g. where habitat losses at the scheme level are greater than those identified in the Strategy or where impacts on high tide roosts cannot be mitigated. We do not feel that further quantification of what is regarded as a significant additional impact would be meaningful at this stage. The decision to carry out a separate scheme AA will be made on a case-by- case basis in consultation with Natural England.];
5. Comment: Details about the 5-year package of works at a scheme level and clarifications about the maintenance works covered by the assessment are needed. [Further details of schemes in the first 5-year package of works were provided to consultees in earlier stages of the programme development for information only. However, further scheme level details of proposed works are not used in this assessment so as to maintain a 'top down' strategic approach to this HRA of the 50 year Strategy. Each component scheme is subject to further design changes and has been/will be assessed following the approval steps in 2.1.5, and the relevant consultees have been/will be consulted as appropriate. Descriptions of which maintenance works anticipated in the 50 year period are covered by the assessment are given in Section 2.3.];

6. Consultees provided updated information on the European Sites and their Conservation Objectives. [This has been used in the assessment.];
7. Consultees provided information for the cumulative impact assessment and IROPI arguments. [This has been used in the assessment.];
8. Calculations of the coastal squeeze compensation requirements for each scheme/location were requested. [Our coastal squeeze predictions are not based on the local scale modelling that would be necessary to provide this information. We are taking a strategic approach to dealing with coastal squeeze throughout the estuary for the 50 year Strategy.];
9. Queries about dealing with predicting impacts where there is a lack of information or uncertainty were raised. [Issues relating to lack of data or uncertainty will be addressed in more detail during the individual scheme-specific design and assessment (see Section 2.1.5 regarding scheme-specific assessment approvals). This assessment is precautionary and attempts to deal with 'likely worst case' scenarios (i.e. 'hold the line' throughout the estuary) but uses the 'mean' predictions (not worst case) for coastal squeeze losses];
10. Queries about resolving local issues of particular concern to a specific area were raised (such as selection of a preferred scheme for Goxhill, resolution of 'conflicts' over scheme choice at Easington, and dealing with potential adverse effects of some schemes on high tide roosts). [Such local issues have been/will be resolved by the design teams through ongoing consultation with Natural England and other key consultees during the detailed design phase and by inclusion in the scheme-specific assessments.]; and
11. Clarification of the definition of 'maintenance' works as opposed to 'improvement' was requested [This has been provided in Section 1.4.3 of this report.]

2.3 *Assessment of 'Adverse Effect' and 'Site Integrity'*

The following baseline information has been used to confirm the presence of 'qualifying features' (under European designation) in the vicinity of the proposed works:

- Detailed Appraisal Reports for individual FRM schemes;
- European site citations;
- a plan of designations and key features of nature conservation interest (Figure 3);
- the Humber Estuary CHaMP;
- English Nature (2003) The Humber Estuary: A comprehensive review of its nature conservation interest (ENRR 547); and
- Humber Estuary Low Tide Bird Count Newsletters (and final report: (ENRR656) and Wetland Bird Survey (WeBS) data).
- ABP Mer (2003) The Prediction of Invertebrate Species Distributions on the Humber Estuary. Report No. R.1017
- ABP Mer (2010) Biological Survey of the Intertidal Sediments of the Humber Estuary. Report No. R.1607

A 'source-pathway-receptor' approach has been used to identify potential impacts on the qualifying features that would result from flood risk management works. These impacts were

then listed in a table based on the HR01/Appendix 11 form (from the EU Habitats Directive Handbook). Impacts considered to represent 'likely significant effect' were then transferred to the HR02/Appendix 12 form where they are investigated in more detail.

English Nature (now Natural England) guidance¹⁰ to decisions on European site 'site integrity' has been used to determine whether the impacts would be likely to be deemed 'adverse effects on integrity' or not. The key elements that were considered when assessing effect on site integrity were:

- whether the area of Annex I habitats (or composite features) would be reduced;
- whether there would be any direct effect on the population of the species for which the site was designated or classified albeit Annex I or otherwise;
- whether there will be any indirect effects on the populations of species for which the site was designated or classified due to loss or degradation of their habitat (quantity/quality);
- whether there would be any changes to the composition of the habitats for which the site was designated (e.g. reduction in species structure, abundance or diversity that comprises the habitat over time); and
- whether there will be any interruption or degradation of the physical, chemical or biological processes that support habitats and species for which the site was designated or classified.

However, each assessment has also been based upon the following assumptions:

- a 'likely worst-case' scenario/precautionary approach has been taken for assessing the impacts of proposed floor risk activities (i.e. by assuming 'hold the line' everywhere in the 'balance sheet').
- given the level of uncertainty (as can be seen from the 95% prediction intervals in the 'balance sheet'), the 'mean' figures of habitat change predictions resulting from coastal squeeze and estuary evolution have been used;
- the proposed 'hold the line' and 'maintenance' works are likely to have an adverse or significant effect on the integrity of Ramsar and SAC qualifying habitat and habitat supporting SPA and Ramsar birds if the works encroach seaward of the current seaward toe of the defences. Works may also have the potential to significantly affect the integrity of the SPA and Ramsar Site landward of the defences in some locations;
- the understanding of the location and use of high tide roosts by SPA species around the estuary is incomplete, and further research and surveys may be required at specific locations to support the 5-yearly reviews of the Strategy and the AAs of individual schemes;

¹⁰ English Nature, May 2004. European Sites Guidance - Internal Guidance to Decisions on 'Site Integrity': A Framework for Provision of Advice to Competent Authorities

- refurbishment stoning (that is improvement to, replacement of or fresh addition of stone to areas which have deteriorated sufficiently to enable reversion to saltmarsh/mudflat and reedbed habitats) may represent encroachment onto the foreshore in some cases, depending on the nature and history of stoning and subsequent recovery;
- on-going operational maintenance and monitoring activities are described as activities that would not intrude onto the foreshore or use noisy machinery/hovercraft, and would only result in small scale disturbance that would not be considered to have likely significant effects and would be included in the Environment Agency's 10 year operations maintenance strategy requiring consent with Natural England rather than being included in this assessment;
- maintenance of capital works has been included in this assessment e.g. embankment repairs and maintenance of existing erosion protection stoning at the toe of embankments, which involves no change in footprint and thus no encroachment onto the foreshore. The area of maintenance stoning likely to involve encroachment onto the designated sites is estimated to be 15ha (approximately 8ha inner, 3ha middle, 2ha outer south and 2ha outer north) during the 50 years;
- modelling will be carried out for the proposed managed realignment schemes (and already has been for completed schemes at Alkborough and Paull Holme Strays) to enable any possible changes in estuary processes to be identified and used to update the 'balance sheet' to ensure the objectives of the Strategy are met; and
- a package of mitigation measures will be included as an integral part of scheme design for each individual scheme to minimise adverse effects on the European Sites in agreement with Natural England. The assessment of adverse effects has been carried out assuming that these mitigation measures are in place.

2.4 *In-Combination Assessment*

The AA provides an 'in-combination' assessment that highlights the cumulative impacts of the programme of works, other works planned for the estuary and the impacts of coastal squeeze over 50 years in the context of prevailing environmental conditions. All impacts that affect the achievement of the conservation objectives of a given feature have the potential to act in combination. These effects can be¹¹:

- additive – where the total effect of a number of effects is equal to the sum of the individual effects;
- synergistic – where the effect of the interaction of a number of effects is greater than the sum of the individual effects; and
- neutralistic – where the effects counteract each other, thereby reducing the overall effect.

¹¹ SEA Procedures: Environment Agency Management System, controlled document

In-combination effects can also be overlapping (affecting the same spatial area and/or attributes of the feature) or discrete (affecting different areas and/or attributes of the feature), but in combination, the effects can result in an unacceptable level of impact in terms of site integrity.

Information for the ‘in-combination’ assessment has been gathered from:

- (a) the 50 year ‘balance sheet’ (which incorporates habitat losses due to coastal squeeze);
- (b) other Environment Agency projects and proposals in/near the Estuary from the Environment Agency’s Development Control and FRM teams; and
- (c) Liaison with the planning departments of East Riding of Yorkshire Council, Kingston upon Hull City Council, North Lincolnshire Council, North East Lincolnshire Council and with Natural England.

2.5 ***Structure of the Findings***

The findings of the assessment of the 50 year Strategy HRA Stages One, Two and Three are discussed in Section 3. A detailed record of the 50 year Strategy’s Stage 2 assessment is presented using the Environment Agency’s HR01 / Appendix 11 form in Appendix C, and Stage 3 using the HR02 / Appendix 12 form in Appendix D.

A summary of the programme of works proposed in the first 25 years of the Strategy is provided in Appendix A. The 50 year ‘balance sheet’ of habitat gains and losses within the estuary is given in Appendix B. Figure 1 is a plan of the area covered by the Strategy and the flood management units. Figure 2 is a plan of the key flood management actions and Figure 3 shows the key nature conservation features.

The ‘Statement of Case’ conclusions (HRA Stage Four) for the 50 year Strategy are given in Volume Two, using the Environment Agency’s Appendix 20 form.

3 Findings of the Assessment: 50 Year Strategy

3.1 *Stage 1 Findings – Plan Relevance*

Stage 1 determines whether the plan falls within the scope of an AA, and who the Competent Authority is.

As the Strategy is a flood risk management plan and the area supports two European Sites and a Ramsar Site), it does require an AA under the Environment Agency’s policy. The Competent Authority for this assessment is the Environment Agency.

3.2 *Stage 2 Findings – Likely Significant Effect*

3.2.1 *Assessment of Likely Significant Effect*

Stage 2 is a precautionary test of whether a FRM plan is likely to have a significant effect on the European site/s (either alone or in combination with other plans or projects), and is not directly connected with or necessary to the management of these designated sites for its nature conservation interest.

English Nature (now Natural England) confirmed in their *letter of comfort (2005)* that the Strategy, the purpose of which is flood risk management, is not considered as *necessary for the management* of any of the relevant Humber Estuary European Sites.

The relevant sites for the ‘likely significant effect’ test are:

- the Humber Estuary SAC;
- the Humber Estuary SPA; and
- the Humber Estuary Ramsar Site.

This scope was confirmed by Natural England during the previous ‘shadow AA’. Although there are a few other designated sites nearby the Estuary (such as the Saltfleetby-Theddlethorpe Dunes and Gibraltar Point SAC), these are considered to be outside the zone of influence of the Strategy and are therefore excluded.

The strategic policies and possible flood risk management works for the Humber Estuary over the next 50 years are presented in the Strategy. The proposed programme of works in the first 25 years of the Strategy is given in Appendix A. In summary, the policies include:

- holding the defence line by maintaining and/or improving and managing existing flood defences;
- flood storage options through managed realignment, habitat creation, and creation of washlands (for flood storage during peak events e.g. when high river flows coincide with surge tides);
- capital works maintenance of existing defences (over and above the routine operational maintenance and monitoring that are not likely to have a significant

effect on the European Sites), such as repair of embankments and erosion protection; and

- withdrawal of maintenance/management of defences by the Environment Agency.

There may also be the need to carry out ‘emergency’ or ‘urgent’ unplanned works as a result of breaches, overtopping or unexpected changes in the condition of the defence structures. Principles have been agreed with Natural England and Local Authorities relating to this. Although emergency works may need to be carried out without consultation or without gaining the normal approvals due to the urgent need to protect human life and property, such works will subsequently be fed into the Strategy review process and mitigated/compensated as needed and agreed.. However it is anticipated that the strategic approach to flood risk management proposed in this Strategy will reduce the likelihood of emergency works of this nature.

The likely flood risk management related activities promoted by the Strategy are listed below:

- In-channel works & structures
- Sea defence works & maintenance
- Construction of flood storage areas
- Withdrawal of maintenance of existing defences
- Bridgework
- Construction of culverts and outfalls
- Channel diversions
- Access tracks & spoil disposal
- Construction of floodbanks (including walls, sheet piles, revetments)
- Maintenance/repair of floodbanks (including walls, sheet piles, revetments)
- Bank works eg reprofiling
- Construction phase activities
- Silt & gravel shoal removal (mainly in rivers)
- Operation of pumping stations
- Erosion protection

Measures to avoid or minimise potentially adverse environmental impacts from particular *hazards* (see Table 3.1 below) have been integral to the Strategy proposals. Individual schemes have been/will be designed to incorporate standard mitigation measures and the construction phase have/will follow good site practices to minimise any potential adverse effects. These measures have been/will be described in the individual scheme-specific HRAs. Examples of typical mitigation measures are:

- minimising the extent of working areas through restricting access (especially seaward of the flood banks) to prevent damage of habitats outside any temporary working areas (which will be recorded under temporary habitat loss it is of necessity within the designated site);
- following Environment Agency Pollution Prevention Guidelines (PPGs); and

- incorporating measures to minimise works, wherever possible, that have the potential for significant disturbance to SAC and SPA species during sensitive times in agreement with Natural England.

The likely impacts of the potential hazards from the Strategy’s flood risk management activities on the interest features of the estuary’s European sites are summarised in Table 3.1.

Table 3.1 Likely significant effects on the SAC, SPA and Ramsar Site interest features from the flood risk related activities from the 50 year Strategy (based on Environment Agency guidance¹²).

Hazard		SPA /Ramsar bird species groups			SAC/Ramsar species groups		SAC/Ramsar habitat groups		
		3.9 Birds of estuarine habitats	3.8 Birds of coastal habitats	3.6 Birds of lowlands and their freshwater margins	2.12 Marine mammals	2.5 Anadromous fish	1.13 Submerged marine habitats	1.12 Estuarine and intertidal habitats	1.10 *Coastal habitats
A	Habitat loss	✓	✓	✓				✓	✓
B	Changes in physical regime	✓	✓	✓			✓	✓	✓
C	Physical damage	✓	✓	✓				✓	✓
D	Turbidity ¹								
E	Habitat/community simplification ¹								
F	Disturbance (noise, vibration, visual)	✓	✓	✓					
G	Competition from non-native species ²								
H	Changes to flow & velocity regime	✓	✓	✓			✓	✓	
I	Reduced surface water flooding ²								
J	Changes to water chemistry ¹								
Likely significant effect, on its own?		Yes	Yes	Yes	No	No	Yes	Yes	Yes

Note 1 Standard mitigation in the scheme design and good working practices ensure there are No Likely Significant Effect on the European Sites from these hazards.

Note 2 No interest features likely to be significantly affected.

The potential sources/ pathways in which the Strategy is anticipated to produce the potential hazards identified in the table above are due to its:

- coastal squeeze effects;
- component flood risk management schemes;
- unplanned, emergency works;
- capital works maintenance and monitoring activities; and

¹² EU Habitats Directive Handbook, Environment Agency Management System, controlled document

- potential cross-estuary impacts¹³ of some managed realignment schemes or larger flood defence schemes.

Further details of Stage 2 for the 50 year Strategy is given in the Environment Agency HR01/Appendix 11 form in Appendix C.

3.2.2 *Conclusion of Stage 2 – Likely Significant Effect*

The Environment Agency’s conclusion from Stage 2 is that the 50 year Strategy is found to have a **likely significant effect on the Humber Estuary SAC, SPA and Ramsar Site**, on its own and in combination with other projects.

Subsequently, the HRA continues to Stage 3.

3.3 *Stage 3 Findings – Adverse Effect on Site Integrity*

3.3.1 *Assessment of Adverse Effect on Site Integrity*

Stage 3 assesses the implications of the Plan on the integrity of the European site/s, in terms of implications on the conservation objectives of those interest features for which it was classified. This stage takes into account the conditions, restrictions or mitigation measures intended to ameliorate the effects of the plan so that the AA can focus on the long-term impacts.

Table 3.2 summarises the additional mitigating measures that will be put in place to prevent or minimise the potential hazards caused by the likely flood risk related activities promoted by the Strategy. The table includes an assessment of whether the residual impacts could have an adverse effect on the integrity of the European sites, and is based on Environment Agency guidance and HR02 / Appendix 12 form¹⁴. Further details are provided in Appendix D using the Appendix 12 form and the 50 year ‘balance sheet’ in Appendix B.

¹³ ‘Cross-estuary impacts’ refer to estuarine habitat losses associated with Alkborough managed realignment scheme due to geomorphological effects remote to Alkborough.

¹⁴ EU Habitats Directive Handbook, Environment Agency Management System, controlled document

Table 3.2 Consideration of the potential mitigation and assessment of adverse effect on integrity of the SAC, SPA and Ramsar Site interest features from the flood risk related activities within the 50 year Strategy (based in part on Environment Agency guidance and on Environment Agency HR02 / Appendix 12).

Potential Hazard	Source of Hazard	Comment on Potential Mitigation and Residual Adverse Impact	Can adverse effects be avoided?	Adverse effect on SAC/SPA/ Ramsar integrity?
<p>A. Habitat loss</p> <p>and</p> <p>C. Physical damage</p>	<p>Much of the Strategy includes work within the footprint of the existing defences that do not support interest feature habitats (e.g. mown grass banks, concrete revetment). However some works will be required at the seaward toe of certain lengths or within designated areas to landward of the existing defence, or withdrawal of maintenance will cause a loss in habitats, such as at Grues Fields (Goxhill).</p> <p>The potential sources/pathways for habitat loss due to the Strategy are:</p> <ul style="list-style-type: none"> • temporary habitat loss from working areas, access tracks, site compounds etc during the construction phase (also source of physical damage); • long-term habitat loss from encroachment of structures into the European sites (and surrounding habitat that may support the integrity of the site; • habitat loss occurring through coastal squeeze and sea level rise; and • habitat loss occurring through maintenance works of capital works outside the ongoing operational maintenance programme. 	<p>Despite the implementation of standard mitigation measures (e.g. minimising the temporary working areas and permanent footprints of structures and avoiding particularly sensitive features) where possible to reduce the adverse effects on the integrity of the European sites, significant residual adverse impacts are anticipated to occur as a result of the 50 year Strategy from the encroachment seaward of flood banks or losses from coastal squeeze and cross-estuary impacts from the Strategy, as indicated below.</p> <p>Coastal Squeeze and Estuary Evolution The effects of coastal squeeze and estuary evolution will involve both gains of intertidal habitat and losses. The balance of this is a net loss of c. 286ha. More specifically the changes predicted over 50 years are:</p> <ul style="list-style-type: none"> • c.330 ha gain Inner estuary, • c.510 ha loss Middle estuary, • c.168 ha loss Outer South, • c.62 ha gain Outer North. <p>Direct FRM Scheme losses Approximately 58ha of intertidal habitat will be lost from the encroachment of improved defences and maintenance works (c.20ha Inner, c.34ha Middle, c.2ha Outer South and c.2ha Outer North).</p> <p>Cross Estuary / Synergistic Effects 35ha of intertidal habitat loss will be caused by cross-estuarine impacts as a result of the Strategy (c.15ha Inner, c.10ha Middle, c.7ha Outer South, c.3ha Outer North).</p> <p>Temporary Approximately 21ha of temporary loss or damage to intertidal habitat from works or maintenance activities (c.7ha Inner, c.3ha Middle, c.4ha Outer South, c.7ha Outer North). Some of these areas are likely to recover within 1 to 2 years given the nature of the accretion/erosion processes with the estuary.</p> <p>There is significant uncertainty around the prediction of habitat loss due to coastal squeeze as indicated by the error bands in the 'balance sheet' (Appendix B). Replacement habitat will be created to compensate for the losses in habitat to ensure there is no net loss in intertidal habitat in the estuary (see Volume 2 Section 2.4).</p>	<p>No</p>	<p>Yes</p> <p>but the Strategy's replacement habitat programme and ratios used are designed where possible to compensate for impacts before adverse effects on integrity are experienced (see Volume 2 Section 2.5).</p>

Potential Hazard	Source of Hazard	Comment on Potential Mitigation and Residual Adverse Impact	Can adverse effects be avoided?	Adverse effect on SAC/SPA/ Ramsar integrity?
B. Changes in physical regime	Includes changes in the flow and flooding regimes, the pattern of sediment movement, erosion and deposition, bathymetry and hydrodynamic processes.	Existing modelling has shown that the 'hold the line' works, even where they require minor encroachment at the toe of the existing defence, have no significant effect on estuary morphology, erosions and deposition.	Yes (hold the line)	No (hold the line)
H. Changes to flow & velocity regime, & improved drainage	An increase in sediment erosion can result in the loss of bird feeding grounds in estuaries. Need to take account of natural processes.	However, there is more uncertainty associated with the potential effects of the larger managed realignment schemes and flood storages schemes that may affect morphology, erosion and deposition. Development of existing managed realignments at Paul Holme Strays and Alkborough have shown that these can be modelled and developed without causing significant adverse morphological effects. We will carry out similar modelling and developmental studies to understand and mitigate the adverse effects from such schemes in the future. Actual habitat losses will be monitored on a minimum of 5-yearly intervals and results used to update the Strategy's programme of works to create compensatory habitat to ensure no overall net loss of intertidal habitat.	No (managed realignment schemes)	Yes (managed realignment) but will create replacement habitat to meet the needs of the CHaMP and are designed to where possible secure compensation for impacts before adverse effects on integrity are experienced.
F. Disturbance	Disturbance of bird species during their wintering, passage and/or breeding seasons	In most cases, disturbance to birds can be avoided because the timing and proximity of works to feeding/breeding areas can be controlled. However, disturbance may not be completely avoidable on every site, depending on the sensitivity of the site and availability of nearby/suitable habitats for birds to use as a substitution. The nature of these potentially adverse impacts are likely to be short-term (for the duration of part of the construction phase), reversible and small in scale (due to the likely availability of substitution habitat elsewhere in the Estuary). Therefore, such disturbance impacts are considered not to affect the integrity of the European Site. Monitoring and site-specific mitigation measures agreed with Natural England will ensure this.	No (on occasion)	No (managed through monitoring and site-specific mitigation measures).

Measures can be designed into the schemes to minimise many of the Strategy's short-term impacts, especially those arising during the construction phase which can often be alleviated, or reduced, through sensitive programming and good management practices on site. However, it is unlikely that the significant adverse impacts relating to SAC/SPA/Ramsar habitat loss can be avoided i.e.:

- permanent loss of c.58ha by encroachment of defences and maintenance works (and c.21ha temporarily¹⁵)
- predicted loss from coastal squeeze of: c.510ha in the middle estuary and 168ha in the outer (south); there are also predicted intertidal habitat gains resulting from estuary evolution and geomorphic changes in the inner (c. 330ha) and outer (north c. 62ha) parts of the estuary)
- predicted loss of c. 35ha across the estuary due to cross-estuary impacts of major schemes (e.g. Alkborough managed realignment).

Note: the uncertainty in the prediction of coastal squeeze is extremely high as indicated by the error bands for these figures shown in Appendix B (the Balance Sheet).

Over the 50 years, these predicted losses, of intertidal habitat within the SAC, shown in the 'balance sheet' represent approximately 4% of the total intertidal habitat within the SAC¹⁶:

- 0.6% from the encroachment of defences, from maintenance and stoning,
- 0.2% from temporary losses,
- 3% from coastal squeeze and estuary evolution, and
- 0.3% from cross-estuary impacts.

However, the Strategy puts in place a series of habitat creation schemes with suitable programme and replacement ratios (see Appendix B, Table B2 and the summary in Table 3.4 below) designed to compensate for impacts before adverse effects on integrity are experienced (see Volume 2 Section 2.4 regarding compensatory measures). It is recognised however that there is a risk of short periods of habitat deficit within certain sectors due to the uncertainties surrounding for instance; ability to gain land ownership, ability to gain planning approval, changed understanding of losses resulting from CHaMP and Strategy review. Any such deficit, once identified, will be addressed as soon as possible through, for example, managed realignment schemes to avoid a build up of such a deficit which would result in further deterioration of the Natura 2000 sites.

¹⁵ This refers to habitat lost temporarily due to the works footprint extending onto the foreshore but will return to the original habitat following completion

¹⁶ This calculation is based on Natural England's estimate of the present area of intertidal habitat: 10,213.62 ha. This comprises areas of intertidal mudflats and sandflats, Salicornia and Atlantic Salt Meadow communities from various datasets used by Natural England in supporting information for Humber Estuary SAC designation, September 2009.

Table 3.3 Summary of Habitat Compensation Requirements, Habitat Creation Programme and Balance over the 50 year Strategy

Estuary Sector	Compensation Requirement (ha) (expressed as habitat changes)*	Habitat Creation Programme (ha)	Balance (ha)	Balance after Compensation Reallocation (ha)	Comments: on proposed allocation of compensation
Inner	250	192	442	442	In the inner estuary we are currently predicting that the Strategy will provide significant environmental benefit to the Estuary and the SAC/SPA/Ramsar site in terms of increased intertidal habitat.
Middle	- 625	256	- 369	102	Paull Holme Strays and Goxhill provide insufficient habitat creation to meet the current prediction for losses. The deficit created can (at this time) only be met by creation of appropriate intertidal habitat in the inner part of the Outer (N) sector where we have significant habitat creation opportunities (e.g. Welwick and Skeffling).
Outer (N)	44	471	515	44	Here we are predicting a significant habitat gain which we propose is used to contribute to meeting the predicted deficit in the Middle estuary. Surplus habitat would provide further environmental benefit to the estuary in terms of excess habitat provision in the sector.
Outer (S)	-185	110	-75	-75	We currently have only a single habitat creation site (Donna Nook) in the Outer (S) sector of the estuary and will need to identify a further site for delivery post 2020-30 when a deficit in this sector is predicted. This will be addressed in the next Strategy review.
Whole Estuary	- 516	1029	513	513	After 50 years our overall habitat loss/creation balance will leave the Estuary c. 500 ha better off than required by compensation under the Habitats Regulations. This is considered a significant environmental benefit from the Strategy
<p>*Compensation Requirement: this is a summary of the losses/gains from predicting coastal squeeze (including changes in morphology through estuary evolution) combined with direct scheme footprint losses and allowances for temporary disturbance multiplied by agreed replacement ratios.</p> <p>Timing of losses and habitat creation are shown over the life of the Strategy in the tables in Appendix B.</p>					

There is also the risk that there will be adverse effects associated with changes in morphology, erosion and deposition as a result of the larger managed realignment schemes and flood storage schemes. Development of existing managed realignments at Paull Holme Strays and Alkborough have shown that these potential changes can be modelled such that the schemes can be developed without causing significant adverse morphological effects. In the case of Alkborough we have taken a precautionary approach that identifies potential cross estuary impacts, for which compensation is then provided. These potential impacts are being monitored and the Strategy will be reviewed accordingly. We will carry out similar modelling and developmental studies to understand and mitigate (and if necessary review compensation requirements) the adverse effects from such schemes in the future. These kinds of schemes are an essential part of the delivery of replacement habitat to meet the needs of the CHaMP, and the Environment Agency's legal obligations under the Habitats Regulations around the estuary and are designed to compensate for impacts before adverse effects on site integrity are experienced.

3.3.2 *Adverse Effect on Site Integrity of the Strategy in Combination with other Plans and Projects*

The following list (developed through consultation with the Local Authorities and review of Local Development Frameworks/Core Strategies) is understood to present most of the short term and medium term plans and projects (in various stages of development) around the estuary that have arisen during development of the Strategy:

- (a) North Lincolnshire
 - Able UK South Humber Bank (Halton Marshes)
 - Able UK Marine Energy Park
 - South Humber Bank Draft Masterplan
 - Proposed Coal Fired Power Station - East Halton Marsh
 - Humber Sea Terminal phase IV.

- (b) North East Lincolnshire
 - Helius Energy Biomass Plant (Stallingborough)
 - Novartis wind turbines
 - Grimsby town football stadium
 - Abengoa Bio-ethanol Plant (Stallingborough)
 - Queens Road warehousing – Magna Holdings
 - Kateon Natic warehousing
 - Grimsby Proposed Ro Ro Berth
 - Bioverda, Immingham
 - Vireol Bio-ethanol Plant (Grimsby)
 - Huntsman Tioxide remedial works and steam pipeline.
 - Pulse Tidal Power Generation, Stallingborough

- (c) East Riding Of Yorkshire
 - Hull Riverside Bulk Terminal
 - Vivergo Bio-ethanol Plant, Saltend

- (d) Hull City
 - City Build's Humber Quay Phase 2, Hull
 - Quay 2005, Hull

- 'Energy From Waste' Project, Hull
 - Bulk Terminal, Hull
 - Potential Housing Development At St Andrews Dock, Hull
 - Easington to Paull Gas pipeline (now complete).
- (e) Further developments/sources of disturbance
- Various Managed Realignment / habitat creation schemes proposed by private companies as compensation for other developments
 - Wind farms: potential to be proposed in various locations including Humber Gateway (E.On) and Westernmost Rough
 - Various dredging proposals e.g. ABP and Iota Dredge
 - Tidal Pulse Generator
 - Housing developments including those identified within the North Lincolnshire, East Yorkshire and East Lindsey LDFs
 - Increased recreation including wildfowling, dog walking, off road vehicles, especially from increased population.

These projects will have a range of impacts that might be additive or synergistic to those of the Strategy including:

- Bio energy plants – possible increased atmospheric nitrogen emissions and deposition within the estuary, with possible contribution to eutrophication.
- Wind turbines – noise and physical impacts that may lead to adverse effects on the habitats and species within the SAC, SPA and Ramsar Site. Potential disturbance of sediment movement by turbines and cabling.
- Housing and waterside development – leading to increased population and disturbance of habitats and species due to increased 'presence' and recreational pursuits.
- Dredging – direct removal of biota, disturbance to sediment movements and increased flow rates.
- Port and other waterside development – direct footprint impacts on intertidal and subtidal habitats.

It has not been possible to predict whether (or when) these developments will all take place (this is dependent on consents and economic conditions). In addition further proposals will arise in the next 50 years within and around the estuary. Where these existing and future proposals are likely to have a significant effect on the European Sites, they will be subject to their own AA. Many of the potential impacts of these proposals can be alleviated or reduced through sensitive working and good site practices, as agreed with Natural England. However, the effects of these other plans and proposals may act in combination with the Strategy in additive ways if they result in intertidal habitat loss (SAC and Ramsar habitat) or disturbance to SPA birds to result in an unacceptable level of impact in terms of the European Site's integrity.

The impacts of this FRM Strategy have also been considered in combination with the impacts of the HECAG SMP throughout, as they share many overlapping and adjacent policies and activities.

As we have concluded that the Strategy will, in isolation, have an adverse effect on the integrity of the European Sites, the effects in-combination with other developments are likely to be increased. The majority of potential in-combination effects of these proposals are likely to be additive in nature, but some disturbance effects may be synergistic (for example if disturbance of several roosts entails birds travelling unacceptable distances to alternative roosts, perhaps resulting in increased mortality). This effect can be reduced providing the programming of flood risk management works (reviewed on a 5-yearly basis) takes into account the locations and programmes of other developments. The delivery of mitigation and, where necessary, compensation for additive effects will be provided for through the consenting processes of individual developments and are not the concern of this HRA.

As outlined earlier in this document the impacts of coastal squeeze relating to 'hold the line by maintenance' or proposals of third parties are accounted for, over the 50 year life of the Strategy, in this assessment. Separate HRA of these third party proposals may need to show that they do not exacerbate the coastal squeeze losses identified and that they do not increase the coastal squeeze compensation requirement presented in Volume 2 (Stage 4 – Statement of Case) of the HRA. Volume 2 of the HRA explains how the Strategy provides compensatory habitat creation to help offset coastal squeeze losses regardless of whether 'hold the line' policies are implemented by the Environment Agency or third parties.

Where third parties wish to 'improve' defences they may require HRA, especially in consideration of any impacts that are additional to those assumed for the 'hold the line through maintenance' approach. If the improvement works are consented then compensation for coastal squeeze impacts would be covered by the Strategy's habitat creation programme but additional footprint or other impacts would not.

3.3.3 Stage 3 Conclusions for the 50 year Strategy

Based on the discussion above, the Appendix 12 form in Appendix D and the 50 year 'balance sheet' in Appendix B, the findings of Stage 3 are as follows:

- The 50 year Strategy represents the best environmental option for meeting the long-term needs of the European sites, whilst delivering the objectives of affordable flood risk management.
- Nevertheless there will be habitat losses as a result of coastal squeeze within the estuary, from the direct impacts of flood risk projects and from the cross-estuary impacts they promote.
- **Therefore, the Strategy will result in 'adverse effect on the integrity' of the Humber Estuary SAC, SPA and Ramsar Site.**

N.B. The Environment Agency is committed to ensuring that no net loss of habitat will occur over 50 years as set out in the CHaMP, and that compensatory habitat through the managed realignment programme will be secured, where possible, before habitat loss occurs. This is described further in Volume 2.

As a consequence of these Stage 3 conclusions, the HRA of the 50 year Strategy needs to continue into HRA Stage 4, which involves an examination of alternatives, imperative reasons of overriding public interest and securing compensatory measures. Stage 4 is recorded in Volume 2.

3.4 *Reviewing the Strategy and Managing Uncertainty*

Throughout this assessment we have referred to the uncertainty associated with predictions of the effects of sea level rise, estuary evolution and habitat loss resulting from coastal squeeze. The nature and magnitude of this uncertainty is shown by the 95% confidence range for the predicted losses shown in the Balance Sheet in Appendix B.

We will review the CHaMP (to develop best practice in the prediction of coastal squeeze losses) and the Strategy in general, and especially the habitat creation programme, in the light of ongoing monitoring (as described in the Review of Monitoring and Maintenance¹⁷.and summarised in the SEA Report¹⁸).to ensure that the programmed habitat provision is meeting the needs. We intend doing this on a c.5 year rolling programme in line with developing packages of schemes for the provision of both flood risk management and habitat creation.

The changing nature of individual schemes within the programme of works will be managed through the requirement to complete an HRA (to whatever stage needed) for each scheme brought forward and through the provision of planning consent for some applicable schemes. Where the HRA shows that the scheme and its impacts are in line with the Strategy, the consent provided for the Strategy will apply to the scheme. Where the impacts of the scheme are significantly different to the Strategy, separate consent under the Habitat Regulations will be required as part of the planning process.

Further details of the process for managing uncertainty and consents are provided in Volume 2 of this assessment.

¹⁷ Humber Estuary Flood Defence Strategy: Strategy Development Study; Review of Monitoring and Maintenance, Environment Agency (2005)

¹⁸ Strategic Environmental Assessment of the Draft Humber Flood Risk Management Strategy, Environment Agency (2005)

APPENDICES

Appendix A

Summary of the Strategy's Programme of Works

Nb this programme was as published in the Strategy (2008) and is subject to change, notably, schemes at Swinefleet, Halton Marshes and Stallingborough are now complete.

Key

Habitat creation opportunities (managed realignment)

- No suitable land or not needed in this area
- Possible if land available
- Site already included in Strategy programme

Flood storage opportunities

- No suitable land or not needed in this area
- Possibly suitable
- Probably suitable (includes existing proposals)

Responsibility for managing defences

- All defences managed by Environment Agency
- Some defences managed by others
- Most defences managed by others
- All defences managed by others



Other assets in flood cell

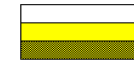
- Limited economic value (e.g. agricultural land only)
- Important economic value (e.g. major infrastructure etc)
- Primary economic value (e.g. key industrial facilities etc)

Case for improving defences

- Probably not difficult to make
- Possibly difficult to make
- Probably difficult to make

Withdrawal warnings (EA defences only)

- Environment Agency will not issue warnings
- Warnings may be issued in more than 20 yrs
- Warnings may be issued in 10 to 20 years
- Warnings may be issued in less than 10 yrs



N.B. Uncertainty about rate of sea level rise means timings are approximate

Flood cell	Name	Area (ha)	Length of defences (km)	Estimated residual life (years)	Works needed in years			Habitat, flood storage	Currently managed by	Residential properties (No)	Other economic assets	Case for improving defences	With-drawal warnings	Number of properties affected
					1-5	5-15	15-25							
1a	Kilnsea (Spurn Road)	97	2.0 (coast) 5.3 (estuary)	10 - 20						9				9
1b	Kilnsea (Kilnsea Village)	17		< 10						14			Note 1	14
1c	Kilnsea (Easington)	567		10 - 20						53			Note 2	53
2	Skeffling	411	4.8	10 - 20					10			Note 2	10	
3	Sunk Island	6812	11.8	10 - 20					668			Note 2	668	
4	Stone Creek to Paull Holme	3300	11.5	10 - 20					195			Note 1	195	
5a	Hull East (Paull Village)	2613	13.2	< 10					5728					
5b	Hull East (Victoria Dock Village)	12355		10 - 20					51356					
6	Hull West	9471	8.4	10 - 20					79974					
7	Hessle	35	2.4	< 5					24			Note 1	24	
8	North Ferriby	32	3.2	> 20					28			Note 2	28	
9a	Brough (East)	389	6.1	< 10					0					
9b	Brough (West)			< 10					483					0
10	Brough Haven to Weighton Lock	4259	6.5	< 10					697					
11	Saltmarshe (Blacktoft to Yokefleet)	14143	24.4	10 - 20					2821		Note 3			
11	Saltmarshe (Sandhall)			> 20										
12	Goole	3380	8.6	> 20					9960					
13	Goole Fields (Swinfleet)	19626	28.7	< 10					10654		Note 3			
13	Goole Fields (Swinfleet to Reedness)			10 - 20										
13	Crowle (Amcotts to Keadby)			> 20										
14	Gunness to Flixborough	1070	5.9	10 - 20					2649					
15	Flixborough Grange	365	6.3	> 20					2			Note 2	7	
16	Alkborough Flats	427	6.4	> 20										
17	Whitton to Winteringham	636	4.6	10 - 20					59			Note 2	59	
18	Winteringham Ings	4760	4.5	< 10					536					
19	South Ferriby	6170	3.2	> 20					1107					
20a	Barton Cliff to Barton Haven (West)	206	2.9	> 20					10			Note 2	10	
20b	Barton Cliff to Barton Haven (East)			> 20					429					
21	Barton Haven to Barrow Haven	442	3.3	> 20					958					
22	Barrow Haven to East Halton Skitter	2551	10.5	> 20					634			Note 2	634	
23a	Halton Marshes	876	7.3	< 10					0				0	
23b	Killingholme Marshes			< 10					26					
24	Immingham to R Freshney	3613	12.6	< 10					11687					
25	East Grimsby	802	3.9	10 - 20					18909					
26	Cleethorpes and Humberston	1669	9.2	> 20					2243					
27	Tetney to Saltfleet Haven	13138	17.4	> 20					2928					

- Notes:-
1. No EA defences, so no withdrawal warning.
 2. Further study may show building secondary defences to protect some groups of properties is economically worthwhile.
 3. Although all the defences will continue to be maintained, some of them are likely to be raised earlier and to a higher standard than others.

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Appendix B Habitat ‘Balance Sheet’

- Table B.1 Summary of Losses of Intertidal Habitat and Compensatory Habitat Requirements Associated with the 50 year Humber FRM Strategy
- Table B.2 Gains in Intertidal Habitat Associated with the Humber FRM Strategy Managed Realignment/ Habitat Creation Schemes
- Table B.3 Details of the Intertidal Habitat Losses Associated with the Humber FRM Strategy, Replacement Requirements and Confidence Limits

Table B.1 Summary of Changes of Intertidal Habitat and Compensatory Habitat Requirements Associated with the 50 Year Humber FRM Strategy

Changes		0-50 years		Replacement requirement		
Changes due to coastal squeeze and estuary evolution		Inner	330.4	Compensation for coastal squeeze		
	Middle	-509.6		Inner	330.4	
	Outer South	-168.0		Middle	-509.6	
	Outer North	61.6		Outer South	-168.0	
	Total	-285.6		Outer North	61.6	
				Total	-285.6	
Losses due to works and maintenance		Total changes without habitat replacement programme		Compensation for works and maintenance		
	Inner	-11.8	Inner	288.77	Inner	-35.5
	Middle	-30.9	Middle	-556.57	Middle	-92.6
	Outer South	0	Outer South	-180.60	Outer South	0
	Outer North	0	Outer North	48.90	Outer North	0
	Total	-42.7	Total	-399.50	Total	-128.1
Losses due to stoning		Total habitat replacement requirement		Compensation for stoning		
	Inner	-7.8	Inner	249.52	Inner	-23.4
	Middle	-3.1	Middle	-624.51	Middle	-9.3
	Outer South	-2.4	Outer South	-185.40	Outer South	-7.2
	Outer North	-2.4	Outer North	44.10	Outer North	-7.2
	Total	-15.7	Total	-516.29	Total	-47.1
total of works and stoning together						
	Inner	-19.6				
	Middle	-34.0				
	Outer South	-2.4				
	Outer North	-2.4				
	Total	-58.4				
Temporary disturbance due to works and maintenance		Compensation for temporary disturbance due to works and maintenance		Compensation for temporary disturbance due to works and maintenance		
	Inner	-7		Inner	-7	
	Middle	-3		Middle	-3	
	Outer South	-3.5		Outer South	-3.5	
	Outer North	-7		Outer North	-7	
	Total	-20.5		Total	-20.5	
Cross estuary impacts/ flood storage (Alk)		Compensation for cross estuary impacts/ flood storage (Alk)		Compensation for cross estuary impacts/ flood storage (Alk)		
	Inner	-15		Inner	-15	
	Middle	-10		Middle	-10	
	Outer South	-6.7		Outer South	-6.7	
	Outer North	-3.3		Outer North	-3.3	
	Total	-35.0		Total	-35.0	

Table B.2 Gains in Intertidal Habitat Associated with the Humber FRM Strategy Managed Realignment/ Habitat Creation Schemes

Planned Habitat Creation Programme (Managed Realignment Schemes) for the Humber FRM Strategy (ha)												
Years covered by band (from start of strategy)	0	2-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	0-50
Corresponding calendar years	2000-07	2008-11	2012-16	2017-21	2022-26	2027-31	2032-36	2037-41	2042-46	2047-51	2052-56	2000-56
Inner estuary and rivers	172	0	0	20	0	0	0	0	0	0	0	192
Middle	80	0	0	0	176	0	0	0	0	0	0	256
Outer North	0	0	150	0	0	0	321	0	0	0	0	471
Outer South	0	0	110	0	0	0	0	0	0	0	0	110
Total	252	0	260	20	176	0	321	0	0	0	0	1029

Locations	(ha)
Alkborough	172
Reeds Island	20
Paull Holme Strays	80
Donna Nook	110
Skeffling	150
Welwick	321
Goxhill	176

Table B.3 Details of the Predicted Intertidal Habitat Losses associated with the Humber FRM Strategy and their Replacement Requirements.

Strategy Period	0	2-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	0-50
Years covered by band (from start of strategy)	2000-07	2008-11	2012-16	2017-21	2022-26	2027-31	2032-36	2037-41	2042-46	2047-51	2052-56	2000-56
Corresponding calendar years	2000-07	2008-11	2012-16	2017-21	2022-26	2027-31	2032-36	2037-41	2042-46	2047-51	2052-56	2000-56
Inner												
Coastal squeeze allowance (2000-2050)												
(replacement 1:1)	41.3	23.6	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	330.4
95% +/-PI	8.4	4.8	6	6	6	6	6	6	6	6	6	67.2
95 % +/-PI	74.2	42.4	53	53	53	53	53	53	53	53	53	593.6
Reconstruction and maintenance losses (3:1)	0	-1.0	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2	-1.29	-1.314	-1.35	-11.826
Replacement for above	0	-3.0	-3.2	-3.3	-3.4	-3.5	-3.6	-3.7	-3.87	-3.942	-4.05	-35.478
Provision of flood storage:												
estimated loss due to Alkborough (1:1)	-3	-3	-3	-3	-3	0	0	0	0	0	0	-15
Reconstruction and maintenance disturbance (1:1) (Temporary Losses)	0	-7	0	0	0	0	0	0	0	0	0	-7
Stoning works (3:1)	0	-6	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-7.8
Replacement for above	0	-18	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-23.4
Inner Estuary Total	38.3	-7.4	22.8	22.6	22.5	25.4	25.3	25.2	25.03	24.958	24.85	249.522
Middle												
Coastal squeeze allowance (2000-2050)	-63.7	-36.4	-45.5	-45.5	-45.5	-45.5	-45.5	-45.5	-45.5	-45.5	-45.5	-509.6
95% +/-PI	-83.3	-47.6	-59.5	-59.5	-59.5	-59.5	-59.5	-59.5	-59.5	-59.5	-59.5	-666.4
95 % +/-PI	-44.1	-25.2	-31.5	-31.5	-31.5	-31.5	-31.5	-31.5	-31.5	-31.5	-31.5	-352.8
Reconstruction and maintenance losses (3:1)	0	-1.8	-1.8	-1.8	-2.205	-3.8	-3.8	-3.8	-3.8	-3.8	-4.1	-30.87
Replacement for above	0	-5.4	-5.4	-5.4	-6.6	-11.5	-11.5	-11.5	-11.5	-11.5	-12.4	-92.61
Provision of flood storage:												
estimated loss due to Alkborough	-2	-2	-2	-2	-2	0	0	0	0	0	0	-10
Reconstruction and maintenance disturbance (Temporary Losses)	0	-3	0	0	0	0	0	0	0	0	0	-3
Stoning works (3:1)	0	-1.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-3.1
Replacement for above	0	-3.9	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-9.3
Middle Estuary Total	-65.7	-50.7	-53.5	-53.5	-54.7	-57.6	-57.6	-57.6	-57.6	-57.6	-58.5	-624.5
Outer South												
Coastal squeeze allowance (2000-2050)	-21	-12	-15	-15	-15	-15	-15	-15	-15	-15	-15	-168
95% +/-PI	-30.8	-17.6	-22	-22	-22	-22	-22	-22	-22	-22	-22	-246.4
95 % +/-PI	-11.2	-6.4	-8	-8	-8	-8	-8	-8	-8	-8	-8	-89.6
Reconstruction and maintenance losses 3:1	0	0	0	0	0	0	0	0	0	0	0	0
Replacement for above	0	0	0	0	0	0	0	0	0	0	0	0
Provision of flood storage: estimated loss due to Alkborough	-1.34	-1.5	-1.5	-1.5	-0.9	0	0	0	0	0	0	-6.7
Reconstruction and maintenance disturbance (Temporary Losses)	0	-3.5	0	0	0	0	0	0	0	0	0	-3.5
Stoning works (3:1)	0	-1.5	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-2.4
Replacement for above	0	-4.5	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-7.2
Outer Estuary Total	-22.34	-21.5	-16.8	-16.8	-16.16	-15.3	-15.3	-15.3	-15.3	-15.3	-15.3	-185.4

Continued overleaf

Strategy Period												
Years covered by band (from start of strategy)	0	2-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	0-50
Corresponding calendar years	2000-07	2008-11	2012-16	2017-21	2022-26	2027-31	2032-36	2037-41	2042-46	2047-51	2052-56	2000-56
Outer North												
Coastal squeeze allowance (2000-2050)	7.7	4.4	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	61.6
95% +/-PI	-1.4	-0.8	-1	-1	-1	-1	-1	-1	-1	-1	-1	-11.2
95 % +/-PI	16.8	9.6	12	12	12	12	12	12	12	12	12	134.4
Reconstruction and maintenance losses (3:1)	0	0	0	0	0	0	0	0	0	0	0	0
Replacement for above	0	0	0	0	0	0	0	0	0	0	0	0
Provision of flood storage: estimated loss due to Alkborough	-0.7	-0.7	-0.7	-0.7	-0.7	0	0	0	0	0	0	-3.3
Reconstruction and maintenance disturbance (Temporary Losses)	0	-7	0	0	0	0	0	0	0	0	0	-7
Stoning works (3:1)	0	-1.5	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-2.4
Replacement for above	0	-4.5	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-7.2
Outer North Estuary Total	7.0	-7.8	4.5	4.5	4.5	5.2	5.2	5.2	5.2	5.2	5.2	44.1
Whole Estuary Total	-42.7	-87.3	-43.0	-43.1	-43.9	-42.3	-42.4	-42.5	-42.6	-42.7	-43.8	-516.3
Totals with +/- 95% PI												
Inner	5.4	-26.2	-0.8	-0.9	-1.0	1.9	1.8	1.7	1.5	1.5	1.4	-13.7
	71.2	11.4	46.3	46.1	46.0	48.9	48.8	48.7	48.5	48.5	48.4	512.7
Middle	-90.3	-64.7	-71.1	-71.1	-72.3	-75.1	-75.1	-75.1	-75.1	-75.1	-76.1	-821.1
	-45.4	-39.1	-39	-39	-40.2	-43.1	-43.1	-43.1	-43.1	-43.1	-44.0	-462.1
Outer South	-32.14	-27.1	-23.8	-23.8	-23.2	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	-263.8
	-12.54	-15.9	-9.8	-9.8	-9.2	-8.3	-8.3	-8.3	-8.3	-8.3	-8.3	-107
Outer North	-2.1	-13.0	-2.0	-2.0	-2.0	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-28.7
	16.1	-2.6	11.0	11.0	11.0	11.7	11.7	11.7	11.7	11.7	11.7	116.9
Whole Estuary Total -95% PI	-119.1	-131.0	-97.6	-97.7	-98.4	-96.8	-96.9	-97.0	-97.2	-97.3	-98.3	-1127.2
Whole Estuary Total +95% PI	29.4	-46.1	8.5	8.4	7.6	9.2	9.1	9.0	8.9	8.8	7.	60.5

Note: Prediction Intervals (PI) Confidence Intervals and standard deviation refer to the population within which the samples fall, not to an individual observation or to a group of observations in the future. A Prediction Interval is an estimate of an interval in which future observations will fall with a certain probability, given what has already been previously observed. For example, a 95% prediction interval for one future observation is the range within which we are 95% confident that the prediction will lie i.e. predicting the distribution of future points. The prediction interval resembles the confidence interval and is based on the same sample of past observations but is wider to account for prediction uncertainties in the future.

Appendix C – HR01 / Appendix 11 form: 50 Year Strategy

The Environment Agency form HR01/ Appendix 11 for the 50 year Humber Flood Risk Management Strategy is presented in this Appendix, which records the findings of Stage Two of the Habitat Regulations Assessment (HRA). Summary details are provided in Section 3 of Volume One.

N.b. The details presented in this appendix are correct at time of writing. There may be some changes in the future with the development of the scheme designs, programming and monitoring in the estuary. These changes will be addressed as part of the five-yearly Strategy review process. They are not anticipated to create any increase in the predicted adverse environmental impacts of the Strategy (the HRA attempts to assess the potential direct impacts of the proposed schemes as a 'likely worse case' scenario although the estimates of intertidal habitat loss due to coastal squeeze has been assessed using the 'mean' predictions). Where appropriate, individual schemes will be subject to separate HRAs where any remaining local issues of concern to a specific area will be resolved in consultation with consultees.

If the site specific assessment demonstrates that there are *additional adverse effects on integrity* to those described in this HRA, or that cannot be demonstrated to be mitigated/compensated in line with the Strategy, then the Habitats Regulations consent supplied for the Strategy will no longer apply to that individual scheme and a separate HRA will be completed for the individual scheme by the Competent Authority. This may then require separate determination by the Secretary of State (SoS).

APPENDIX 11

Form HR01: Proforma for new applications within Stage 2 criteria.



**ENVIRONMENT
AGENCY**

Environment Agency Record of Assessment of Likely Significant Effect On A European Site (Stage 2)
The new application for approval of the Humber Flood Risk Management Strategy detailed below is within the Stage 1 criteria of being a relevant plan, and in order to progress the application a Stage 2 assessment and consultation with Natural England is required.

PART A

1. Type of permission/activity:	Approval of the 50 Year Humber Flood Risk Management Strategy (Environment Agency, March 2008).
2. Agency reference no:	
3. National Grid reference:	c. 100,000ha centred around TA 175228
4. Site reference:	The Humber Estuary
5. Brief description of proposal:	<p>Long-term flood risk management strategy of the Humber Estuary, which includes proposals for 'hold the line' flood defence works, flood storage options through managed realignment schemes, habitat creation and creation of temporary washlands, capital works maintenance of existing defences and withdrawal of maintenance/management of defences by the Environment Agency.</p> <p>The habitat creation proposed by the Strategy contributes to addressing the intertidal habitat loss associated with coastal squeeze predicted by the CHaMP.</p>
6. European site name(s) and status:	Humber Estuary SAC; Humber Estuary SPA; and Humber Estuary Ramsar Site.
7. List of interest features:	See section 9 below
8. Is the proposal directly connected with or necessary to the management of the site for nature conservation?	No

9. What potential hazards are likely to affect the interest features? (Refer to relevant sensitivity matrix and only include those to which the interest features are sensitive). **Are the interest features potentially exposed to the hazard?**

Humber Estuary SAC

Sensitive Interest Feature	Potential hazard/impact	Magnitude of impact	'Likely significant effect'
SAC features:			
<p>Estuaries (see component habitats below)</p> <p>Atlantic salt meadows (<i>Glaucopuccinellietalia maritima</i>)</p> <p>Dunes with <i>Hippophae rhamnoides</i></p> <p>Mudflats and sandflats not covered by seawater at low tide</p> <p><i>Salicornia</i> and other annuals colonising mud or sand</p>	<p>Continued habitat losses from coastal squeeze as sea levels rise.</p> <p>Direct habitat losses in the footprint of defence works and maintenance activities, and some losses from cross-estuary or synergistic effects of projects</p>	<p>The following figures summarise the intertidal habitat losses throughout the estuary resulting from the FRM Strategy. Some of these losses will relate to Atlantic salt meadow, dunes with <i>Hippophae rhamnoides</i>, <i>Salicornia</i> and other annuals colonising mud or sand, and mudflats and sandflats not covered by seawater at low tide.</p> <p>Coastal Squeeze and Estuary Evolution The effects of coastal squeeze and estuary evolution are such that parts of the estuary will gain intertidal habitat whilst others lose habitat. The balance of this is a net loss of c. 286ha. More specifically the changes predicted over 50 years are:</p> <ul style="list-style-type: none"> • c.330 ha gain Inner estuary, • c.510 ha loss Middle estuary, • c.168 ha loss Outer South, • c.62 ha gain Outer North. <p>Direct FRM Scheme losses Approximately 58 ha intertidal habitat will be lost from encroachment of improved defences and maintenance works (c.20 ha Inner, c.34 ha Middle, c.2 ha Outer South and c.2 ha Outer North).</p> <p>Cross Estuary / Synergistic Effects 35 ha intertidal habitat loss will be caused by cross-estuarine impacts as a result of the Strategy (c.15 ha Inner, c.10 ha Middle, c.7 ha Outer South, c.3 ha Outer North).</p>	Yes
	<p>Additional temporary intertidal habitat loss (damage) caused by encroachment from temporary working areas (including physical damage to habitats caused by trampling or machinery in the working area)</p>	<p>Temporary Approximately 21 ha temporary loss or damage to intertidal habitat from works or maintenance activities (c.7 ha Inner, c.3 ha Middle, c.4 ha Outer South, c.7 ha Outer North). These areas are likely to recover within 1 to 2 years given the nature of the accretion/erosion processes with the estuary.</p> <p>Some of these losses will relate to Atlantic salt meadow, dunes with <i>Hippophae rhamnoides</i>, <i>Salicornia</i> and other annuals colonising mud or sand and mudflats and sandflats not covered by seawater at low tide. Approximately 0.1 ha of this will be to dunes with <i>Hippophae rhamnoides</i> in the first five years.</p>	Yes

	Potential local alteration of designated inter-tidal habitat due to possible change in coastal processes (physical regime, flow & velocity)	Potential to affect habitat through erosion and deposition at managed realignment schemes. Magnitude of potential impact is small and localised for hold the line schemes. Strategic modelling studies have shown that there are no significant morphological effects from such works. Monitoring will be carried out to confirm this.	Yes (managed realignment) No (other schemes)
	Potential temporary local reduction in condition of designated inter-tidal habitat due to possible community simplification, physical damage, competition from non-native species, reduced surface water flooding and change in turbidity and water chemistry during the construction phase	Small and localised, but significant impacts can be avoided by sensitive scheme design.	No
Sensitive Interest Feature	Potential hazard/impact	Magnitude of impact	'Likely significant effect'
Coastal lagoons (priority)	Habitat losses from construction of works. There are coastal lagoons at Easington which are not discussed here as part of the Strategy . A separate HRA is being carried out as part of the HECAG SMP. There are no in-combination or synergistic effects on these sites arising from the FRM Strategy	Small and localised, but significant effects can be avoided by sensitive scheme design..	No
Fixed dunes with herbaceous vegetation ('grey dunes') (priority habitat)	Potential habitat loss due to exposure from construction and widening at managed realignment breaches.	Small and localised (e.g. <0.1ha at Donna Nook)	Yes
Embryonic shifting dunes	None	n/a	No
Estuaries	See component habitat types/features	See component habitat types/features	Yes
Sandbanks which are slightly covered by sea water all the time	Potential habitat loss due to construction works	Only minimal impacts anticipated, such as at Donna Nook.	Yes
Shifting Dunes along the shoreline with <i>Ammophila arenaria</i> ('white dunes')	None	n/a	No
River lamprey <i>Lampetra fluviatilis</i>	Habitat loss by defence works and loss to coastal squeeze and cross estuarine impacts	Only minimal impacts anticipated.	No
Sea lamprey <i>Petromyzon marinus</i>	Potential local alteration of habitat due to possible change in physical regime, flow & velocity		No
	Potential temporary local reduction in condition of designated inter-tidal habitat due to possible community simplification, physical damage, competition from non-native species, reduced surface water flooding and change in turbidity and water chemistry during the construction phase		No
	Potential temporary disturbance during temporary construction works from vibration of piling		No
Grey seal <i>Halichoerus grypus</i>	Disturbance from noise, vibration and visual disturbance from works (mainly on foreshore) affecting breeding (temporary).	Small and localised, but significant impacts avoided by sensitive scheme design and timing of works to avoid breeding season.	No

	<p>Potential local alteration of habitat due to possible change in coastal processes (physical regime), community simplification, physical damage, competition from non-native species, reduced surface water flooding and change in turbidity and water chemistry during the construction phase</p>	<p>Sensitive scheme design will ensure that there are no significant impacts on breeding habitat.</p>	<p>No</p>
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Humber Estuary SPA/ Ramsar Site

Sensitive Interest Feature	Potential hazard/impact	Magnitude of impact	'Likely significant effect'
SPA qualifying species (article 4.1) regularly used by 1% or more of the GB populations of:			
<p>Bittern <i>Botaurus stellaris</i> (wintering & breeding)</p> <p>Hen harrier <i>Circus cyaneus</i> (wintering)</p> <p>Marsh harrier <i>Circus aeruginosus</i> (breeding)</p> <p>Avocet <i>Recurvirostra avosetta</i> (wintering & breeding)</p> <p>Golden plover <i>Pluvialis apricaria</i> (wintering) (R)</p> <p>Bar-tailed godwit <i>Limosa lapponica</i> (wintering) (R)</p> <p>Ruff <i>Philomachus pugnax</i> (passage) (R)</p> <p>Little tern <i>Sterna albifrons</i> (breeding)</p>	<p>Loss of wintering/foraging and breeding habitat from permanent encroachment (designated terrestrial and intertidal habitat), sea level rise and cross-estuary/synergistic effects and from maintenance works.</p>	<p>The following figures summarise the intertidal habitat losses throughout the estuary resulting from the FRM Strategy.</p> <p>Coastal Squeeze and Estuary Evolution The effects of coastal squeeze and estuary evolution are such that parts of the estuary will gain intertidal habitat whilst others lose. The balance of this is a net loss of c. 286ha. More specifically the changes predicted over 50 years are:</p> <ul style="list-style-type: none"> c.330 ha gain Inner estuary, c.510 ha loss Middle estuary, c.168 ha loss Outer South, c.62 ha gain Outer North. <p>Direct FRM Scheme losses Approximately 58 ha intertidal habitat will be lost from encroachment of improved defences and maintenance works (c.20 ha Inner, c.34 ha Middle, c.2 ha Outer South and c.2 ha Outer North).</p> <p>Cross Estuary / Synergistic Effects 35 ha intertidal habitat loss will be caused by cross-estuarine impacts as a result of the Strategy (c.15 ha Inner, c.10 ha Middle, c.7 ha Outer South, c.3 ha Outer North).</p>	Yes
	<p>Additional temporary wintering/foraging and breeding habitat loss (damage) in footprint of working areas. In the first five years there will be habitat losses at Swinefleet, Halton Marshes, Stallingborough, Donna Nook and monitoring and maintenance sites</p>	<p>Temporary Approximately 21 ha temporary loss or damage to intertidal habitat from works or maintenance activities (c.7 ha Inner, c.3 ha Middle, c.4 ha Outer South, c.7 ha Outer North). These areas are likely to recover within 1 to 2 years given the nature of the accretion/erosion processes with the estuary.</p> <p>There will be unknown loss of terrestrial habitat</p>	Yes
	<p>Potential local alteration of designated inter-tidal habitat due to possible change in coastal processes (physical regime, flow & velocity)</p>	<p>Potential to affect habitat by erosion and deposition at managed realignment schemes (e.g. Donna Nook).</p> <p>Magnitude of potential impact is small and localised for hold the line schemes (strategic modelling studies have shown that there are no significant morphological effects from such works). Monitoring will be carried out to confirm this.</p>	Yes (managed realignment) No
	<p>Potential temporary local reduction in condition of designated inter-tidal habitat due to possible community simplification, physical damage, competition from non-native species, reduced surface water flooding and change in turbidity and water chemistry during the construction</p>	<p>Small and localised, but avoided by sensitive scheme design.</p>	No

	phase		
	Noise, vibration and visual disturbance from works affecting wintering/ breeding/foraging during the construction phase and maintenance activities (temporary)	Mostly small and localised (footprint and vicinity) that can be avoided by sensitive scheme design. However, there may be occasions where this is not possible.	Yes
	Loss of adjacent areas of high tide roost site (outside of designated area) or reed fringes. In the first five years, there will be losses at Swinefleet, Brough (BAe) and Donna Nook	Area partially dependent on land purchase for small part of site and ongoing design/ modelling and further assessment/data. The majority of the area lost in the next five years will be at Donna Nook habitat creation site.	No
SPA qualifying species (article 4.2) regularly used by 1% or more of population of the following migratory species:			
Shelduck <i>Tadorna tadorna</i> (wintering) (R)	As in article 4.1 species above	As in article 4.1 species above	As in article 4.1 species
Knot <i>Calidris canutus</i> (wintering & passage) (R)	As above	As above	As above
Dunlin <i>Calidris alpina</i> (wintering & passage) (R)	As above	As above	As above
Black-tailed godwit <i>Limosa limosa</i> (wintering & passage) (R)	As above	As above	As above
Redshank <i>Tringa tetanus</i> (wintering & passage) (R)	As above	As above	As above
Sensitive Interest Feature	Potential hazard/impact	Magnitude of impact	'Likely significant effect'
Other SPA qualifying features:			
Used regularly by over 20,000 waterbirds (R)	As in article 4.1 species above	As in article 4.1 species above	As in article 4.1 species
Proposed Ramsar qualifying features are noted with an R above – others listed below			
Criterion 1 – near natural estuary with dune systems, humid dune slacks, estuarine waters, intertidal mud and sand flats, saltmarshes and coastal brackish/saline lagoons (c.f SAC features)	See mudflats and sandflats, dunes and Atlantic salt meadows	See mudflats and sandflats, dunes and Atlantic salt meadows	See mudflats and sandflats, dunes and Atlantic salt meadows
Criterion 3 – supports populations of animal species important for maintaining biodiversity – grey seals (<i>Halichoerus grypus</i>), natterjack toad (<i>Bufo calamita</i>)	See grey seals	See grey seals	See grey seals
Criterion 5 and 6 bird species listed I under SPA features	As in article 4.1 species above	As in article 4.1 species above	As in article 4.1 species
Criterion 8 – a migration path on which fish stocks (river lamprey and sea lamprey) depend	See river and sea lamprey	See river and sea lamprey	See river and sea lamprey

10. Is the potential scale or magnitude of any effect likely to be significant?	
a) Alone?	Yes: Humber Estuary SAC, SPA & Ramsar site
b) In combination with other plans or projects?	Yes (the HECAG SMP)
c) In combination with plans/projects of other Competent Authorities?	<p>Yes</p> <p>As a result of its risk assessment, the Environment Agency can conclude that this application could act in combination with plans/projects of other competent authorities. Consultation is being undertaken and an appropriate assessment will be made in Stage 3 (to be used when a conclusion of Likely Significant Effect is reached)</p> <p>Supporting information is given in the: Humber FRM Strategy Habitats Regulations Assessment Report</p>
11. Conclusion: Is the proposal likely to have a significant effect 'alone or in combination' on a European site?	Yes
Name of EA Officer: Lesley Clarke Senior NEAS Officer	<div style="background-color: black; width: 150px; height: 20px; display: inline-block;"></div> Date: 1 st March 2011
NE comment on assessment: (If the EN/CCW officer disagrees with the conclusion of 10c, please include details of the other Competent Authorities which should be consulted).	
Name of NE Officer:	<div style="background-color: black; width: 150px; height: 20px; display: inline-block;"></div> Date: 02/03/2011

Appendix D1 – HR02 / Appendix 12 form: 50 Year Strategy

The Environment Agency form HR02/ Appendix 12 for the 50 Year Strategy is presented in this Appendix, which records Stage 3 of the HRA. Further discussion and details of the Appendix 12 are provided in Volume One Section 3.3.

N.b. The details presented in this appendix are correct at time of writing. There may be some changes in the future with the development of the scheme designs, programming and monitoring in the estuary. These changes will be addressed as part of the five yearly Strategy review process. They are not anticipated to create any increase in the adverse environmental impacts of the Strategy (the HRA attempts to assess the potential direct impacts of the proposed schemes as a 'likely worse case' scenario although the estimates of habitat loss due to coastal squeeze has been assessed using the 'mean' predictions). Where appropriate, individual schemes will be subject to separate HRAs where any remaining local issues of concern to a specific area will be resolved in consultation with consultees.

Form HR02: Proforma for FRM stage 3 appropriate assessment (Appendix 12)

Part A: Technical consideration

1 Table 1 – Plan details

Type of plan:	Humber Flood Risk Management Strategy: 50 Year Strategy									
Agency reference no:										
National Grid Reference:	c. 100,000 ha centred around TA 175228									
Site reference:	The Humber Estuary									
Plan Elements/Components (assessed as having 'likely significant effect' in HR01 form)	Hazard									
	A: Habitat Loss	B: Changes in physical regime	C: Physical damage	D: Changes in turbidity	E: Simplification of communities	F: Disturbance	G: Competition from non-native species	H: Changes to flow and velocity regime and improved drainage	I: Reduced surface water flooding	J: Changes in water chemistry
Hold the line flood defence works Applies to Humber Estuary SAC, SPA & Ramsar site	✓	✗	✓	✗	✗	✓	✗	✗	✗	✗
Flood storage options through managed realignment schemes, habitat creation and creation of temporary washlands	✓	✓	✓	✗	✗	✓	✗	✓	✗	✗
Withdrawal of maintenance/management of defences by the Environment Agency	✓	✓	✓	✗	✗	✓	✗	✓	✗	✗
Capital works maintenance of existing defences and monitoring	✓	✗	✓	✗	✗	✓	✗	✗	✗	✗
50 year Strategy	✓	✓	✓	✗	✗	✓	✗	✓	✗	✗

2 Table 2 – Site details

Name, Legal Status, and Priority of the European site:	<i>Humber Estuary</i>	<i>SAC</i>	<i>High Priority</i>
	<i>Humber Estuary</i>	<i>SPA</i>	<i>High Priority</i>
	<i>Humber Estuary</i>	<i>Ramsar Site</i>	<i>High Priority</i>

3 Table 3 – Features List

	Features	Plan has associated hazards to which features are sensitive?	Details of Hazard (plan component reference)	Condition (SSSI Refs; Size)
Humber Estuary SAC/ Ramsar habitat groups				
1.10	Coastal habitats	✓	A: Habitat loss B: Changes in physical regime C: Physical damage	information not available
1.12	Estuarine and intertidal habitats	✓	A: Habitat loss B: Changes in physical regime C: Physical damage H: changes to flow and velocity regime and improved drainage	
1.13	Submerged marine habitats	✓	B: Changes in physical regime H: changes to flow and velocity regime and improved drainage	
Humber Estuary SAC/Ramsar species groups				
2.5	Anadromous fish	✘		
2.12	Marine mammals	✘		
Humber Estuary SPA/ Ramsar bird groups				
3.6	Birds of lowlands and their freshwater margins	✓	A: Habitat loss B: Changes in physical regime C: Physical damage F: Disturbance H: Changes to flow and velocity regime and improved drainage	
3.8	Birds of coastal habitats	✓	A: Habitat loss B: Changes in physical regime C: Physical damage F: Disturbance H: Changes to flow and velocity regime and improved drainage	
3.9	Birds of estuarine habitats	✓	A: Habitat loss B: Changes in physical regime C: Physical damage F: Disturbance H: Changes to flow and velocity regime and improved drainage	

4 Report

Please see Volume Two describing Appropriate Assessment, to which this is appended. A summary table is presented below.

Table 4a Appendix 12: Proforma for Stage 3 (Appropriate Assessment Record) – 50 Year Strategy

Humber Estuary SAC Summarised Conclusions

Habitat	Interest feature	Relevant favourable condition target for attribute ¹	Contribution of:		Adverse Effect of:		Can adverse affects be avoided?	Adverse affect on integrity; long term, short term. Yes, No or uncertain ³ ?
			attribute ¹ to ecological structure and function of site	management ² or other unauthorised sources to attribute / feature condition	proposal alone on attribute ¹ and/or feature	plan in combination with other plans or projects, on attribute ¹ / feature		
Hazards A, C: Habitat loss, physical damage								
Coastal habitats, estuarine & intertidal habitats	<p>Estuaries (details given in component habitats)</p> <p>Atlantic salt meadows (<i>Glauco-Puccinellietalia maritima</i>)</p> <p>Dunes with <i>Hippophae rhamnoides</i></p> <p>Mudflats and sandflats not covered by seawater at low tide</p> <p><i>Salicornia</i> and other annuals colonising mud or sand</p>	Subject to natural change, maintain the Atlantic salt meadows, dunes, mudflats and sandflats not covered by seawater at low tide in favourable condition	Extent of saltmarsh, mudflats, <i>Salicornia</i> , dune communities	Loss to coastal squeeze	<p>The following figures summarise the intertidal habitat losses throughout the estuary resulting from the FRM Strategy. Some of these losses will relate to Atlantic salt meadow, dunes with <i>Hippophae rhamnoides</i>, <i>Salicornia</i> and other annuals colonising mud or sand, and mudflats and sandflats not covered by seawater at low tide.</p> <p>Coastal Squeeze and Estuary Evolution</p> <p>The effects of coastal squeeze and estuary evolution are such parts of the estuary will gain intertidal habitat whilst others lose. The balance of this is a net loss of c. 286ha. More specifically the changes predicted over 50 years are:</p> <ul style="list-style-type: none"> • c.330 ha gain Inner estuary, • c.510 ha loss Middle estuary, • c.168 ha loss Outer South, • c.62 ha gain Outer North. <p>Direct FRM Scheme Losses</p> <p>Approximately 58 ha intertidal habitat will be lost from encroachment of improved defences and maintenance works (c.20 ha Inner, c.34 ha Middle, c.2 ha Outer South and c.2 ha Outer North).</p>	Yes potential for additional loss of habitat as a result of other plans or projects.	No	<p>Yes, long term;</p> <p>However, the replacement habitat programme and ratios used are designed to compensate for impacts before adverse effects on integrity experienced, where possible. (See Stage 4.)</p> <p>Potential losses in the Estuary as a result of other plans or projects (other than coastal squeeze impacts) would need to be avoided or compensated for by the relevant applicant.</p>

Habitat	Interest feature	Relevant favourable condition target for attribute ¹	Contribution of:		Adverse Effect of:		Can adverse affects be avoided?	Adverse affect on integrity; long term, short term. Yes, No or uncertain ³ ?
			attribute ¹ to ecological structure and function of site	management ² or other unauthorised sources to attribute / feature condition	proposal alone on attribute ¹ and/or feature	plan in combination with other plans or projects, on attribute ¹ / feature		
					<p>Cross Estuary / Synergistic Effects 35 ha intertidal habitat loss will be caused by cross-estuarine impacts as a result of the Strategy (c.15 ha Inner, c.10 ha Middle, c.7 ha Outer South, c.3 ha Outer North).</p> <p>Temporary Approximately 21 ha temporary loss or damage to intertidal habitat from works or maintenance activities (c.7 ha Inner, c.3 ha Middle, c.4 ha Outer South, c.7 ha Outer North). These areas are likely to recover within 1 to 2 years given the nature of the accretion/erosion processes with the estuary.</p>			
Estuarine & intertidal habitats, coastal habitats	Grey dunes Sandbanks which are slightly covered by sea water all the time	Subject to natural change, maintain the grey dunes and sandbanks which are slightly covered by sea water all the time in favourable condition	Extent of grey dune and sandbanks which are slightly covered by sea water all the time communities	None	No – the overall extent of habitat loss will be very small proportion of SCI resource	No	N/A	No
Hazards B, H: Changes in physical regime, changes in flow and velocity regime								
Coastal habitats, estuarine & intertidal habitats, submerged marine habitats	Estuaries (see component habitats below) Atlantic salt meadows (<i>Glauco-Puccinellietalia maritimae</i>) Dunes with <i>Hippophae</i>	Subject to natural change, maintain the Atlantic salt meadows, <i>Salicornia</i> , dunes, mudflats and sandflats not covered by	Extent of saltmarsh, mudflats, dune communities	Loss to coastal squeeze	Potential changes in the coastal processes, flow and velocity regime at Managed Realignment sites. Timescale unknown (probably at least medium term).	Yes	No	Yes, long term; However, the replacement habitat programme and ratios used are designed to compensate for impacts before adverse effects on integrity experienced, where possible. (See

Habitat	Interest feature	Relevant favourable condition target for attribute ¹	Contribution of:		Adverse Effect of:		Can adverse affects be avoided?	Adverse affect on integrity; long term, short term. Yes, No or uncertain ³ ?
			attribute ¹ to ecological structure and function of site	management ² or other unauthorised sources to attribute / feature condition	proposal alone on attribute ¹ and/or feature	plan in combination with other plans or projects, on attribute ¹ / feature		
	<i>rhamnoides</i> Mudflats and sandflats not covered by seawater at low tide <i>Salicornia</i> and other annuals colonising mud or sand	seawater at low tide in favourable condition						Stage 4.)

Humber Estuary SPA Summarised Conclusions

Habitat	Interest feature	Relevant favourable condition target for attribute ¹	Contribution of:		Adverse Effect of:		Can adverse affects be avoided ?	Adverse affect on integrity; long term, short term. Yes, No or uncertain ³ ?
			attribute ¹ to ecological structure and function of site	management ² or other unauthorised sources to attribute / feature condition	proposal alone on attribute ¹ and/or feature	plan in combination with other plans or projects, on attribute ¹ / feature		
Hazards A, C: Habitat loss and physical damage								
Coastal habitats, estuarine & intertidal habitats, submerged marine habitats	<p>Birds of estuarine habitats, coastal habitats, farmlands and freshwater margins:</p> <ul style="list-style-type: none"> ▪ Avocet <i>Recurvirostra avosetta</i> (wintering & breeding) ▪ Bittern <i>Botaurus stellaris</i> (wintering & breeding) ▪ Hen harrier <i>Circus cyaneus</i> (wintering) ▪ Golden plover <i>Pluvialis apricaria</i> (wintering) (R) ▪ Bar-tailed godwit <i>Limosa lapponica</i> (wintering) (R) ▪ Ruff <i>Philomachus pugnax</i> (passage) ▪ Marsh harrier <i>Circus aeruginosus</i> (breeding) ▪ Little tern <i>Sterna albifrons</i> (breeding) ▪ Shelduck <i>Tadorna tadorna</i> (wintering)(R) ▪ Knot <i>Calidris canutus</i> (wintering & passage) (R) ▪ Dunlin <i>Calidris alpina</i> (wintering & passage) (R) ▪ Black-tailed godwit <i>Limosa limosa</i> (wintering & passage) (R) ▪ Redshank <i>Tringa tetanus</i> (wintering & passage) (R) <p>Used regularly by over 20,000 waterbirds golden plover, avocet, bittern, bar-tailed godwit, hen harrier, dark-bellied geese, wigeon, teal, mallard, pochard, scaup, goldeneye, cormorant, lapwing, sanderling, whimbrel, curlew, greenshank, turnstone</p>	Subject to natural change, maintain the habitat regularly supporting 1% or more of the individuals in a population of one species or sub-species of waterfowl and regularly occurring migratory bird species and assemblage of waterfowl	Potentially important wintering/ foraging and roosting habitat	Intertidal habitat loss to coastal squeeze	<p>The following figures summarise the intertidal habitat losses throughout the estuary resulting from the FRM Strategy. Some of these losses will relate to Atlantic salt meadow, dunes with <i>Hippophae rhamnoides</i>, <i>Salicornia</i> and other annuals colonising mud or sand, and mudflats and sandflats not covered by seawater at low tide.</p> <p>Coastal Squeeze and Estuary Evolution The effects of coastal squeeze and estuary evolution are such parts of the estuary will gain intertidal habitat whilst others lose. The balance of this is a net loss of c. 286ha. More specifically the changes predicted over 50 years are:</p> <ul style="list-style-type: none"> • c.330 ha gain Inner estuary, • c.510 ha loss Middle estuary, • c.168 ha loss Outer South, • c.62 ha gain Outer North. <p>Direct FRM Scheme losses Approximately 58 ha intertidal habitat will be lost from encroachment of improved defences and maintenance works (c.20 ha Inner, c.34 ha Middle, c.2 ha Outer South and c.2 ha Outer North).</p> <p>Cross Estuary / Synergistic Effects 35 ha intertidal habitat loss will be caused by cross-estuarine impacts</p>	Yes potential for additional loss of habitat as a result of other plans or projects.	No	<p>Yes, short term;</p> <p>However, the replacement habitat programme and ratios used are designed to compensate for impacts before adverse effects on integrity experienced, where possible. (See Stage 4.)</p>

Habitat	Interest feature	Relevant favourable condition target for attribute ¹	Contribution of:		Adverse Effect of:		Can adverse affects be avoided ?	Adverse affect on integrity; long term, short term. Yes, No or uncertain ³ ?
			attribute ¹ to ecological structure and function of site	management ² or other unauthorised sources to attribute / feature condition	proposal alone on attribute ¹ and/or feature	plan in combination with other plans or projects, on attribute ¹ / feature		
					as a result of the Strategy (c.15 ha Inner, c.10 ha Middle, c.7 ha Outer South, c.3 ha Outer North). Temporary Approximately 21 ha temporary loss or damage to intertidal habitat from works or maintenance activities (c.7 ha Inner, c.3 ha Middle, c.4 ha Outer South, c.7 ha Outer North). Some of this loss or damage will be to Atlantic salt meadow. These areas are likely to recover within 1 to 2 years given the nature of the accretion/erosion processes with the estuary.			
Adjacent high tide roost (non SPA and SPA/ Ramsar fields)	Birds of estuarine habitats (SPA & Ramsar) Wintering and passage birds, >20,000 waterfowl	None specifically for high tide roosts	Agricultural fields Important roosting habitat	Breaches to create new intertidal habitat by managed realignment.	Potential for permanent loss of high tide roost habitats within the SPA and outwith. e.g. Goxhill where impacts and mitigation will depend on the configuration of the project and design etc.	No	Yes, in part (will be assessed further in scheme design)	Yes, long term (managed realignment schemes); but integral to replacement habitat. Will be assessed in scheme design

Hazard B, H: Changes in physical regime, changes to flow and velocity regime and improved drainage								
Coastal habitats, estuarine & intertidal habitats, submerged marine habitats	<p>Birds of estuarine habitats, coastal habitats, farmlands, lowlands and freshwater margins:</p> <ul style="list-style-type: none"> ▪ Avocet <i>Recurvirostra avosetta</i> (wintering & breeding) ▪ Bittern <i>Botaurus stellaris</i> (wintering & breeding) ▪ Hen harrier <i>Circus cyaneus</i> (wintering) ▪ Golden plover <i>Pluvialis apricaria</i> (wintering) (R) ▪ Bar-tailed godwit <i>Limosa lapponica</i> (wintering) (R) ▪ Ruff <i>Philomachus pugnax</i> (passage) ▪ Marsh harrier <i>Circus aeruginosus</i> (breeding) ▪ Little tern <i>Sterna albifrons</i> (breeding) ▪ Shelduck <i>Tadorna tadorna</i> (wintering)(R) ▪ Knot <i>Calidris canutus</i> (wintering & passage) (R) ▪ Dunlin <i>Calidris alpina</i> (wintering & passage) (R) ▪ Black-tailed godwit <i>Limosa limosa</i> (wintering & passage) (R) ▪ Redshank <i>Tringa tetanus</i> (wintering & passage) (R) <p>Used regularly by over 20,000 waterbirds. Golden Plover, Avocet, Bittern, Bar-tailed Godwit, Hen Harrier, Dark-bellied geese, Wigeon, Teal, Mallard, Pochard, Scaup, Goldeneye, Cormorant, Lapwing, Sanderling, Whimbrel, Curlew, Greenshank, Turnstone</p>	Subject to natural change, maintain the habitat regularly supporting 1% or more of the individuals in a population of one species or sub-species of waterfowl and regularly occurring migratory bird species and assemblage of waterfowl in favourable condition.	Potentially important wintering/foraging habitat	Breach to create managed retreat	At realignment schemes, creeks are expected to erode naturally, resulting in the potential scour of existing intertidal habitat. This would not however result in habitat loss (only change).	Yes	No	<p>Yes, short term.</p> <p>However, managed realignment schemes are integral to the delivery of replacement habitat. The habitat will be converted to a mosaic of intertidal habitats such as salt marsh, mudflat and creeks.</p> <p>The replacement habitat programme and ratios used are designed to compensate for impacts before adverse effects on integrity experienced where possible. (See Stage 4.)</p>

Hazard F: Disturbance								
Coastal habitats, estuarine & intertidal habitats, submerged marine habitats	<p>Birds of estuarine habitats, coastal habitats, farmlands, lowlands and freshwater margins:</p> <ul style="list-style-type: none"> ▪ Avocet <i>Recurvirostra avosetta</i> (wintering & breeding) ▪ Bittern <i>Botaurus stellaris</i> (wintering & breeding) ▪ Hen harrier <i>Circus cyaneus</i> (wintering) ▪ Golden plover <i>Pluvialis apricaria</i> (wintering) (R) ▪ Bar-tailed godwit <i>Limosa lapponica</i> (wintering) (R) ▪ Ruff <i>Philomachus pugnax</i> (passage) ▪ Marsh harrier <i>Circus aeruginosus</i> (breeding) ▪ Little tern <i>Sterna albifrons</i> (breeding) ▪ Shelduck <i>Tadorna tadorna</i> (wintering)(R) ▪ Knot <i>Calidris canutus</i> (wintering & passage) (R) ▪ Dunlin <i>Calidris alpina</i> (wintering & passage) (R) ▪ Black-tailed godwit <i>Limosa limosa</i> (wintering & passage) (R) ▪ Redshank <i>Tringa tetanus</i> (wintering & passage) (R) <p>Used regularly by over 20,000 waterbirds golden plover, avocet, bittern, bar-tailed godwit, hen harrier, dark-bellied geese, wigeon, teal, mallard, pochard, scaup, goldeneye, cormorant, lapwing, sanderling, whimbrel, curlew, greenshank, turnstone</p>	Subject to natural change, maintain the habitat regularly supporting 1% or more of the individuals in a population of one species or sub-species of waterfowl and regularly occurring migratory bird species and assemblage of waterfowl in favourable condition.	Potentially important wintering/ foraging habitat	Loss to coastal squeeze	Disturbance of bird species during their wintering, passage and/or breeding seasons (from noise, visual impact and/or vibration),. Where possible this impact will be avoided through controlling the timing and proximity of works. Short-term (for the duration of part of the construction phase), reversible and small in scale (due to the localised nature and likely availability of substitution habitat elsewhere in the Estuary). Monitoring and site-specific mitigation measures agreed with Natural England will help ensure no adverse effects on integrity of the European Site.	Yes potential disturbance from other schemes being implemented at the same time.	Yes	No

Humber Estuary Ramsar Site Summarised Conclusions

Habitat	Interest feature	Relevant favourable condition target for attribute ¹	Contribution of:		Adverse Effect of:		Can adverse effects be avoided?	Adverse affect on integrity; long term, short term. Yes, No or uncertain ³ ?
			attribute ¹ to ecological structure and function of site	management ² or other unauthorised sources to attribute / feature condition	proposal alone on attribute ¹ and/or feature	plan in combination with other plans or projects, on attribute ¹ / feature		
Hazards A, C: Habitat loss, physical damage								
Criterion 1 – near natural estuary with dune systems, humid dune slacks, estuarine waters, intertidal mud and sand flats, saltmarshes and coastal brackish/saline lagoons (c.f SAC features)	See mudflats and sandflats, and Atlantic salt meadows and dunes	See mudflats and sandflats, dunes and Atlantic salt meadows	See mudflats and sandflats, dunes and Atlantic salt meadows	See mudflats and sandflats, dunes and Atlantic salt meadows	See mudflats and sandflats, dunes and Atlantic salt meadows	Yes	No	Yes , long term; However, the replacement habitat programme and ratios used are designed to compensate for impacts before adverse effects on integrity experienced where possible. (See Stage 4.)
Criterion 5 and 6 - bird species listed (R) under SPA features	See SPA birds	See SPA birds	See SPA birds	See SPA birds	See SPA birds	Yes	No	Yes in the long term; However, the replacement habitat programme and ratios used are designed to compensate for impacts before adverse effects on integrity experienced where possible. (See Stage 4.)
Hazards B, H: Changes in physical regime, changes in flow & velocity regime								
Criterion 1 – near natural estuary with dune systems, humid dune slacks, estuarine waters, intertidal mud and sand flats, saltmarshes and coastal brackish/saline lagoons (c.f SAC features)	See mudflats and sandflats, dunes and Atlantic salt meadows and dunes	See mudflats and sandflats, dunes and Atlantic salt meadows	See mudflats and sandflats, dunes and Atlantic salt meadows	See mudflats and sandflats, dunes and Atlantic salt meadows	See mudflats and sandflats, dunes and Atlantic salt meadows	Yes	No	Yes medium term. However, the replacement habitat programme and ratios used are designed to compensate for impacts before adverse effects on integrity experienced where possible. (See Stage 4.)
Criterion 5 and 6 - bird species listed (R) under SPA features	See SPA birds	See SPA birds	See SPA birds	See SPA birds	See SPA birds	Yes	No	Yes, short term. However, managed realignment schemes are integral to the delivery of replacement habitat and compensate before adverse

Habitat	Interest feature	Relevant favourable condition target for attribute ¹	Contribution of:		Adverse Effect of:		Can adverse affects be avoided?	Adverse affect on integrity; long term, short term. Yes, No or uncertain ³ ?
			attribute ¹ to ecological structure and function of site	management ² or other unauthorised sources to attribute / feature condition	proposal alone on attribute ¹ and/or feature	plan in combination with other plans or projects, on attribute ¹ / feature		
								effects on integrity experienced where possible. (See Stage 4.)
Hazard F: Disturbance								
Criterion 5 and 6 - bird species listed (R) under SPA features	See SPA birds	See SPA birds	See SPA birds	See SPA birds	See SPA birds	Yes	No	No

Notes:

1 ATTRIBUTE = Quantifiable aspects of interest features that can be used to help define favourable condition for that feature

2 MANAGEMENT = in this context management refers to management of the European site

5. Stage 3 Environment Agency Conclusion

Can it be ascertained that the plan will not adversely affect the integrity of the European site(s)?

No. The Strategy is considered to adversely affect the integrity of the three European Sites.

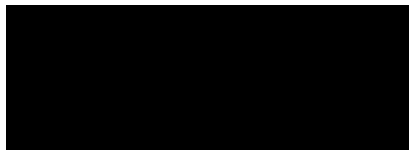
The 50 year Strategy will result in permanent and temporary losses of intertidal habitat which is designated as SAC and Ramsar habitat, namely Atlantic salt meadows, dunes with *Hippophae rhamnoides* and mudflats and sandflats not covered by seawater at low tide *Salicornia* and other annuals colonising mud or sand, and estuaries. These habitats are also likely to be adversely affected by potential changes in physical regime and changes in flow and velocity regime as a result of implementing managed realignment schemes.

These habitat losses and changes in physical regime and changes in flow and velocity regime will also adversely impact on SPA birds (birds of estuarine habitats, coastal habitats lowland habitats with freshwater margins), which utilise the area for overwintering, foraging, breeding and roosting.

However, the Strategy puts in place a series of habitat replacement schemes (of which the managed realignment schemes are integral) with suitable programme and replacement ratios designed to compensate for impacts before the adverse effects on integrity are experienced, where possible. For example, the Alkborough and Paull Holme Strays (a combined total of 251.1 ha of intertidal habitat created in 2006 and 2003) is part of the 1029 ha of habitat creation provided over the first 50 years of the Strategy.

Name of EA officer undertaking appropriate assessment:

Signed:



Date:



**Lesley Clarke
Senior Environmental Project Manager,
National Environmental Assessment Service**

Endorsed by (if appropriate) e.g. team leader and date

NE COMMENTS ON APPROPRIATE ASSESSMENT:

The EA has committed to deliver replacement habitat and compensate before adverse effects on integrity are experienced. However throughout the appropriate assessment the term 'where possible' accompanies this commitment. The exact meaning of 'where possible' needs to be clarified in the HRA process and agreed with Natural England to ensure compliance with the Habitat Regulations.

IS THERE AGREEMENT WITH THE CONCLUSION? YES

(Please provide summary and explanation for answer given)

Signed: 

(NE local team manager)

Date: 02/03/2011

Part B: Final Appropriate Assessment record

To be completed following consultation and agreement with NE

Title, grid reference and description of the plan:

- Plan approval: the Humber Flood Risk Management Strategy (Environment Agency March 2008)
- Location: The Humber Estuary, centred around TA 175228
- Description: Long-term flood risk management strategy of the Humber Estuary, which includes proposals for 'hold the line' flood defence works, flood storage options through managed realignment schemes, habitat creation and creation of temporary washlands, capital works maintenance of existing defences and withdrawal of maintenance/management of defences by the Environment Agency. The habitat creation proposed by the Strategy contributes to addressing the intertidal habitat loss associated with coastal squeeze predicted by the CHaMP.
- Details of the assessment are given in the main report.

Date of appropriate assessment:

- 22.02.2011

The following statements should also be included:

"This is a record of the appropriate assessment required by the Conservation of Habitats and Species Regulations 2010, undertaken by the Environment Agency in respect of the above plan, in accordance with the Habitats Directive (Council Directive 92/43/EEC). Having considered that the plan would be likely to have a significant effect on the Humber Estuary SAC, SPA and Ramsar Site and that the plan was not directly connected with or necessary to the management of the site for nature conservation, an appropriate assessment has been undertaken of the implications of the proposal in view of the site's conservation objectives.

*Natural England was consulted under the former Regulation 48(3) throughout the development of the HRA (now Section 61 of the amended Regulations). The conclusions of this appropriate assessment **are** in accordance with the advice and recommendations of NE".*

"The site's nature conservation objectives have been taken into account, including consideration of the citation for the site and information supplied by NE. The likely effects of the proposal on the is summarised in the HRA Stages One to Three report.

The assessment has concluded that:

- *The plan as proposed **cannot** be shown to have no adverse effect on the integrity of the site. The imposition of conditions or restrictions on the way the proposal is to be carried out has been considered and it is ascertained that:*
 - i conditions or restrictions cannot/may not overcome the adverse effects on the integrity of the site*

Signed (relevant Area Management Team member) and date.



Phillip Winn, Humber Strategies Manager 03.03.11

Figures

Figure 1 – Study Area, Management Units and Flood Cells

Figure 2 – Summary Map of Flood Risk Management Actions

Figure 3 – Key Nature Conservation Features in the Estuary

Figure 1 – Study Area, Management Units and Flood Cells

The floodplain of the Humber Estuary

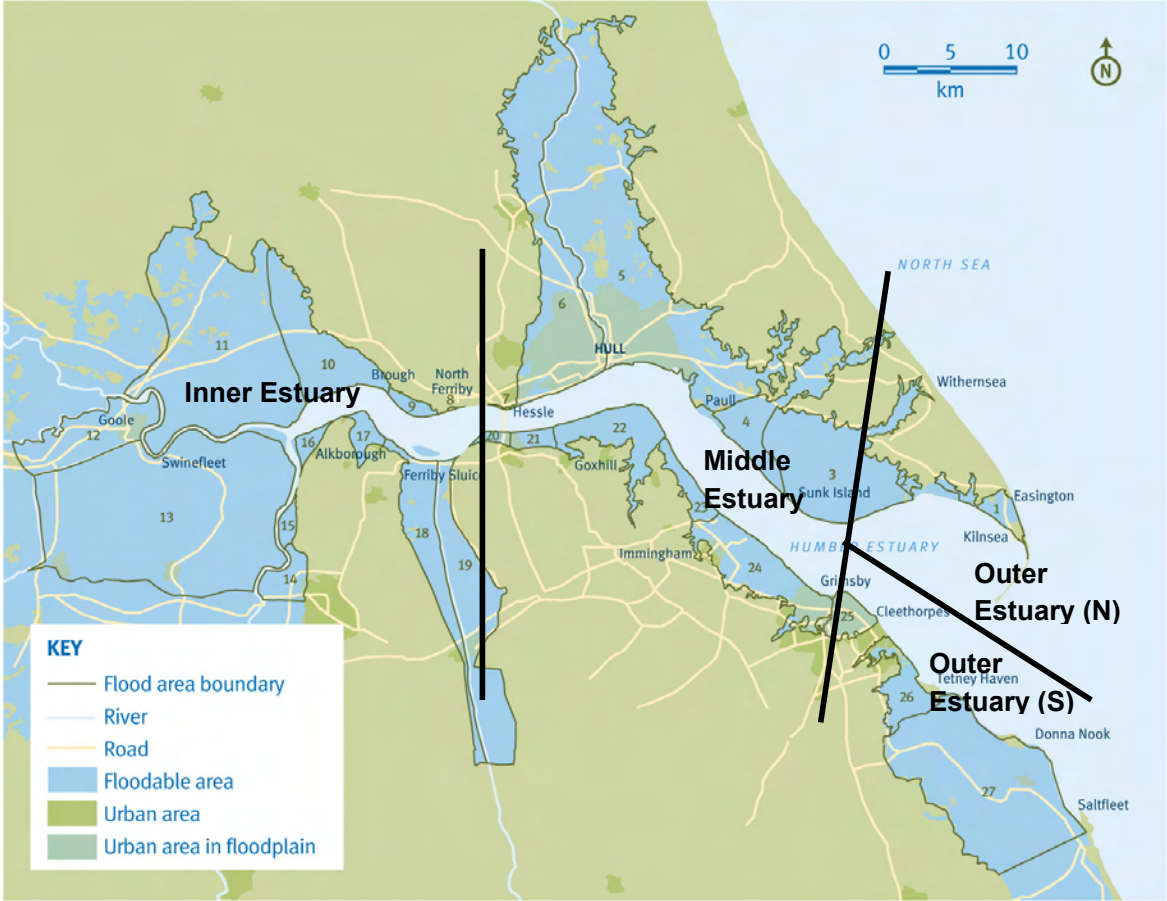


Figure 2 – Summary Map of Flood Risk Management Actions

Habitat creation, flood storage and potential withdrawal of maintenance

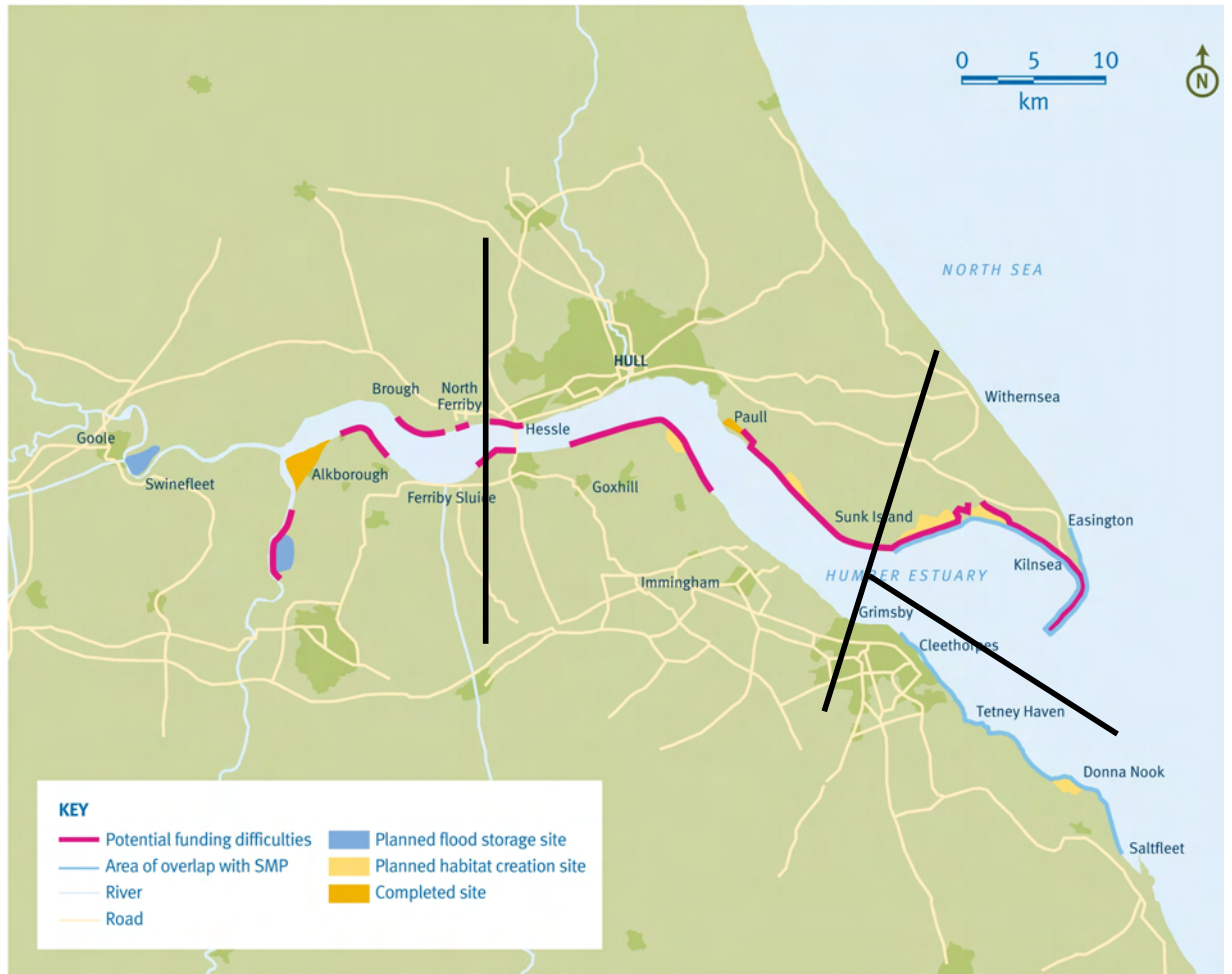
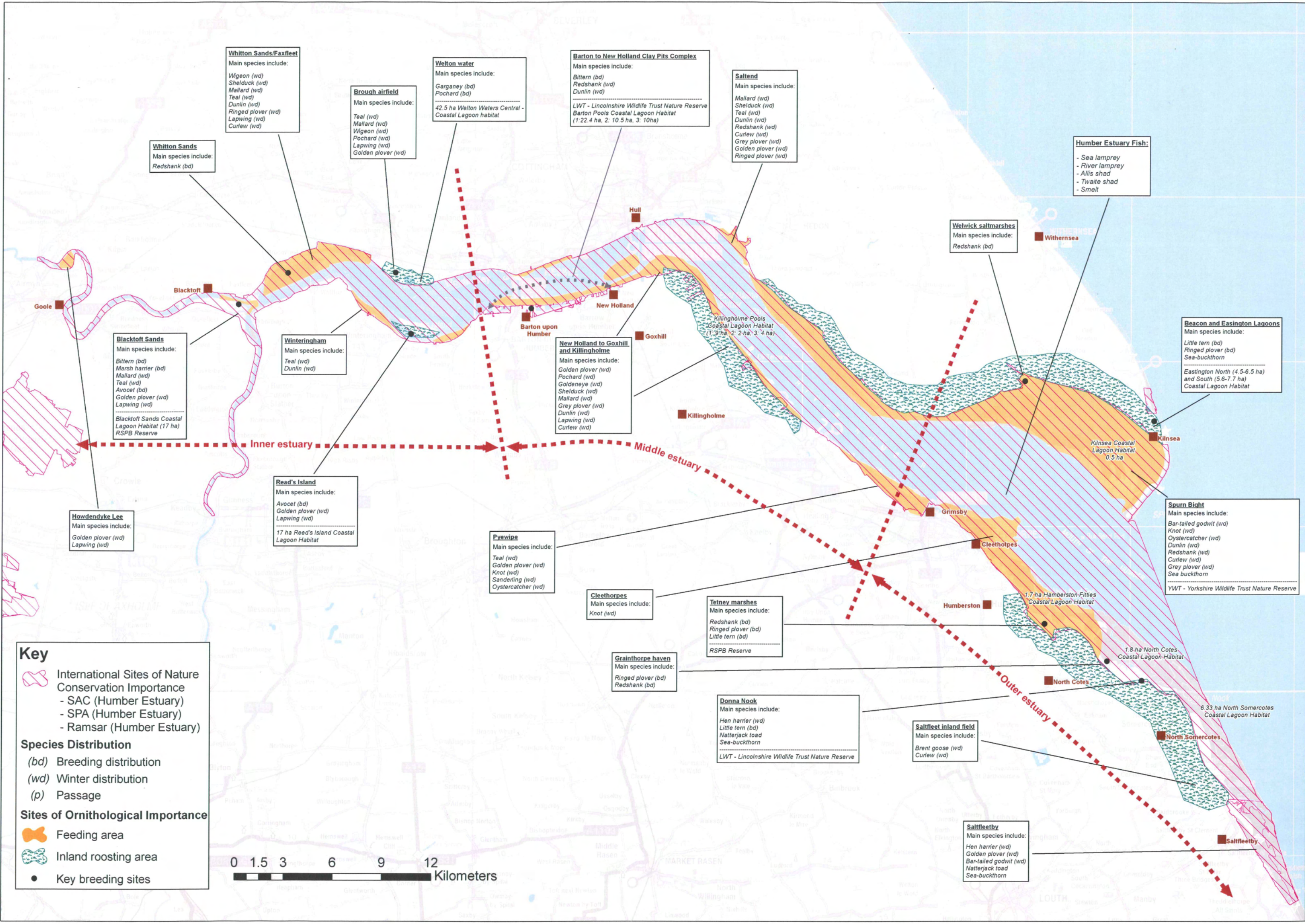


Figure 3 – Key Nature Conservation Features in the Estuary



Whitton Sands/Faxfleet
Main species include:
Wigeon (wd)
Shelduck (wd)
Mallard (wd)
Teal (wd)
Dunlin (wd)
Ringed plover (wd)
Lapwing (wd)
Curlew (wd)

Whitton Sands
Main species include:
Redshank (bd)

Brough airfield
Main species include:
Teal (wd)
Mallard (wd)
Wigeon (wd)
Pochard (wd)
Lapwing (wd)
Golden plover (wd)

Wellton water
Main species include:
Garganey (bd)
Pochard (bd)
42.5 ha Wellton Waters Central - Coastal Lagoon habitat

Barton to New Holland Clay Pits Complex
Main species include:
Bittern (bd)
Redshank (wd)
Dunlin (wd)
LWT - Lincolnshire Wildlife Trust Nature Reserve
Barton Pools Coastal Lagoon Habitat
(1.22.4 ha, 2. 10.5 ha, 3. 10ha)

Saltend
Main species include:
Mallard (wd)
Shelduck (wd)
Teal (wd)
Dunlin (wd)
Redshank (wd)
Curlew (wd)
Grey plover (wd)
Golden plover (wd)
Ringed plover (wd)

Humber Estuary Fish:
- Sea lamprey
- River lamprey
- Allis shad
- Twait shad
- Smelt

Welwick saltmarshes
Main species include:
Redshank (bd)

Beacon and Easington Lagoons
Main species include:
Little tern (bd)
Ringed plover (bd)
Sea-buckthorn
Easington North (4.5-6.5 ha) and South (5.6-7.7 ha) Coastal Lagoon Habitat

New Holland to Goxhill and Killingholme
Main species include:
Golden plover (wd)
Pochard (wd)
Goldeneye (wd)
Shelduck (wd)
Mallard (wd)
Grey plover (wd)
Dunlin (wd)
Lapwing (wd)
Curlew (wd)

Killingholme Pools
Coastal Lagoon Habitat
(1.9 ha, 2. 2 ha, 3. 4 ha)

Kilnsea Coastal Lagoon Habitat
0.5 ha

Blacktoft Sands
Main species include:
Bittern (bd)
Marsh harrier (bd)
Mallard (wd)
Teal (wd)
Avocet (bd)
Golden plover (wd)
Lapwing (wd)
Blacktoft Sands Coastal Lagoon Habitat (17 ha) RSPB Reserve

Winterringham
Main species include:
Teal (wd)
Dunlin (wd)

Read's Island
Main species include:
Avocet (bd)
Golden plover (wd)
Lapwing (wd)
17 ha Read's Island Coastal Lagoon Habitat

Howdendyke Lee
Main species include:
Golden plover (wd)
Lapwing (wd)

Pvewipe
Main species include:
Teal (wd)
Golden plover (wd)
Knot (wd)
Sanderling (wd)
Oystercatcher (wd)

Cleethorpes
Main species include:
Knot (wd)

Tetney marshes
Main species include:
Redshank (bd)
Ringed plover (bd)
Little tern (bd)
RSPB Reserve

Grainthorpe haven
Main species include:
Ringed plover (bd)
Redshank (bd)

Donna Nook
Main species include:
Hen harrier (wd)
Little tern (bd)
Natterjack toad
Sea-buckthorn
LWT - Lincolnshire Wildlife Trust Nature Reserve

Saltfleet inland field
Main species include:
Brent goose (wd)
Curlew (wd)

Spurn Bight
Main species include:
Bar-tailed godwit (wd)
Knot (wd)
Oystercatcher (wd)
Dunlin (wd)
Redshank (wd)
Curlew (wd)
Grey plover (wd)
Sea buckthorn
YWT - Yorkshire Wildlife Trust Nature Reserve

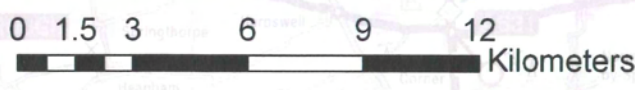
1.7 ha Hamberston Fittes
Coastal Lagoon Habitat

1.8 ha North Cotes
Coastal Lagoon Habitat

6.33 ha North Somercotes
Coastal Lagoon Habitat

Key

- International Sites of Nature Conservation Importance
 - SAC (Humber Estuary)
 - SPA (Humber Estuary)
 - Ramsar (Humber Estuary)
- Species Distribution**
 - (bd) Breeding distribution
 - (wd) Winter distribution
 - (p) Passage
- Sites of Ornithological Importance**
 - Feeding area
 - Inland roosting area
 - Key breeding sites



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APPENDIX A

**Humber Flood Risk Management Strategy
Habitats Regulation Assessment – Volume 2**

enhancing... improving... cleaning... restoring...
changing... tackling... protecting... reducing...
create a better place... influencing... inspiring...
advising... managing... adapting...

Humber Flood Risk Management Strategy Habitats Regulations Assessment Volume Two (Stage Four): Statement of Case

28th February 2011 - FINAL

We are The Environment Agency. It's our job to look after your environment and make it **a better place** - for you, and for future generations.

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Out there, making your environment a better place.

Published by:

Environment Agency
Rio House
Waterside Drive, Aztec West
Almondsbury, Bristol BS32 4UD
Tel: 0870 8506506
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

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Environment Agency

Humber Flood Risk Management Strategy

Habitats Regulations Assessment

Volume Two (Stage Four)

Contents Amendment Record

This report has been issued and amended as follows:

Issue	Rev	Description	Date	Signed Author/ Reviewer
6	0	Amended final version following further NEAS comments; separation into two volumes	April 2009	Katie Born / Richard Ashby-Crane
6	1	Draft for consultation, incorporating clarifications of Strategy and outcomes of ongoing consultation with Environment Agency, Defra and Natural England since Dec 2007	Jan 2011	Katie Born / Richard Ashby-Crane
7	0	DRAFT Final	Feb 2011	Katie Born / Richard Ashby-Crane
7	1	DRAFT Final	Feb 2011	Katie Born / Richard Ashby-Crane
7	2	FINAL for consultee comment	22 Feb 2011	Katie Born / Richard Ashby-Crane
7	3	FINAL with Environment Agency sign-off from Phillip Winn (Humber Strategies Manager) and Sue Manson (Technical Specialist Humber Strategies)	28 Feb 2011	Katie Born / Richard Ashby-Crane

Halcrow Group Limited
 Burderop Park Swindon Wiltshire SN4 0QD
 Tel +44 (0)1793 812479 Fax +44 (0)1793 812089
 www.halcrow.com

Project Reference: CEFAXA

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1 Introduction

The Environment Agency has responsibility for managing flood risk within the Humber Estuary. The Humber Flood Risk Management (FRM) Strategy¹ which was adopted in March 2008, hereafter called ‘the Strategy’, describes how flood risk will be managed in the estuary for the next 100 years. The Humber Estuary is of international importance for nature conservation. This is reflected in its European or Natura 2000 site designations as a Special Protection Area (SPA) and Special Area of Conservation (SAC), and international designation as a Ramsar Site.

The context and purpose of the Habitat Regulations Assessment (HRA) of the first 50 years of the Strategy is provided in Volume One, which records HRA Stages One to Three. Following the conclusions of Stages One to Three, this second Volume records the findings of the final HRA stage: Stage Four. Stage Four is the ‘Statement of Case’ and involves an examination of alternatives, imperative reasons of overriding public interest and any necessary compensation measures. It should be read in conjunction with Volume One of the HRA and with the Strategy.

The findings of the Stage Four assessment of the 50 year Strategy are discussed in Section 2. The information is summarised using the Environment Agency Appendix 20 form for the Humber Estuary SAC, SPA and Ramsar site separately in Section 3, to inform the Secretary of State (SoS)/Defra according to Regulations 49(5) and 52(2) of the Habitats Regulations. The 50 year ‘balance sheet’ of proposed compensatory measures set out in the Strategy over the next 50 years is given in Appendix B.

The final section of this volume (Section 4) presents the conclusions of all four HRA stages (Stages One to Four) in both volumes and a proposed way forward for the approvals process.

¹ Humber Flood Risk Management Strategy March 2008, Environment Agency (2008)

2 Findings of the Assessment: Stage Four

2.1 *Key Conclusions of Stage 3 ‘Appropriate Assessment’*

Based on the assessment carried out at Stage 3 it was concluded that:

- The 50 year Strategy represents the best environmental option for meeting the long-term needs of the European Sites, whilst delivering the objectives of affordable flood risk management.
- Nevertheless there will be significant intertidal habitat loss throughout the estuary as a result of coastal squeeze from a hold the line policy as well as some smaller, more localised, losses from the direct impacts of flood risk management projects and from the cross-estuary impacts they promote.
- **Therefore, the Strategy does represent ‘adverse effect on the integrity’ of the Humber Estuary SAC, SPA and Ramsar Site.**

2.2 *Scope of Stage 4*

As the Appropriate Assessment cannot find that the proposed Strategy will not have an adverse effect on the integrity of the European Site, the Strategy can only be adopted if Defra, acting on behalf of the SoS, is satisfied as regards all three of the following:

1. there are no available alternative solutions, and
2. there are imperative reasons of overriding public interest (IROPI); and
3. that compensatory measures (e.g. compensatory habitat creation) are secured to ensure that the overall coherence of the European Site is protected.

The following sections present information to inform Defra, acting on behalf of the SoS, in their consideration of the plan approval.

2.3 *Consideration of the Alternative Options*

The review of options in the Strategy-making process was driven by the Environment Agency’s corporate objective to protect and enhance European Sites and the Strategy’s specific objectives, which are summarised below:

Humber FRM Strategy Overall Objectives
To manage flood risk around the Humber Estuary in ways that are sustainable, taking into account:- <ul style="list-style-type: none">- natural estuary processes; and- future changes in the environment (human, built or natural), in sea levels or in the climate. To ensure that all proposals are:- <ul style="list-style-type: none">- technically feasible;- economically viable;- environmentally appropriate; and- socially beneficial.

2.3.1

Strategic Alternatives

The Strategy's alternative options are discussed in the Strategy and the accompanying Strategic Environmental Assessment (SEA) in detail, and are summarised below:

(a) *'do nothing' option:*

This option represents the likely evolution of the environment in the absence of the Strategy i.e. without defence raising or maintenance in future. Strategic implementation of this option would, in time, result in full inundation of the floodplain, requiring the relocation of approximately 400,000 people as well as industry, port facilities and the infrastructure on which both local economies and a substantial part of the national economy is based. As a 'strategic' option this was discounted on social and economic grounds.

(b) *'do minimum/business as usual' option:*

This option represents the scenario where future work or maintenance to defences continues in a 'non-strategic' manner with the need for work being determined by visible damage and emergency failures etc. This approach could result in the promotion of inappropriate schemes, developed in isolation that could lead to adverse impacts on the estuary's processes and on the European Sites. This approach could also lead to an increase in the frequency of life-threatening breaches and sub-optimal use of funding through 'fire fighting'. Compensation and mitigation for impacts on the designated site would also be 'piece-meal' and would lack the security and benefits of an integrated programme, especially with regard to meeting the needs of coastal squeeze losses. The future of the designated site would therefore be less secure. As a 'strategic' option this was discounted on environmental, social and economic grounds

(c) *'do something' option:*

This is the preferred 'strategic' option which comprises a suite of approaches that have been combined to meet the environmental and social and economic needs of the estuary and the livelihoods it supports, within the constraints of available funding. The preferred 'strategic' option comprises elements of the following:

- 'hold the line' i.e. maintain or improve existing defences, where this is economically justified;
- managed realignment to provide both flood risk management solutions and to provide a package of compensatory habitat creation;
- strategic withdrawal of maintenance in locations where, and when, the case for financial investment can no longer be made; and
- facilitation of flood storage (generally through controlled overtopping of defences) in the future to reduce the flood/surge impacts on densely inhabited areas.

The overall approach of the Strategy within the context of this preferred option is to 'hold the line' where justifiable but to consider managed realignment where this provides strategic habitat creation/water level management benefits or is justified locally through consideration of costs and other issues. It also includes maintenance, inspection and monitoring. The

capital works are programmed according to 'priority' (as defined using a standard Defra methodology: FCDPAG3) based on the existing condition, existing standard of protection, probability of failure and economic (or other) justification.

During the option appraisal presented in the Detailed Appraisal Reports (Appended to the Strategy), the preferred option was selected to best meet a combination of social, economic, technical and environmental criteria. Where 'hold the line' schemes were preferred for social/economic reasons, and there was no opportunity for realignment, then the 'outline' designs have attempted to reduce any adverse impact on the designated site. For instance, increases in defence footprint were minimised and where widening was required this was designed on the landward side of the defence rather than the seaward side, where possible. During detailed design, attempts will be made to reduce impacts on the designated site even further.

Where, and when, holding the line (by maintenance or improvement) or managed realignment options are not justifiable in economic terms, a strategic withdrawal of maintenance is proposed in conjunction with investigating other ways to protect people and property, such as by building secondary lines of defence and advising people on how to prepare for flooding. This would not preclude third parties from continuing to maintain or improve defences. In many areas the maintenance will not become uneconomic for perhaps 30 years, in others it will be sooner but current assessment indicates it is unlikely to be less than 10 years hence. However our assessment of coastal squeeze habitat losses is based on a worst case scenario with respect to 'holding the line' throughout the estuary (although statistics for coastal squeeze losses are based on mean predictions not worst case). In this worst case scenario the current defence line is held over the 50 year life of the Strategy, whether by the Environment Agency or by third parties.

It should be noted that maintenance approach will result in a gradual reduction in the 'standard of protection' due to the anticipated rise in sea levels. Environment Agency or third party work to maintain defences under the Strategy may, like any project, still require HRA to show that impacts are not greater than those assumed within the Strategy approval. The compensatory habitat requirement for coastal squeeze losses associated with Environment Agency or third party works to maintain defence will be met by the compensatory habitat creation programme identified in the Strategy (and underpinned by the regional habitat creation programmes for the EA Anglian, North East and Midlands regions..

Environment Agency or third party works to improve defences may also require HRA especially in consideration of any impacts that are additional to those assumed for the 'hold the line through maintenance' approach provided by the Strategy. If the improvement works are consented then compensation for coastal squeeze impacts would be covered by the Strategy's habitat creation programme but additional footprint or other impacts would not.

2.3.2 *Alternative Sites for Managed Realignment*

The managed realignment schemes proposed within the Strategy meet the primary purpose of compensating for intertidal habitat that will be lost (largely through the effect of coastal

squeeze) over the 50 year life of the Strategy. This compensatory habitat package has been designed to ensure that the integrity of the designated site is maintained. However some of the proposed (and completed) managed realignment sites also contribute to provision of flood storage that will help manage water levels during serious floods, and the embankments that are built at the 'back' of sites can be designed to deliver long-term defence improvements.

The package of realignment schemes in the current Strategy represent the most feasible options for significant habitat creation, based on technical, environmental/social and value for money criteria, whilst attempting to meet the aim to replace inner, middle and outer estuary losses in appropriate locations within the estuary. The sites were selected after an initial review of more than 25 potential locations. Additional realignment schemes will continue to be sought as opportunities arise and smaller scale less strategic realignments will be promoted where opportunities arise in the delivery of hold the line and maintenance schemes.

The intertidal habitat gains and losses will occur at different locations throughout the European Site and at different periods over the life of the Strategy. However, the programme of works within the Strategy aims to ensure that as far as is possible, the net balance of habitat loss/gain is always positive. The ongoing monitoring (as described in the Review of Monitoring and Maintenance² and summarised in the SEA Report³) of 'actual' habitat gains/losses and subsequent updating of the 'balance sheet' will be used to demonstrate this is occurring as predicted. The 3:1 habitat replacement ratio quoted in the CHaMP for direct habitat losses from flood defence works inherently makes an allowance for delay in development of the quality of the replacement habitat. The managed realignment schemes and overall habitat losses and gains within the 50 year Strategy are described further in Section 2.5 of this report.

2.3.3 *Summary of 'No Alternatives' Argument*

In conclusion it is considered that:

- there are **no alternative options** for meeting the objectives of the Humber FRM Strategy and in particular for:
 - maintaining the integrity of the Humber SAC, SPA and Ramsar site in the face of sea level rise and resultant coastal squeeze losses from Strategy implementation;
 - providing affordable, sustainable and effective flood risk management for people, houses, commercial properties and infrastructure located within the floodplain.

² Humber Estuary Flood Defence Strategy: Strategy Development Study; Review of Monitoring and Maintenance, Environment Agency (2005)

³ Strategic Environmental Assessment of the Draft Humber Flood Risk Management Strategy, Environment Agency (2005)

- the preferred option represents the best environmental/social option for long-term management of flood risk in the Humber Estuary.

2.4 *Consideration of IROPI*

Currently about 115,000 ha of land around the Humber is at risk of being flooded by a storm surge in the North Sea. This area contains the homes of about 400,000 people. The majority of inhabitants are in cities such as Hull and Grimsby, but a substantial number live in smaller towns or villages, and the area also contains major industries, including power stations, refineries and the country's largest port complex handling 80 million tonnes of cargo each year. Much of the remaining land, over 85% of the total, is farmed and consequently has relatively few people living on it.

Looking to the future, our climate is changing, causing sea levels to rise and severe storms to occur more often, and our defences are ageing. If they are not maintained and/or improved, they will become less effective and eventually fail. Furthermore, as outlined above, more of the land behind the defences has been developed and more development is planned, so more homes and industry would be affected if flooding occurs.

Therefore, the conclusion of HRA Stage 4 is that the Strategy as described represents **'imperative reasons of overriding public interest' (IROPI)** because:

- 'there is a need to address a serious risk to human health and public safety'
 - the Strategy will help protect nearly 400,000 people from serious flooding (nearly 4,000 residential and commercial properties are already being protected by the completion of the first five-year package of works of the Strategy); and
- 'there is a need to protect infrastructure, facilities and land of regional and national economic importance' including
 - port facilities including those at Hull (the 'gateway to Europe') and Grimsby
 - energy and chemical industry facilities providing significant regional employment
 - versatile, high quality agricultural land (for example much of it is Grade 1 and 2), which is highly significant in terms of food security of the country.

2.5 *Securing Compensatory Measures*

The Strategy and the 50 year 'balance sheet' (Appendix B) set out the Environment Agency's proposed compensatory measures over the next 50 years. These measures are based on the following commitments:

- to replace any direct loss of intertidal habitat from the works, based on a 3:1 ratio, unless otherwise agreed;
- to replace any intertidal habitat temporarily disturbed by the works, based on a 1:1 ratio, unless otherwise agreed;
- to replace any intertidal habitat lost to coastal squeeze, based on a 1:1 ratio, unless otherwise agreed;

- to create compensatory habitat of a similar character and ecological function to that being lost, and if at all possible, in the same part of the Estuary (inner, middle or outer north, outer south) in which it has been lost;
- to design and implement a programme of compensatory measures and habitat creation schemes to compensate for the direct losses arising from the Environment Agency flood risk management programme and from coastal squeeze (wherever this occurs on the estuary). We will seek to ensure that overall gains balance losses, and that compensation is secured before losses occur. However,, during the life of the Strategy there may be short periods when the balance is in deficit as a result of circumstances outside our control.
- to address any such deficit once identified, as soon as possible, through managed realignment schemes, and to avoid a build up of such a deficit which would result in further deterioration of the Natura 2000 site. If appropriate the significance of the size and duration of any deficit that arises can be agreed with Natural England in the context of the uncertainty surrounding the prediction of coastal squeeze losses and the natural variation in intertidal area due to the nodal tide cycle.
- to monitor habitat losses and gains over the life of the Strategy, revise the calculations of habitat gains/losses and uncertainty (by updating the ‘balance sheet’) with the latest monitoring information at least every five years through the Environment Agency’s managed realignment (and habitat creation) programme and Strategy reviews and adjust the programme accordingly.

The current programme of habitat creation schemes, identified within the Strategy to meet the compensatory habitat needs under the Habitats Regulations, is summarised in Table 2.1.

Table 2.1 50 year Strategy managed realignment schemes, and overall habitat gains and losses.

50 year Strategy (2007-2057)				
Managed realignment schemes / Habitat Creation Package				
Flood Cell	Location	Estuary location	Proposed completion	Intertidal habitat created (ha)
4	Paull Holme Strays*	Middle	completed 2003	80
16	Alkborough Flats	Inner	completed 2006	172
27	Donna Nook	Outer	2012-16	110
2	Skeffling	Outer	2012-16	150
17	Whitton / Reeds Island	Inner	2017-21	20
22	Goxhill*	Middle	2022-26	176
3	Sunk Island / Welwick	Outer	2032-36	321
Total				1029
<p><i>*At Goxhill we have identified potential intertidal habitat creation of 176ha, but we acknowledge that there is a possibility that the scheme may require additional mitigation or compensation for areas of high tide roost landward of the defence, in order to achieve this. These details will be agreed with Natural England as the scheme is investigated and designed.</i></p>				

Further details of these habitat creation schemes and the risks associated with their delivery are provided in Appendix C: The Role of the Regional Habitat Creation Programme in Compliance of the Humber Strategy with the Habitats Regulations.

The main purpose of the suite of habitat creation schemes is to compensate for the adverse effects resulting from the Strategy. However, in some cases these schemes also provide flood risk management benefits through storage and reduction in water levels during peak/surge tides, with the embankments built at the 'back' of sites designed to deliver long-term defence improvements. These schemes are important for maintaining the cohesion of the designated site, but they are also integral to the Strategy as without them maintenance or improvement of local defences / defence standards might not be possible (for instance at Paul Holme Strays and Skeffling).

The habitat loss / replacement balance sheet (Appendix B) shows details of the predicted losses from coastal squeeze, flood risk management scheme footprint and maintenance works. It can be seen from the 95% confidence intervals that there is considerable uncertainty around the 'mean' figures resulting from coastal squeeze and estuary evolution. The Environment Agency will continue to monitor actual losses and sea level rise to improve predictions over time. We will also review the habitat creation programme on a five yearly basis to confirm that it is meeting the habitat replacement requirements or to adjust as necessary in consultation with Natural England.

The following provides a summary of replacement needs over the 50 years of the Strategy:

- **Inner Estuary** – predictions show that even in the face of sea level rise the intertidal area will increase by 330ha over 50 years, due to evolutionary processes within the estuary. There are some direct habitat losses through improvement works and maintenance but replacement of these habitats is easily met by the managed realignment scheme at Alkborough, which has provided approximately 170ha of new intertidal habitat.
- **Middle Estuary** – predictions of coastal squeeze loss in this location have increased markedly following recently revised calculations (as part of the CHaMP review (unpublished 2010)). The requirement for habitat replacement in the middle estuary is now calculated as c.625ha over the 50 year Strategy life. The Paul Holme Strays managed realignment scheme has already contributed c. 80ha of replacement habitat but given the current rate of loss this part of the estuary will soon go into deficit. We have plans for another middle estuary realignment at Goxhill⁴ (c. 176ha). This is unlikely to be delivered until after 2022, but we will deliver the project sooner than that if it proves to be possible to do so. We will continue to look for other opportunities to progress realignment schemes elsewhere in the middle part of the estuary. As there are no

⁴ We recognise that there are areas of high tide roost at Goxhill which are part of the SPA and that if realignment causes damage to or the loss of this area then scheme specific mitigation (and if there are no alternatives, compensation) may need to be delivered. There are no other suitable middle estuary realignment sites that are readily deliverable, although we will continue to seek opportunities to strengthen the habitat creation programme or to create additional benefit through smaller non-strategic realignment schemes.

immediate opportunities to progress ‘middle’ sites however, we propose to provide compensatory habitat through sites at Skeffling (c. 150ha) and Welwick/Sunk Island (up to c. 321ha) where the Environment Agency has some land ownership and has been discussing realignment with relevant organisations and interested parties. These sites are toward the western / middle estuary end of the outer estuary zone and thus far, reviews of habitat/community information (sediments, invertebrates and birds) indicate that this area could provide appropriate habitat replacement for middle estuary losses (see Appendix D for further details). However we understand that there are risks associated with this approach and we intend to manage these by:

- Working with Natural England, and others as appropriate to ensure that the Skeffling managed realignment site incorporates specific measures/features designed in such a way as to best meet the functional needs of the birds displaced by coastal squeeze in the middle estuary. The measures/features incorporated will be based on an understanding of the ecology of the birds as agreed with Natural England.
 - Clear objectives will be set for the Skeffling site that reflect, the functional needs of the birds displaced from the middle estuary, and an agreed vision of habitat that meets the agreed compensatory needs.
 - A comprehensive monitoring package for Skeffling will be with Natural England and used to assess whether the site is meeting the objectives set.
 - Monitoring information will be reviewed regularly (as a minimum at the time of the 5-yearly strategy review) to inform the need for management intervention at Skeffling and/or the need to identify new sites to be added to the habitat creation programme.
 - Information from monitoring the implementation and success, or otherwise, of Skeffling will be used to confirm whether further sites at Welwick/Sunk Island, currently identified as ‘middle estuary’ compensation, will be capable of meeting the relevant functional needs. If this is not the case then new sites will be identified within the revised habitat creation programme. Note: It is intended that the middle estuary realignment at Goxhill will be progressed before sites at Welwick/Sunk Island.
- **Outer Estuary** – predictions show that the intertidal habitat area will increase on the north bank of the outer estuary, whilst on the south bank habitat replacement requirements are c. 185ha. We intend to meet these replacement needs through a managed realignment scheme at Donna Nook, which will create c. 110ha and through a further (no decisions have been made on this) site in the Outer (S). The Donna Nook scheme was initially refused planning permission but the Environment Agency intends to appeal this decision

Table 2.2 below provides a summary of the balance between the replacement needs of the Strategy and the habitat created through the habitat creation programme.

Table 2.2 Summary of Habitat Compensation Requirements, Habitat Creation Programme and Balance over the 50 year Strategy

Estuary Sector	Compensation Requirement (ha) (expressed as habitat changes)*	Habitat Creation Programme (ha)	Balance (ha)	Balance after Compensation Reallocation (ha)	Comments
Inner	250	192	442	442	In the inner estuary we are currently predicting that the Strategy will provide significant environmental benefit to the Estuary and the SAC/SPA/Ramsar site in terms of increased intertidal habitat.
Middle	- 625	256	- 369	102	Paull Holme Strays and Goxhill provide insufficient habitat creation to meet the current prediction for losses. The deficit created can (at this time) only be met by creation of appropriate intertidal habitat in the inner part of the Outer (N) sector where we have significant habitat creation opportunities (e.g. Welwick and Skeffling). Management of the risks associated with this is discussed on page 9.
Outer (N)	44	471	515	44	Here we are predicting a significant habitat gain which we propose is used to contribute to meeting the predicted deficit in the Middle estuary. Surplus habitat would provide further environmental benefit to the estuary in terms of excess habitat provision in the sector.
Outer (S)	-185	110	-75	-75	We currently have only a single habitat creation site (Donna Nook) in the Outer (S) sector of the estuary and will need to identify a further site for delivery post 2020-30 when a deficit in this sector is predicted. This will be addressed in the next Strategy review.
Whole Estuary	- 516	1029	513	513	After 50 years our overall habitat loss/creation balance will leave the Estuary c. 500 ha better off than required by compensation under the Habitats Regulations. This is considered a significant environmental benefit from the Strategy
<p>*Compensation Requirement: this is a summary of the losses/gains from predicting coastal squeeze (including changes in morphology through estuary evolution) combined with direct scheme footprint losses and allowances for temporary disturbance multiplied by agreed replacement ratios.</p> <p>Timing of losses and habitat creation are shown over the life of the Strategy in the tables in Appendix B.</p>					

Ideally we would create all habitat within the zones of loss, however this is unlikely to be deliverable so we have designed a programme that is both realistic and effective, and that provides the best achievable outcomes, in the context of the considerable uncertainty surrounding the coastal squeeze loss figures.

The results of monitoring at the Paull Holme Strays and Alkborough Flats schemes show that high quality replacement habitat can be delivered through managed realignment within the estuary. There is a presumption that the new habitats will eventually become included within the European and International Site boundary when they are of sufficient quality and there is sufficient monitoring data to support this.

We recognise that there are concerns regarding the ability of Outer (N) habitat creation sites such as Skeffling and Welwick to create adequate compensatory habitat for losses within the Middle Estuary. However we believe that we can work with a range of stakeholders to create sites with appropriate character and ecological function, especially given our proven success at Paull Holme Strays and Alkborough, and the tendency for realignment areas to reflect the more sheltered habitats generally found further upstream. We will agree objectives for the compensatory habitat sites with Natural England, monitor the results and review the scheme designs, the Strategy and our package of habitat creation measures accordingly.

Therefore these compensatory measures are considered to maintain the coherence of the European Sites.

3 Appendix 20 Form

Humber Estuary SAC, SPA and Ramsar Site



Environment
Agency
Asiantaeth yr
Amgylchedd

Habitats Directive

Information to the Secretary of State according to Regulations 62(5) and 64(2) of the Habitats Regulations

Purpose: This document provides a framework and proforma for the provision of information to the Secretary of State for cases of Overriding Public Interest under the Habitats Regulations.

Scope: This document provides a format for Environment Agency staff to use when providing information to the Secretary of State over cases of OPI under the Habitats Directive.

A: ADMINISTRATION

B: SITE DETAILS

C: SUMMARY OF THE PLAN OR PROJECT HAVING AN EFFECT ON THE SITE

D: SUMMARY OF THE ASSESSMENT OF THE NEGATIVE EFFECTS ON THE SITE

E: MODIFICATIONS CONSIDERED

F: ALTERNATIVE SOLUTIONS CONSIDERED

G: IMPERATIVE REASONS

H: COMPENSATION MEASURES

I: SUPPORTING DOCUMENTATION

A: Administration details

Date:
Plan Reference:
Contact person: (Area HD Project Executive)
Address:
Tel:
Fax:
E-mail:

B: Site details

Name of European site affected: Humber Estuary
This site is:
<input checked="" type="checkbox"/> a designated Special Area of Conservation (SAC)
<input type="checkbox"/> a candidate SAC under the Habitats Directive
<input checked="" type="checkbox"/> a classified Special Protection Area (SPA)
<input type="checkbox"/> a proposed SPA under the Birds Directive
<input checked="" type="checkbox"/> a Ramsar hosting a priority habitat/species
<input type="checkbox"/> a Site of Community Importance (SCI)

C: Summary of the plan or project having an effect on the site

The Humber Flood Risk Management (FRM) Strategy (Environment Agency 2008), hereafter called 'the Strategy' was developed out of the policies of the Humber Estuary Shoreline Management Plan (HESMP) produced by the Environment Agency in 2000, and further studies on the estuarine habitats and sea level change predictions. The study area is shown in Figure 1 of Volume 1.

The Strategy describes a strategic approach to flood risk management within the Humber Estuary for the next 100 years. The aim is to provide an integrated and consistent approach to the provision of defence standards within the estuary and to take into consideration that individual schemes in isolation may have an adverse effect on the nature conservation interests of the Humber Estuary and the European site designations. The first 25 years of the Strategy was approved by Defra in March 2008, and it will be revised, as appropriate, through a rolling programme of reviews.

The Strategy presents proposals for 'hold the line' flood defence works, flood storage options through managed realignment schemes, habitat creation and creation of temporary washlands, capital works maintenance of existing defences, and also indicates that in the future there will be problems justifying investment in certain areas and the Environment Agency will withdraw maintenance from these as they become uneconomic.

The Strategy estimates the quantity of habitat to be gained and lost during the implementation of the first 50 years of the Strategy throughout the estuary, and is presented in a 50 year 'balance sheet' in Appendix B. The habitat creation proposed by the Strategy contributes to addressing the intertidal habitat loss associated with coastal squeeze and the direct losses predicted by the CHaMP.

D: Summary of the assessment of the negative effects on the site

A Habitat Regulations Assessment (HRA) has been carried out for the first 50 years of the Humber Estuary Flood Risk Management Strategy. Full details of the HRA are provided in the main text and Appendices C and D (HR01/Appendix 11 and HR02/Appendix 12 forms) of Volume 1 (HRA stages One to Three). A summary of the conclusions is presented below.

a) Loss of Annex I habitats (affecting estuaries, Atlantic salt meadows *Glauco-Puccinellietalia maritimae*; mudflats and sandflats not covered by seawater at low tide; *Salicornia* and other annuals colonising mud or sand; Sandbanks which are slightly covered by sea water all the time and dunes with *Hippophae rhamnoides*) SAC qualifying habitat. Over the 50 years, without the habitat replacement programme, the amount of intertidal habitat lost is estimated to be approximately:

Coastal Squeeze and Estuary Evolution

The effects of coastal squeeze and estuary evolution are such that parts of the estuary will gain intertidal habitat whilst others lose. The balance of this is a net loss of c. 286ha. More specifically the changes predicted over 50 years are:

- c.330 ha gain Inner estuary,
- c.510 ha loss Middle estuary,
- c.168 ha loss Outer South,
- c.62 ha gain Outer North.

Direct FRM Scheme losses

Approximately 58 ha of intertidal habitat will be lost from encroachment of improved defences and maintenance works (c.20 ha Inner, c.34 ha Middle, c.2 ha Outer South and c.2 ha Outer North).

Cross Estuary / Synergistic Effects

35 ha of intertidal habitat loss will be caused by cross-estuarine impacts as a result of the Strategy (c.15 ha Inner, c.10 ha Middle, c.7 ha Outer South, c.3 ha Outer North).

Temporary

Allowance has been made for up to 21 ha of temporary loss or damage to intertidal habitat from works or maintenance activities (c.7 ha Inner, c.3 ha Middle, c.4 ha Outer South, c.7 ha Outer North). Some of these areas are likely to recover within 1 to 2 years given the nature of the accretion/erosion processes with the estuary.

Over the 50 years, the losses of intertidal habitat represent approximately:

- 4% of the total intertidal habitat within the SAC
- 0.6% from the encroachment of defences, maintenance and stoning
- 0.2% from temporary losses
- 3% from coastal squeeze and estuary evolution, and
- 0.3% from cross-estuary impacts.

(n.b. This calculation is based on Natural England's estimate of the present area of intertidal habitat: 10,213.62 ha. This comprises areas of intertidal mudflats and sandflats, *Salicornia* and Atlantic Salt Meadow communities from various datasets used by Natural England in supporting information for Humber Estuary SAC designation, September 2009.)

Section H describes the proposed managed realignment schemes which are integral to the Strategy and provide replacement compensatory habitat.

b) Reduction in condition of Annex I habitats due to changes in coastal processes and changes in flow and velocity regime at the managed realignment or washlands schemes (affecting estuaries; Atlantic salt meadows *Glauco-Puccinellietalia maritima*; mudflats and sandflats not covered by seawater at low tide; *Salicornia* and other annuals colonising mud or sand; Sandbanks which are slightly covered by sea water all the time; and dunes with *Hippophae rhamnoides*, SAC qualifying habitat).

c) Loss of coastal, estuarine & intertidal, submerged marine and high tide roost habitats or reduction in condition of habitats due to changes in coastal processes and changes in flow and velocity regime affecting SPA qualifying species or Ramsar criterion. Over the 50 years, without the habitat creation programme, coastal habitats, estuarine & intertidal habitats, submerged marine habitats and high tide roosts thought to be potentially important for wintering or foraging birds are likely to be lost. Details of the loss of and changes to these habitats are described in (a) and (b) above. The loss and changes to these habitats are anticipated to adversely affect:

(i) SPA qualifying species (article 4.1) regularly used by 1% or more of the GB populations of

- Bittern *Botaurus stellaris* (wintering & breeding)
- Hen harrier *Circus cyaneus* (wintering)
- Marsh harrier *Circus aeruginosus* (breeding)
- Avocet *Recurvirostra avosetta* (wintering & breeding)
- Golden plover *Pluvialis apricaria* (wintering) (R)
- Bar-tailed godwit *Limosa lapponica* (wintering) (R)
- Ruff *Philomachus pugnax* (passage) (R)
- Little tern *Sterna albifrons* (breeding)

(ii) SPA qualifying species (article 4.2) regularly used by 1% or more of population of the following migratory species

- Shelduck *Tadorna tadorna* (wintering) (R)
- Knot *Calidris canutus* (wintering & passage) (R)
- Dunlin *Calidris alpina* (wintering & passage) (R)
- Black-tailed godwit *Limosa limosa* (wintering & passage) (R)
- Redshank *Tringa tetanus* (wintering & passage) (R)

(iii) other SPA qualifying features

- Used regularly by over 20,000 waterbirds

(iv) Ramsar Site criterion

- Criterion 1 – near natural estuary with dune systems, humid dune slacks, estuarine waters, intertidal mud and sand flats, saltmarshes and coastal brackish/saline lagoons (as with similar SAC features); and
- Criterion 5 and 6 - bird species listed (R) under SPA features in the SPA Form 20 above.

d) potential cumulative impacts on Annex I habitats with other projects, plans and policies. The impacts of this Strategy have been considered in combination with the impacts of the Humber Estuary Coastal Authorities Group Flamborough Head to Gibraltar Point Shoreline Management Plan (SMP) throughout, as their policies and activities are the same for the outer parts of the estuary which are covered by both. The assessment that has been

undertaken concludes adverse effect on the Humber Estuary SAC due to the in-combination effects of all the policies within these two documents.

There are, however, additional projects and plans that will be delivered by other parties. Although it is not possible to predict the proposals for projects, plans or policies in the longer term within and around this large estuary, there is potential for their effects to act in combination with the Strategy in additive ways if they result in intertidal habitat loss (SAC habitat). However, they will be subject to their own Habitats Regulations Assessment, and the list of proposals will be updated and the 'in-combination' assessment will be re-visited every time the Strategy and Habitat Regulations Assessment is revised.

E: Modifications or restrictions considered

Measures to avoid and minimise potentially adverse environmental impacts on the Humber Estuary SAC, SPA and Ramsar site are integral to the Strategy's scheme designs. Individual schemes will be designed to incorporate standard mitigation and the construction phase will follow good site practices to minimise any potential adverse effects of hazards. The aim will be for an assessment result of No Likely Significant Effects on the designated site, with Natural England's agreement. Measures to achieve this will be described in the individual scheme-specific Habitat Regulations Assessments. Examples of typical mitigation measures are:

- minimising the extent of working areas through restricting access (especially seaward of the flood banks) and adopting the most appropriate design to prevent damage of habitats outside the temporary working areas (which will be recorded under temporary habitat loss);
- following Environment Agency Pollution Prevention Guidelines (PPGs) to safeguard aquatic flora and fauna within and adjacent to the construction sites;
- incorporating measures to minimise works with the potential for significant disturbance to SAC and SPA species during sensitive times in agreement with Natural England;
- progressive implementation of managed realignment schemes to reduce the potential combined effects of scouring resulting from sudden changes in water flow and geomorphology.

However, in some cases, the modifications of the Strategy's flood risk management activities cannot fully avoid or mitigate some of the likely residual adverse impacts from the potential hazards. Consequently, these are considered likely to have an adverse effect on the integrity of the interest features of the SAC. These are summarised in the table overleaf.

Hazards	Residual Adverse Impacts on Integrity of the Site
<p><u>Habitat loss and physical damage:</u> Habitat may be affected by works:</p> <ul style="list-style-type: none"> - at the seaward toe of some defences - within parts of the designated sites landward of the existing defence, - to areas outside the designated sites but which help to support the integrity of the site. <p>Losses may also occur through coastal squeeze and cross-estuary impacts, and through maintenance of capital works outwith the ongoing maintenance programme. The net loss of intertidal habitat caused by coastal squeeze and cross-estuary impacts resulting from the 50 year Strategy is estimated to be approximately 286 ha and 35 ha respectively. The intertidal habitat loss caused directly by the works, stoning and maintenance proposed in the 50 year Strategy permanently is estimated to be c. 58 ha (and 21 ha temporary).</p>	<p>Much of the Strategy includes work within the footprint of the existing defences that do not support interest feature habitats (e.g. mown grass banks, concrete revetment) and some mitigation measures and more detailed design may reduce the temporary and permanent footprint from that identified in the current Strategy.</p> <p>However, it is not possible to fully avoid or mitigate the habitat losses resulting in residual adverse impacts on the integrity of the European sites due to the works and coastal squeeze and cross-estuary impacts resulting from the 50 year Strategy. Intertidal habitat will therefore be created through managed realignment to compensate for the losses in intertidal habitat (see Section H).</p>
<p><u>Changes in physical regime and changes to flow & velocity regime, & improved drainage:</u> Existing modelling has shown that the 'hold the line' works, even where they require minor encroachment at the toe of the existing defence, have no significant effect on estuary morphology, erosion and deposition.</p> <p>However, there is more uncertainty associated with the potential effects of the larger managed realignment schemes and flood storage schemes with regard to effects on morphology, erosion and deposition. Development of existing managed realignments at Paull Holme Strays and Alkborough has shown that these potential effects can be modelled and that realignment sites can be developed in such a way as to not cause adverse morphological effects. However there still remains some uncertainty.</p>	<p>Potentially adverse residual impacts may not be avoidable at large managed realignment schemes. However the suite of managed realignment schemes is integral to the delivery of the 50 year Strategy as the best environmental option for long-term flood risk management in the Estuary.</p> <p>We will carry out similar modelling and developmental studies to those carried out at Alkborough and Paull Holme Strays to understand and mitigate, where possible, the adverse morphological effects from such schemes in the future. We monitor 'actual' habitat losses at the larger managed realignment sites and will continue to review these at 5-yearly intervals (minimum). We will use this information to revise the Strategy, if necessary, to ensure, wherever possible, no net loss in habitat due to flood risk management activities and coastal squeeze.</p>

F: Alternative solutions considered

Strategic Alternatives

The Strategy's alternative options are discussed in the Strategy and the accompanying SEA in detail, and are summarised below:

(a) 'do nothing' option:

This option represents the likely evolution of the environment in the absence of the Strategy i.e. without defence raising or maintenance in future. Strategic implementation of this option would, in time, result in full inundation of the floodplain, requiring the relocation of c.400,000 people as well as industry, port facilities and the infrastructure on which both local economies and a substantial part of the national economy is based. As a 'strategic' option this was discounted on social and economic grounds.

(b) 'do minimum/business as usual' option:

This option represents the scenario where future work or maintenance to defences continues in a 'non-strategic' manner with the need for work being determined by visible damage and emergency failures etc. This approach could result in the promotion of inappropriate schemes, developed in isolation that could lead to adverse impacts on the estuary's processes and on the European sites. This approach could also lead to an increase in the frequency of life-threatening breaches and sub-optimal use of funding through 'fire fighting'. Compensation and mitigation for impacts on the European sites would also be 'piece-meal' and would lack the security and benefits of an integrated programme, especially with regard to meeting the needs of coastal squeeze losses. The future of the European sites would therefore be less secure. As a 'strategic' option this was discounted on environmental, social and economic grounds

(c) 'do something' option:

This is the preferred 'strategic' option which comprises a suite of approaches that have been combined to meet the environmental and social and economic needs of the estuary and the livelihoods it supports, within the constraints of available funding. The preferred 'strategic' option comprises elements of the following:

- 'hold the line' i.e. maintain or improve existing defences, where this is economically justified;
- managed realignment to provide both flood risk management solutions and to provide a package of compensatory habitat creation;
- strategic withdrawal of maintenance in locations where, and when, the case for financial investment can no longer be made;
- facilitation of flood storage (generally through controlled overtopping of defences) in the future to reduce the flood/surge impacts on more densely inhabited areas.

The overall approach of the Strategy within the context of this preferred option is to 'hold the line' where justifiable but to consider managed realignment where this provides strategic habitat creation/water level management benefits or is justified locally through consideration of costs and other issues. It also includes maintenance, inspection and monitoring. The capital works are programmed according to 'priority' (as defined using a standard Defra methodology: FCDPAG3) based on the existing condition, existing standard of protection, probability of failure and economic (or other) justification.

During the option appraisal presented in the Detailed Appraisal Reports (Appendix to the Strategy), the preferred option was selected to best meet a combination of social, economic, technical and environmental criteria. Where 'hold the line' schemes were preferred for social/economic reasons, and there was no opportunity for realignment, then the 'outline' designs have attempted to reduce any adverse impact on the European sites. For instance increases in defence footprint were minimised and where widening of the footprint was required, this was designed on the landward side of the defence rather than the seaward, where possible. When detailed design is carried out concerted efforts will be made (and already have been with respect to the first 5 years of schemes) to reduce impacts on the designated site even further.

Where, and when, holding the line (by maintenance or improvement) or managed realignment options are not justifiable, a strategic withdrawal of maintenance may be proposed in conjunction with investigating other ways to protect people and property, such as by building secondary lines of defences and advising people on how to prepare for flooding.

Alternative Sites for Managed Realignment

The managed realignment schemes within the Strategy meet the primary purpose of creating intertidal habitat to help offset losses (largely through the effect of coastal squeeze) over the 50 year life of the Strategy. This compensatory habitat package has been designed to ensure that the coherence of the Humber Estuary SAC, SPA and Ramsar site is maintained. However some of the proposed managed realignment sites also contribute to provision of flood storage that will help manage water levels during serious floods, and the embankments that are built at the 'back' of sites can be designed to deliver long-term defence improvements.

The package of realignment schemes in the current Strategy represent the most feasible options for significant habitat creation, based on technical, environmental/social and value for money criteria, whilst attempting to meet the aim to replace inner, middle and outer estuary habitat losses in appropriate locations within the estuary. The sites were selected after an initial review of more than 25 potential locations. Additional realignment schemes will continue to be sought as opportunities arise and smaller scale less strategic realignments will be promoted where opportunities arise in the delivery of hold the line and maintenance schemes.

The intertidal habitat gains and losses will occur at different locations throughout the Humber Estuary and at different periods over the life of the Strategy. However, the programme of works has been defined to ensure the net balance of habitat loss/gain remains, as far as is possible, positive. The ongoing monitoring of 'actual' habitat gains/losses and subsequent updating of the 'balance sheet' will be used to demonstrate this is occurring. The 3:1 habitat replacement ratio quoted in the CHaMP for direct losses from flood defence works inherently makes an allowance for delay in development of the quality of the replacement habitat. The managed realignment schemes and overall habitat losses and gains within the 50 year Strategy are described further in Section 2.5 of this report.

Summary of 'No Alternatives' Argument

In conclusion it is considered that:

- **there are no alternative options** for meeting the objectives of the Humber FRM Strategy and in particular for:
 - maintaining the integrity of the Humber Estuary SAC, SPA and Ramsar site in the face of sea level rise and resultant coastal squeeze;
 - providing sustainable, affordable and effective flood risk management for the people, houses, commercial properties and infrastructure located within the floodplain.
- the preferred option represents the best environmental/social option for long-term management of flood risk in the Humber Estuary.

The principles of this were agreed with Natural England (see 'letter of comfort' to Environment Agency of July 2005, in Appendix A).

G: Imperative reasons of Overriding Public Interest

Reason to carry out this permission, plan or project notwithstanding the negative assessment:

- Imperative reasons of overriding public interest, including those of a social or economic nature (in the absence of priority habitat/species)
- Human health
- Public safety

Short description of the reason:

Currently about 115,000 ha of land around the Humber is at risk of being flooded by a storm surge in the North Sea. This area contains the homes of about 400,000 people. Most of them are in cities such as Hull and Grimsby, or in smaller towns or villages, and the area also contains major industries, including power stations, refineries and the country's largest port complex handling 80 million tonnes of cargo each year. Much of the remaining land, over 85% of the total, is farmed and consequently has relatively few people living on it.

Looking to the future, our climate is changing, causing sea levels to rise and severe storms to happen more often, and our defences are ageing. If they are not improved, they will become less and less effective and in due course they will fail. Furthermore, as outlined above, more of the land behind them has been, and is being, developed, so more homes and more industry will be affected if it is flooded.

Therefore, the conclusion of HRA Stage 4 is that the Strategy as described represents '**imperative reasons of overriding public interest**' (IROPI) because:

- 'there is a need to address a serious risk to human health and public safety'
 - the Strategy will help protect nearly 400,000 people from serious flooding (nearly 4,000 residential and commercial properties are already being protected by the completion of the first five-year package of works of the Strategy); and
- 'there is a need to protect infrastructure, facilities and land of regional and national economic importance' including
 - port facilities including those at Hull (the 'gateway to Europe') and Grimsby
 - energy and chemical industry facilities providing significant regional employment
 - versatile, high quality agricultural land (for example much of it is Grade 1 and 2), which is highly significant in terms of food security of the country.

H: Compensatory measures

The Strategy and the 50 year 'balance sheet' (Appendix B) set out the Environment Agency's proposed compensatory measures over the next 50 years. These measures are based on the following commitments:

- to replace any direct loss of intertidal habitat from the works, based on a 3:1 ratio, unless otherwise agreed;
- to replace any intertidal habitat temporarily disturbed by the works, based on a 1:1 ratio, unless otherwise agreed;
- to replace any intertidal habitat lost to coastal squeeze, based on a 1:1 ratio, unless otherwise agreed;
- to create compensatory habitat of a similar character and ecological function to that being lost, and if at all possible, in the same part of the Estuary (inner, middle or outer north, outer south) in which it has been lost;
- to design and implement a programme of compensatory measures and habitat creation schemes to compensate for the direct losses arising from the Environment Agency flood risk management programme and from coastal squeeze (wherever this occurs on the estuary). We will seek to ensure that overall gains balance losses, and that compensation is secured before losses occur. However, during the life of the Strategy there may be short periods when the balance is in deficit as a result of circumstances outside our control;
- to address any such deficit once identified, as soon as possible, through managed realignment schemes, and to avoid a build up of such a deficit which would result in further deterioration of the Natura 2000 site. If appropriate the significance of the size and duration of any deficit that arises can be agreed with Natural England in the context of the uncertainty surrounding the prediction of coastal squeeze losses and the natural variation in intertidal area due to the nodal tide cycle;
- to monitor habitat losses and gains over the life of the Strategy, revise the calculations of habitat gains/losses and uncertainty (by updating the 'balance sheet') with the latest monitoring information at least every five years through the Environment Agency's managed realignment (and habitat creation) programme and Strategy reviews and amend the programme accordingly.

The current programme of habitat creation schemes, identified within the Strategy to meet the compensatory habitat needs under the Habitats Regulations is summarised in the table below.

*50 year Strategy managed realignment schemes, and overall habitat gains and losses***50 year Strategy (2007-2057) Managed realignment schemes / habitat creation package**

Flood Cell	Location	Estuary location	Proposed completion	Intertidal habitat created (ha)
4	Paull Holme Strays	Middle	Completed 2003	80
16	Alkborough Flats	Inner	Completed 2006	172
27	Donna Nook	Outer	2012-16	110
2	Skeffling	Outer	2012-16	150
17	Whitton / Reeds Island	Inner	2017-21	20
22	Goxhill	Middle	2022-26	176
3	Sunk Island / Welwick	Outer	2032-36	321
<i>Total</i>				<i>1029</i>

**At Goxhill we have identified potential intertidal habitat creation of 176ha, but we acknowledge that there is a possibility that the scheme may require additional mitigation or compensation for areas of high tide roost landward of the defence, in order to achieve this. These details will be agreed with Natural England as the scheme is investigated and designed.*

Further details of these habitat creation schemes are provided in Appendix B and C of this document as well as in the subsequent paragraphs.

The main purpose of the suite of habitat creation schemes is to compensate for the adverse effects resulting from the Strategy. However, in some cases these schemes also provide flood risk management benefits through storage and reduction in water levels during peak/surge tides and embankments that are built at the 'back' of sites can be designed to deliver long-term defence improvements. These schemes are important for maintaining the cohesion of the designated site, but they are also integral to the Strategy as without them maintenance or improvement of local defences / defence standards might not be possible (for instance at Paull Holme Strays and Skeffling).

The habitat loss / replacement balance sheet (Appendix B) shows details of the predicted losses from coastal squeeze, flood risk management scheme footprint and maintenance works. It can be seen from the 95% prediction intervals that there is considerable uncertainty around the 'mean' figures resulting from coastal squeeze and estuary evolution. The Environment Agency will continue to monitor actual losses and sea level rise to improve predictions over time. We will also review the habitat creation programme on a five yearly basis to confirm that it is meeting the habitat replacement quota or to adjust as necessary in consultation with Natural England.

The following provides a summary of replacement needs over the 50 years of the Strategy:

Inner Estuary – predictions show that even in the face of sea level rise estuary evolution suggests that the intertidal area will increase by 330ha over 50 years due to evolutionary processes within the estuary. There are some direct losses through improvement works and maintenance but replacement for these is easily met by the managed realignment scheme at Alkborough which has provided c. 170ha of new intertidal habitat.

Middle Estuary – predictions of coastal squeeze loss in this location have increased markedly following recently revised calculations (as part of the CHaMP review). Habitat replacement requirement in the middle estuary is now calculated as c.625ha over the 50 years. The Paull Holme Strays managed realignment scheme has already contributed c. 80ha of replacement but given the rate of loss this part of the estuary will soon go into deficit. We have plans for another middle estuary realignment at Goxhill (c. 176ha). This is unlikely to be delivered until 2022 but we would deliver it sooner than that if it proves possible to do so. There are no other suitable middle estuary realignment sites in our current programme, although we will continue to seek opportunities. We therefore propose to provide replacement habitat through sites at Skeffling (c. 150ha) and Welwick/Sunk Island (up to c. 320ha) where the Environment Agency has some land ownership and has been discussing realignment with relevant organisations and interested parties. These sites are toward the western / middle estuary end of the outer estuary zone and thus far reviews habitat/community information (sediments, invertebrates and birds) indicate that this area could provide appropriate habitat replacement for middle estuary losses (see Appendix D for further details). However we understand that there are risks associated with this approach and we intend to manage these by:

- Working with Natural England, and others as appropriate to ensure that the Skeffling managed realignment site incorporates specific measures/features designed in such a way as to best meet the functional needs of the birds displaced by coastal squeeze in the middle estuary. The measures/features incorporated will be based on an understanding of the ecology of the birds as agreed with Natural England;
- Clear objectives will be set for the Skeffling site that reflect, the functional needs of the birds displaced from the middle estuary, and an agreed vision of habitat that meets the agreed compensatory needs.
- A comprehensive monitoring package for Skeffling will be with Natural England and used to assess whether the site is meeting the objectives set.
- Monitoring information will be reviewed regularly (as a minimum at the time of the 5-yearly strategy review) to inform the need for management intervention at Skeffling and/or the need to identify new sites to be added to the habitat creation programme.
- Information from monitoring the implementation and success, or otherwise, of Skeffling will be used to confirm whether further sites at Welwick/Sunk Island, currently identified as ‘middle estuary’ compensation, will be capable of meeting the relevant functional needs. If this is not the case then new sites will be identified within the revised habitat creation programme. Note: It is intended that the middle estuary realignment at Goxhill will be progressed before sites at Welwick/Sunk Island.

Outer Estuary – predictions show that intertidal habitat area will increase on the north bank of the outer estuary, whilst on the south bank replacement requirements are c. 185ha. We intend to meet these replacement needs through a managed realignment scheme at Donna Nook which will create c. 110ha and through a further (no decisions have been made on this) site in the Outer (S). The Donna Nook scheme was initially refused planning permission but

the Environment Agency is appealing this decision.

A summary of the habitat creation schemes and how they balance losses is provided in the table below.

Estuary Sector	Compensation Requirement (ha) (expressed as habitat changes)*	Habitat Creation Programme (ha)	Balance (ha)	Balance after Compensation Reallocation (ha)	Comments
Inner	250	192	442	442	In the inner estuary we are currently predicting that the Strategy will provide significant environmental benefit to the Estuary and the SAC/SPA/Ramsar site in terms of increased intertidal habitat.
Middle	- 625	256	- 369	102	Paull Holme Strays and Goxhill provide insufficient habitat creation to meet the current prediction for losses. The deficit created can (at this time) only be met by creation of appropriate intertidal habitat in the inner part of the Outer (N) sector where we have significant habitat creation opportunities (e.g. Welwick and Skeffling).
Outer (N)	44	471	515	44	Here we are predicting a significant habitat gain which we propose is used to contribute to meeting the predicted deficit in the Middle estuary. Surplus habitat would provide further environmental benefit to the estuary in terms of excess habitat provision in the sector.
Outer (S)	-185	110	-75	-75	We currently have only a single habitat creation site (Donna Nook) in the Outer (S) sector of the estuary and will need to identify a further site for delivery post 2020-30 when a deficit in this sector is predicted. This will be addressed in the next Strategy review.
Whole Estuary	- 516	1029	513	513	After 50 years our overall habitat loss/creation balance will leave the Estuary c. 500 ha better off than required by compensation under the Habitats Regulations. This is considered a significant environmental benefit from the Strategy

*Compensation Requirement: this is a summary of the losses/gains from predicting coastal squeeze (including changes in morphology through estuary evolution) combined with direct scheme footprint losses and allowances for temporary disturbance multiplied by agreed replacement ratios.

Timing of losses and habitat creation are shown over the life of the Strategy in the tables in Appendix B.

Ideally we would have created all habitat replacement within the zones of loss, however this is unlikely to be deliverable so we have designed a programme that is both realistic and effective, and that provides the best achievable outcomes, in the context of the considerable uncertainty surrounding the coastal squeeze loss figures.

The results of monitoring at Paull Holme Strays and Alkborough Flats schemes show that high quality replacement habitat can be delivered through managed realignment within the

estuary.

There is a presumption that the new habitats will eventually become included within the European site boundary when they are of sufficient quality and there is sufficient monitoring data to support this.

We recognise that there are concerns regarding the ability of Outer (N) habitat creation sites such as Skeffling and Welwick to create adequate compensatory habitat for losses within the Middle Estuary. However we believe that we can work with a range of stakeholders to create sites with appropriate character and ecological function, especially given our proven success at Paull Holme Strays and Alkborough, and the tendency for realignment areas to reflect the more sheltered habitats generally found further upstream. We will agree objectives for the compensatory habitat sites with Natural England, monitor the results and review the scheme designs, the Strategy and our package of habitat creation measures accordingly.

Therefore these compensatory measures are considered to maintain the coherence of the SAC, SPA and Ramsar Site.

4 HRA Conclusions and Way Forward

The Environment Agency is both the Plan/Strategy maker/implementer and the Competent Authority under the Habitats Regulations for the Humber Flood Risk Management Strategy. All of the Humber Estuary is covered by European Site designations (SAC, SPA) and Ramsar Site designation and we have therefore completed an assessment of the Strategy under the Habitats Regulations as required by our own policy and best practice. Our conclusions from this assessment are that:

- The 50 year Strategy represents the best environmental option for long-term management of flood risk in the Estuary, and this has been agreed ‘in-principle with NE (see ‘letter of comfort’ to Environment Agency of July 2005);
- The 50 year Strategy represents ‘adverse effect on the integrity’ of the SAC, SPA and Ramsar Site;
- There are ‘no alternatives’ to the Strategy that are capable of delivering the combined flood risk management and habitat replacement objectives;
- In addition to balancing the coastal squeeze and scheme related losses resulting from the Strategy the associated habitat creation programme creates significant environmental benefits for the Estuary and the designated sites through provision of intertidal habitat that exceeds the compensatory habitat requirements.
- There are ‘imperative reasons of overriding public interest’ for implementing the Strategy;
- Appropriate ‘compensation’ in the form of habitat creation can be secured to help offset the adverse impacts of the Strategy and these are detailed in this report and in Appendix C: The Role of the Regional Habitat Creation Programme in Compliance of the Humber Strategy with the Habitats Regulations;
- This compensation package provides habitat compensation for coastal squeeze losses throughout the estuary and for direct losses from the Environment Agency flood risk management programme. If third parties carry out flood maintenance or improvement works the compensation for coastal squeeze losses is provided if the works do not conflict with the Strategy and any necessary approvals (for instance under the Habitats Regulations) are gained (see Section 2.3.1 page 4 for further clarification of this). Compensation for any direct losses from third party works is not provided.
- The 50 year Strategy addresses sea level rise and ‘coastal squeeze’ by meeting the habitat replacement needs identified in the CHaMP (these losses and the replacement requirements will be reviewed on a 5-year cycle).

Note: The HECAG Shoreline Management Plan and associated HRA has also recently been submitted to Defra. We acknowledge the close relationship between our two submissions and indeed the SMP relies on data and results developed under the Humber FRM Strategy

for its first two epochs for policy units within the middle/outer estuary. In the SMP the information used to develop requirements for replacement of intertidal habitat lost through coastal squeeze was the best available at the time (HFRMS CHaMP, 2005). However the information used within this Strategy HRA is now based on revised CHaMP predictions (October, 2011) that are more evidence based. This has resulted in an understanding that there will be greater requirements for compensatory habitat provision within the Outer (S) and Middle sectors of the estuary than was previously understood and described in the SMP. This recent increase is acknowledged in the Strategy by stating the requirement for another (in addition to Donna Nook) site for habitat creation in the Outer (S) sector. Current predictions indicate that this site will not be needed until the period 2020-2030.

In accordance with the conclusions above, we are 'minded' to adopt the Strategy and seek approval from Defra/ Secretary of State to do so.

In approving the Strategy we are also asking that Defra/Secretary of State (SoS) also approve the following 'way forward' (points 1-4 below) for the approval of schemes supported by the Strategy:

- Approval of the Strategy under the Habitats Regulations is taken to mean approval of the:
 - overall **50 year Strategy** (March 2008), including the long-term package of 'managed realignment' schemes identified to meet the requirements of habitat loss identified in the CHaMP, where possible;
 - 1) At regular intervals the Strategy will be reviewed, monitoring results will be used to update the CHaMP and habitat 'balance sheet' and any shortfalls in 'environmental' performance will be addressed in the subsequent programmes of work. This is especially important in the context of areas where future habitat gains may occur from managed realignment schemes that are currently not identified.
 - 2) Each individual scheme will be examined, in consultation with Natural England and the Local Planning Authority (where relevant) to determine whether there is a likely significant effect on the designated site. If there is no likely significant effect, AA is not required and the scheme will progress through planning approvals or as permitted development.
 - 3) If there is likely significant effect, an AA will be completed by the Competent Authority. If this demonstrates that there are no *additional adverse effects on integrity* to those approved under the Strategy (as described in this Habitat Regulations Assessment) the scheme can be approved without requiring determination by the SoS.
 - 4) However, if the Competent Authority determines that the scheme has adverse effects on the integrity of the European Sites *in addition* to those approved under the Strategy or cannot be demonstrated to be mitigated/compensated in line with the Strategy, then the Habitats Regulations consent supplied for the Strategy will no longer apply. In this situation, a separate approval under the Habitat Regulations will be required and may require separate determination by the SoS.

APPENDICES

Appendix A Letter of Comfort from English Nature July 2005

Philip Winn
Humber Strategies Manager
Environment Agency
Phoenix House
Global Avenue
LEEDS
LS11 8PG

Your ref: HE SSSI / O / EA /
HEFDS

Our ref:

22nd July 2005

Dear Philip,

**Humber Estuary Special Protection Area (SPA) and potential SPA
Humber Estuary possible Special Area of Conservation (pSAC)
Humber Estuary Ramsar site and proposed Ramsar site
Humber Estuary Site of Special Scientific Interest (SSSI)**

Option-choice advice to the Environment Agency:

Humber Estuary Flood Defence Strategy:-

Overall Strategy

First Five Year Package of Works

(as outlined in the documents listed in Annex 1)

Following the correspondence received from the Environment Agency regarding the above, we write to confirm:-

- (i) English Nature's support for the proposed Overall Strategy and for the approach used to develop the First Five Year Package of Works;
- (ii) that it is English Nature's view that **the proposed options for the works included in the first Five Year Package of Works (listed in Annex 2) are likely to lead to environmentally acceptable solutions.**

However, based on the information available to date, we anticipate that the proposals are likely to have a significant effect on the Humber Estuary SPA/pSAC/Ramsar site and, therefore, **the individual schemes are likely to require appropriate assessments** under The Conservation (Natural Habitats, &c.) Regulations 1994. We stress that this advice is provisional, and will need to be reviewed under the Regulations when the details of the proposed options are available because all the works (including the maintenance works) are within or adjacent to the Humber Estuary SPA/pSAC/Ramsar site.

We stress that this letter does not constitute English Nature's assent or advice for the purposes of S28H of the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act 2000). When details of the proposed works become available and before carrying them out, the Environment Agency, having considered its general duty under section 28G(2) of the Wildlife and Countryside Act 1981, is required to give notice to English Nature. The Environment Agency is required to carry out the works in accordance with the provisions of section 28H of the Wildlife and Countryside Act 1981 as the proposed works are within or adjacent to the Humber Estuary SSSI.

This advice is offered based on the information provided to date. It is given without prejudice to any advice that English Nature may offer in accordance with its statutory role under The Conservation (Natural Habitats, &c.) Regulations 1994 or assent that may be required under the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act 2000). Formal comment on the proposals will be provided following consultation on the Environmental Statements as required under the relevant Regulations. We look forward to receiving further information as the proposals are developed, particularly in relation to the points listed in Annex 3.

For your information, this letter has been copied direct to the Defra Regional Engineer.

Summary of English Nature's advice at the option choice stage	Answer only yes or no
Is the proposal likely to lead to an environmentally acceptable solution?	Yes
Is the proposal likely to require an appropriate assessment under Habitats Regulations?	Yes

Yours sincerely

Ben McCarthy
Conservation Officer

cc. Jim Hutchinson (Defra Regional Flood Defence Engineer)

Tim Collins (EN Head of Coastal Conservation)

HUMBER ESTUARY FLOOD DEFENCE STRATEGY

ENGLISH NATURE ADVICE DATED 22nd JULY 2005

ANNEX 1 – LIST OF DOCUMENTS ON WHICH THIS ADVICE IS BASED

Project Appraisal Report - Overall Strategy, Jul 2005
Project Appraisal Report - First Five Year Package of Works, Jul 2005
Strategic Environmental Assessment of the Strategy
'Shadow' Appropriate Assessments
Coastal Habitat Management Plan (CHaMP)
Technical Report

ANNEX 2 – LIST OF WORKS IN FIRST FIVE YEAR PACKAGE OF WORKS

Confirmed works (outline designs completed)

- (a) Flood defence works
 - Paull Village
 - BAe Works to East Clough
 - Old Goole
 - Swine fleet
 - Halton Marshes *
 - Stallingborough

* Subject to consultations regarding proposed abandonment of northern section of defences

- (b) Managed realignment works
 - Donna Nook

Works to be confirmed (subject to further study and/or consultations)

- (a) Flood defence works
 - Halton Marshes (see above)
 - Erosion protection (stoning)
 - Unforeseen works (failures, emergency repairs etc)
- (b) Managed realignment works
 - Easington

Monitoring and maintenance works

- (a) Flood defence monitoring/maintenance (including grass-cutting etc)
- (b) Estuary monitoring (including CHaMP requirements)

ANNEX 3 – POINTS REGARDING ENGLISH NATURE’S FURTHER INFORMATION REQUIREMENTS

- (a) More detailed information necessary to progress schemes through the Habitat Regulations required, including an Appropriate Assessment (if required), to be provided for each item in the ‘Confirmed works’ list in Annex 2 following design development and further environmental assessment.
- (b) English Nature to be consulted about the development of options for each item in the ‘Works to be confirmed’ list in Annex 2 (in particular regarding the possible abandonment of the defences at Halton Marshes and the possible re-alignment of the defences at Easington to avoid the loss of The Lagoons due to coastal erosion) and subsequently to be provided with more detailed information as in (a) above.
- (c) Further consideration to be given to ‘in-combination’ effects once more detailed information is available
- (d) An estuary monitoring programme to be agreed.
- (e) A report containing the results of the estuary monitoring programme and confirming that the Environment Agency is complying with the CHaMP requirements regarding replacement habitat to be provided annually.
- (f) Delivery of DEFRA/EA high level BAP targets.

Appendix B Habitat ‘Balance Sheet’

Table B.1 Summary of Changes of Intertidal Habitat and Compensatory Habitat Requirements Associated with the 50 Year Humber FRM Strategy

Changes		0-50 years		Replacement requirement	
Changes due to coastal squeeze and estuary evolution		Inner	330.4	Compensation for coastal squeeze	
	Middle	-509.6		Inner	330.4
	Outer South	-168.0		Middle	-509.6
	Outer North	61.6		Outer South	-168.0
	Total	-285.6		Outer North	61.6
Losses due to works and maintenance				Total	-285.6
	Inner	-11.8	Total changes without habitat replacement programme	Compensation for works and maintenance	
	Middle	-30.9		Inner	-35.5
	Outer South	0		Middle	-92.6
	Outer North	0		Outer South	0
	Total	-42.7		Outer North	0
Losses due to stoning				Total	-128.1
	Inner	-7.8	Total habitat replacement requirement	Compensation for stoning	
	Middle	-3.1		Inner	-23.4
	Outer South	-2.4		Middle	-9.3
	Outer North	-2.4		Outer South	-7.2
	Total	-15.7		Outer North	-7.2
	Total	-58.4		Total	-47.1
Temporary disturbance due to works and maintenance				Compensation for temporary disturbance due to works and maintenance	
	Inner	-7	Total changes without habitat replacement programme	Inner	-7
	Middle	-3		Middle	-3
	Outer South	-3.5		Outer South	-3.5
	Outer North	-7		Outer North	-7
	Total	-20.5		Total	-20.5
Cross estuary impacts/ flood storage (Alkborough)				Compensation for cross estuary impacts/ flood storage (Alkborough)	
	Inner	-15	Total habitat replacement requirement	Inner	-15
	Middle	-10		Middle	-10
	Outer South	-6.7		Outer South	-6.7
	Outer North	-3.3		Outer North	-3.3
	Total	-35.0		Total	-35.0

Table B.2 Gains in Intertidal Habitat Associated with the Humber FRM Strategy Managed Realignment/ Habitat Creation Schemes

Planned Habitat Creation Programme (Managed Realignment Schemes) for the Humber FRM Strategy (ha)												
Years covered by band (from start of strategy)	0	2-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	0-50
Corresponding calendar years	2000-07	2008-11	2012-16	2017-21	2022-26	2027-31	2032-36	2037-41	2042-46	2047-51	2052-56	2000-56
Inner estuary and rivers	172	0	0	20	0	0	0	0	0	0	0	192
Middle	80	0	0	0	176	0	0	0	0	0	0	256
Outer North	0	0	150	0	0	0	321	0	0	0	0	471
Outer South	0	0	110	0	0	0	0	0	0	0	0	110
Total	252	0	260	20	176	0	321	0	0	0	0	1029

Locations	(ha)
Alkborough	172
Reeds Island	20
Paull Holme Strays	80
Donna Nook	110
Skeffling	150
Welwick	321
Goxhill	176

Table B.3 Details of the Predicted Intertidal Habitat Losses associated with the Humber FRM Strategy and their Replacement Requirements.

Strategy Period	0	2-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	0-50
Years covered by band (from start of strategy)	2000-07	2008-11	2012-16	2017-21	2022-26	2027-31	2032-36	2037-41	2042-46	2047-51	2052-56	2000-56
Inner												
Coastal squeeze allowance (2000-2050)												
(replacement 1:1)	41.3	23.6	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	330.4
95% +/-PI	8.4	4.8	6	6	6	6	6	6	6	6	6	67.2
95 % +/-PI	74.2	42.4	53	53	53	53	53	53	53	53	53	593.6
Reconstruction and maintenance losses (3:1)	0	-1.0	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2	-1.29	-1.314	-1.35	-11.826
Replacement for above	0	-3.0	-3.2	-3.3	-3.4	-3.5	-3.6	-3.7	-3.87	-3.942	-4.05	-35.478
Provision of flood storage:												
estimated loss due to Alkborough (1:1)	-3	-3	-3	-3	-3	0	0	0	0	0	0	-15
Reconstruction and maintenance disturbance												
(1:1) (Temporary Losses)	0	-7	0	0	0	0	0	0	0	0	0	-7
Stoning works (3:1)	0	-6	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-7.8
Replacement for above	0	-18	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-23.4
Inner Estuary Total	38.3	-7.4	22.8	22.6	22.5	25.4	25.3	25.2	25.03	24.958	24.85	249.522
Middle												
Coastal squeeze allowance (2000-2050)	-63.7	-36.4	-45.5	-45.5	-45.5	-45.5	-45.5	-45.5	-45.5	-45.5	-45.5	-509.6
95% +/-PI	-83.3	-47.6	-59.5	-59.5	-59.5	-59.5	-59.5	-59.5	-59.5	-59.5	-59.5	-666.4
95 % +/-PI	-44.1	-25.2	-31.5	-31.5	-31.5	-31.5	-31.5	-31.5	-31.5	-31.5	-31.5	-352.8
Reconstruction and maintenance losses (3:1)	0	-1.8	-1.8	-1.8	-2.205	-3.8	-3.8	-3.8	-3.8	-3.8	-4.1	-30.87
Replacement for above	0	-5.4	-5.4	-5.4	-6.6	-11.5	-11.5	-11.5	-11.5	-11.5	-12.4	-92.61
Provision of flood storage:												
estimated loss due to Alkborough	-2	-2	-2	-2	-2		0	0	0	0	0	-10
Reconstruction and maintenance disturbance												
(Temporary Losses)	0	-3	0	0	0	0	0	0	0	0	0	-3
Stoning works (3:1)	0	-1.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-3.1
Replacement for above	0	-3.9	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-9.3
Middle Estuary Total	-65.7	-50.7	-53.5	-53.5	-54.7	-57.6	-57.6	-57.6	-57.6	-57.6	-58.5	-624.5
Outer South												
Coastal squeeze allowance (2000-2050)	-21	-12	-15	-15	-15	-15	-15	-15	-15	-15	-15	-168
95% +/-PI	-30.8	-17.6	-22	-22	-22	-22	-22	-22	-22	-22	-22	-246.4
95 % +/-PI	-11.2	-6.4	-8	-8	-8	-8	-8	-8	-8	-8	-8	-89.6
Reconstruction and maintenance losses 3:1	0	0	0	0	0	0	0	0	0	0	0	0
Replacement for above	0	0	0	0	0	0	0	0	0	0	0	0
Provision of flood storage: estimated loss due												
to Alkborough	-1.34	-1.5	-1.5	-1.5	-0.9	0	0	0	0	0	0	-6.7
Reconstruction and maintenance disturbance												
(Temporary Losses)	0	-3.5	0	0	0	0	0	0	0	0	0	-3.5
Stoning works (3:1)	0	-1.5	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-2.4
Replacement for above	0	-4.5	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-7.2
Outer Estuary Total	-22.34	-21.5	-16.8	-16.8	-16.16	-15.3	-15.3	-15.3	-15.3	-15.3	-15.3	-185.4

Continued overleaf

Strategy Period												
Years covered by band (from start of strategy)	0	2-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	0-50
Corresponding calendar years	2000-07	2008-11	2012-16	2017-21	2022-26	2027-31	2032-36	2037-41	2042-46	2047-51	2052-56	2000-56
Outer North												
Coastal squeeze allowance (2000-2050)	7.7	4.4	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	61.6
95% +/-PI	-1.4	-0.8	-1	-1	-1	-1	-1	-1	-1	-1	-1	-11.2
95 % +/-PI	16.8	9.6	12	12	12	12	12	12	12	12	12	134.4
Reconstruction and maintenance losses (3:1)	0	0	0	0	0	0	0	0	0	0	0	0
Replacement for above	0	0	0	0	0	0	0	0	0	0	0	0
Provision of flood storage: estimated loss due to Alkborough	-0.7	-0.7	-0.7	-0.7	-0.7	0	0	0	0	0	0	-3.3
Reconstruction and maintenance disturbance (Temporary Losses)	0	-7	0	0	0	0	0	0	0	0	0	-7
Stoning works (3:1)	0	-1.5	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-2.4
Replacement for above	0	-4.5	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-7.2
Outer North Estuary Total	7.0	-7.8	4.5	4.5	4.5	5.2	5.2	5.2	5.2	5.2	5.2	44.1
Whole Estuary Total	-42.7	-87.3	-43.0	-43.1	-43.9	-42.3	-42.4	-42.5	-42.6	-42.7	-43.8	-516.3
Totals with +/- 95% PI												
Inner	5.4	-26.2	-0.8	-0.9	-1.0	1.9	1.8	1.7	1.5	1.5	1.4	-13.7
	71.2	11.4	46.3	46.1	46.0	48.9	48.8	48.7	48.5	48.5	48.4	512.7
Middle	-90.3	-64.7	-71.1	-71.1	-72.3	-75.1	-75.1	-75.1	-75.1	-75.1	-76.1	-821.1
	-45.4	-39.1	-39	-39	-40.2	-43.1	-43.1	-43.1	-43.1	-43.1	-44.0	-462.1
Outer South	-32.14	-27.1	-23.8	-23.8	-23.2	-22.3	-22.3	-22.3	-22.3	-22.3	-22.3	-263.8
	-12.54	-15.9	-9.8	-9.8	-9.2	-8.3	-8.3	-8.3	-8.3	-8.3	-8.3	-107
Outer North	-2.1	-13.0	-2.0	-2.0	-2.0	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-28.7
	16.1	-2.6	11.0	11.0	11.0	11.7	11.7	11.7	11.7	11.7	11.7	116.9
Whole Estuary Total -95% PI	-119.1	-131.0	-97.6	-97.7	-98.4	-96.8	-96.9	-97.0	-97.2	-97.3	-98.3	-1127.2
Whole Estuary Total +95% PI	29.4	-46.1	8.5	8.4	7.6	9.2	9.1	9.0	8.9	8.8	7.	60.5

Note: Prediction Intervals (PI) Confidence Intervals and standard deviation refer to the population within which the samples fall, not to an individual observation or to a group of observations in the future. A Prediction Interval is an estimate of an interval in which future observations will fall with a certain probability, given what has already been previously observed. For example, a 95% prediction interval for one future observation is the range within which we are 95% confident that the prediction will lie i.e. predicting the distribution of future points. The prediction interval resembles the confidence interval and is based on the same sample of past observations but is wider to account for prediction uncertainties in the future.

Appendix C The Role of the Regional Habitat Creation Programme in Compliance of the Humber Strategy with the Habitats Regulations

Statement on the Role of the Humber Regional Habitat Creation Programme in the compliance of the Humber FRM Strategy with the Habitats Regulations



For information

Part A

Regional Habitat Creation Programme manager to complete this section

Name of the Strategy	Humber Flood Risk Management Strategy
Sites of international importance within the Strategy area	Humber Estuary SAC Humber Estuary SPA Humber Estuary Ramsar Site
Conclusion of the Habitats Regulation Assessment	The HRA concluded that there may be adverse effects on the integrity of the following international sites, largely from loss of habitat due to coastal squeeze but also due to smaller direct (footprint) and cross-estuary process impacts from hold the line and managed realignment schemes respectively: <ul style="list-style-type: none"> • Humber Estuary SAC • Humber Estuary SPA • Humber Estuary Ramsar Site
How the compensatory habitat will be delivered (as described by the Statement of Case)	The Statement of Case for IROPI confirms that the compensation habitat requirements arising from the Humber Flood Risk Management Strategy will be delivered by the Environment Agency's 'Humber' Regional Habitat Creation Programme which is supported jointly by Anglian, North East and Midlands Regions of the Environment Agency.
RHCP programme manager	Philip Winn (Humber Strategies Manager)

Part B

The Role of the RHCP in delivering the compensatory habitat

What is an RHCP	<p>A Regional Habitat Creation Programme (RHCP) provides a strategic approach to identifying and addressing potential losses of internationally protected habitats, thus helping to ensure that our flood risk management activities are compliant with the Habitats and Birds Directives.</p> <p>A Regional Habitat Creation Programme has three distinct phases or elements:</p> <p>PHASE A - Habitat Account Assessment - involves the identification of future losses to European Sites due to flood risk management activities and where habitat has to be created to compensate for those losses. It also involves the identification of losses of BAP habitat as well as gains that offset these losses and contribute to the target of creating 200ha of new BAP habitat a year. For the Humber FRM Strategy this assessment is provided by the Humber Coastal Habitat Management Plan (CHaMP) and the recent review of this, the Habitats Regulation Assessment and the SEA.</p> <p>PHASE B - Finding and Securing Habitat Site - involves the identification and investigation of suitable sites on which compensatory habitat can be created. It also involves identifying schemes where there may be opportunities for BAP habitat creation.</p> <p>PHASE C - Creating the Habitat - involves gaining control over those sites and the creation and long-term management of appropriate habitat.</p> <p>The programme has a cyclical nature. In each phase a series of actions need to be completed, and each phase needs to be revisited at regular intervals.</p>
------------------------	--

How the RHCP works	<p>The Humber FRM Strategy is supported by the Humber Regional Habitat Creation Programme (RHCP), in turn supported by the Environment Agency's Anglian, North East and Midlands regions.</p> <p>These RHCPs are managed and run by the National Capital Programme Management Service (ncpms) on behalf of the Regional Flood and Coastal Risk Managers.</p> <p>To ensure high-level buy in, the RCHP will have a Steering Group. Its members will comprise Natural England and possibly the RSPB, the county wildlife trusts, National Trust and the Wildfowl and Wetlands Trust as appropriate.</p> <p>The RHCPs maintain a database to record and update information on all the relevant strategies and projects within the flood risk management long-term plan and revenue works. The database is updated annually to ensure all needs are captured. This allows reprioritisation to take account of changes in Shoreline Management Plans (SMPs) and strategies or particular events (for example, the impact of storms).</p> <p>The RHCP has an approved land acquisition strategy, which confirms the approach to purchasing land or otherwise acquiring the rights to habitat creation. Among other things, this seeks to ensure the most cost effective approach is taken to meeting requirements.</p> <p>Land purchase is often necessary to meet compensation and replacement requirements in compliance with the Habitats Regulations, but the project will work closely with Natural England and their Countryside Stewardship programme to fulfil BAP commitments.</p> <p>The RHCP budgets form part of the Agency's capital programme. Funds are bid for against the national Flood and Coastal Risk Management projects. Creation of some BAP habitat is funded through the Flood Defence Grant In Aid revenue budget.</p>
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Part C

Review of the habitat losses predicted in the Strategy and the compensation requirements arising

SAC	Humber Estuary SAC, SPA and Ramsar Site		
Predicted Losses	<i>Location</i>	<i>Habitat type</i>	<i>Area of habitats likely to be lost during Strategy (2000-2056) in hectares</i>
	Inner estuary	Intertidal	289ha gain: <ul style="list-style-type: none"> • 330ha gain from coastal squeeze/estuary evolution • 20ha loss from improvement/maintenance works • 15ha loss from cross estuary/synergistic impacts • 7ha loss from temporary disturbance
	Middle estuary	Intertidal	557 loss: <ul style="list-style-type: none"> • 510ha loss from coastal squeeze/estuary evolution • 34ha loss from improvement/maintenance works • 10ha loss from cross estuary/synergistic impacts • 3ha loss from temporary disturbance
	Outer South estuary	Intertidal	181 loss: <ul style="list-style-type: none"> • 168ha loss from coastal squeeze/estuary evolution • 2ha loss from improvement/maintenance works • 7ha loss from cross estuary/synergistic impacts • 4ha loss from temporary disturbance
	Outer North estuary	Intertidal	49 gain: <ul style="list-style-type: none"> • 62ha loss from coastal squeeze/estuary evolution • 2ha loss from improvement/maintenance works • 3ha loss from cross estuary/synergistic impacts • 7ha loss from temporary disturbance
	Totals		400 net loss BUT 738ha loss for compensation purposes due to sector by sector balance requirement

Compensation ratios to be used	<p>The following ratios have been agreed with Natural England, unless agreed otherwise on a case by case basis or following review of the habitat 'balance sheet' .:</p> <ul style="list-style-type: none"> • to replace any direct loss of intertidal habitat from the works, based on a 3:1 ratio • to replace any intertidal habitat temporarily disturbed from the works, and from cross estuary/synergistic impacts, based on a 1:1 ratio • to replace any intertidal habitat lost to coastal squeeze, based on a 1:1 ratio <p>Therefore the compensation requirements below differ from the losses on the previous page due to the 3:1 replacement of the direct losses component.</p>	
Total Compensation habitat requirement arising from the Strategy	<i>Habitat Type</i>	<i>Years 2000-2056</i>
	Intertidal	Inner:0ha Middle: 625ha Outer: 185ha
	High tide roost	Unknown. To be assessed during future feasibility and design of schemes.

Part D Work undertaken to identify sites for compensatory losses					
Sites being developed by the RHCP to provide compensatory habitat for the Strategy	<i>Location</i>	<i>Species the site is compensating for</i>	<i>Habitat Type</i>	<i>Area to be Created</i>	<i>Current Progress</i>
	Paull Holme Strays	SPA/Ramsar birds	Intertidal	80	completed 2003 and site being used by SPA/Ramsar species
	Alkborough Flats	SPA/Ramsar birds	Intertidal	172	completed 2006 and site being used by SPA/Ramsar species
	Donna Nook	SPA/Ramsar birds	Intertidal	110	proposed completion 2012-16
	Skeffling	SPA/Ramsar birds	Intertidal	150	proposed completion 2012-16
	Whitton / Reeds Island	SPA/Ramsar birds	Intertidal	20	proposed completion 2017-21
	Goxhill	SPA/Ramsar birds	Intertidal	176	proposed completion 2022-26
	Sunk Island / Welwick	SPA/Ramsar birds	Intertidal	321	proposed completion 2032-36
	Totals	underway		252	
		start 2011		0	
		other possible projects		777	

Other points on progress

The results of monitoring at the Paull Holme Strays (Middle estuary) and Alkborough Flats (Inner estuary) schemes show that high quality replacement habitat can be delivered through managed realignment within the estuary.

There is considerable uncertainty around the 'mean' figures resulting from coastal squeeze and estuary evolution. We will continue to monitor actual losses and sea level rise to improve predictions over time. We will also review the habitat creation programme on a five yearly basis to confirm that it is meeting the habitat replacement requirements or to adjust as necessary in consultation with Natural England.

The following provides a summary of replacement needs over the 50 years of the Strategy:

Inner Estuary – predictions show that even in the face of sea level rise the intertidal area will increase by 330ha over 50 years, due to evolutionary processes within the estuary. There are some direct habitat losses through improvement works and maintenance but replacement of these habitats is easily met by the managed realignment scheme at Alkborough, which has provided approximately 170ha of new intertidal habitat.

Middle Estuary – predictions of coastal squeeze loss in this location have increased markedly following recently revised calculations (as part of the CHaMP review (unpublished 2010)). The requirement for habitat replacement in the middle estuary is now calculated as c.625ha over the 50 years. The Paull Holme Strays managed realignment scheme has already contributed c. 80ha of replacement habitat but given the rate of loss this part of the estuary will soon go into deficit. We have plans for another, middle estuary, realignment at Goxhill (c. 176ha). This is unlikely to be delivered until after 2022, but we would deliver the project sooner than that if it proves to be possible to do so. There are no other suitable middle estuary realignment sites in our current programme, although we will continue to seek opportunities. We therefore propose to provide replacement habitat through sites at Skeffling (c. 150ha) and Welwick/Sunk Island (up to c. 321ha) where the Environment Agency has some land ownership and has been discussing realignment with various stakeholders. These sites are toward the western / middle estuary end of the outer estuary zone and thus far, reviews of habitat/community information (sediments, invertebrates and birds) indicate that this area could provide appropriate habitat replacement for middle estuary losses (see HRA Appendix D for further details).

Outer Estuary – predictions show that the intertidal habitat area will increase on the north bank of the outer estuary, whilst on the south bank habitat replacement requirements are c. 185ha. We intend to meet these replacement needs through a managed realignment scheme at Donna Nook, which will create c. 110ha and through the excess habitat (with respect to middle estuary needs) created on the north bank. The Donna Nook scheme was initially refused planning permission but the Environment Agency intends to appeal this decision.

We will seek to ensure that overall gains balance losses but during the life of the Strategy there may be short periods when the balance is in deficit. Ideally we would create all habitat within the zones of loss, however this is unlikely to be deliverable so we have designed a programme that is both realistic and effective, and that provides the best achievable outcomes, in the context of the considerable uncertainty surrounding the coastal squeeze loss figures.

Part E

The risks to the RHCP in delivering the requirements in the required timescale

<p>Available powers and funds to secure the necessary compensation</p>	<p>Flood and Coastal Risk Management Grant in Aid (with possible third party contributions) Agri-environment scheme</p> <p>The RHCP has an approved land acquisition strategy, which confirms the approach to purchasing land or otherwise acquiring the rights to habitat creation. Among other things, this seeks to ensure the most cost effective approach is taken to meeting requirements.</p> <p>The RHCP budget forms part of the Agency's capital programme. Funds are bid for against the national Flood and Coastal Risk Management projects. Creation of some BAP habitat is funded through the Flood Defence Grant In Aid revenue budget.</p>				
<p>Risks/mitigation of overall delivery</p>	<p><i>Importance (state whether the risk is high medium or low importance)</i></p>	<p><i>Risk Description (Describe what the potential risk is and how it could impact deliver of the RHCP compensatory habitat)</i></p>	<p><i>Counter measure (Describe what action will be taken to stop this risk becoming an issue)</i></p>	<p><i>Owner (who is in charge of ensuring this risk does not become an issue)</i></p>	<p><i>Comments (Add any comments relating to the progress of mitigating this risk)</i></p>
	<p>Medium</p>	<p>Incorrect amount of habitat loss predicted</p>	<p>In view of the uncertainties about future climate change and processes affecting estuarine evolution, and also because Government policy changes over time, the Strategy and CHaMP will be reviewed approximately every 5 years.</p>	<p>Philip Winn (Humber Strategies Manager)</p>	<p>An indication of the current levels of certainty are provided in the HRA balance sheet.</p>
	<p>Low</p>	<p>Monitoring of future habitat losses is insufficient to fully inform RHCPs</p>	<p>Ensure monitoring programme is fully implemented</p>	<p>Philip Winn (Humber Strategies Manager)</p>	
	<p>Low</p>	<p>Failure of RHCP to take account of results of monitoring and future review of SMP polices</p>	<p>Annual review of RHCP to fully incorporate outputs of monitoring and review</p>	<p>Philip Winn (Humber Strategies Manager)</p>	<p>Annual review process is in place</p>
	<p>Medium</p>	<p>Lack of opportunities</p>	<p>Proactive and ongoing searches for suitable habitat creation opportunities</p>	<p>Philip Winn (Humber Strategies Manager)</p>	

	High		Lack of public support	Early engagement, follow the building trust with communities.	Philip Winn (Humber Strategies Manager)	
	Medium		Delays in delivery	Effective programme and risk management, ensuring stakeholders are on board	Philip Winn (Humber Strategies Manager)	Donna Nook has been delayed – stakeholders have been informed of the Agency's intention to appeal the planning decision
Site level risks and mitigation	Site	Likelihood of site delivery within required timescale	Importance (state whether the risk is high medium or low importance)	Risk Description (Describe what the potential risk is and how it could impact deliver of the RHCP compensatory habitat)	Counter measure (Describe what action will be taken to stop this risk becoming an issue)	Owner (who is in charge of ensuring this risk does not become an issue)
	Paull Holme Strays	Completed	Medium	Failure to develop appropriate habitats	Monitoring and managing site to optimise habitat for SPA/Ramsar species and SAC habitats	Philip Winn (Humber Strategies Manager)
	Alkborough Flats	Completed	Medium	Failure to develop appropriate habitats	Monitoring and managing site to optimise habitat for SPA/Ramsar species and SAC habitats	Philip Winn (Humber Strategies Manager)
	Donna Nook	Medium	High	Scheme was rejected Planning Permission, Environment Agency are planning to appeal this decision	Appropriate effort in project development, consultation and planning appeal	Philip Winn (Humber Strategies Manager)
			Medium	Failure to develop appropriate habitats	Habitat creation work follows best practice and experience from other Humber managed realignment sites. Site development will be monitored to ensure any necessary modifications are incorporated to create appropriate habitat	Philip Winn (Humber Strategies Manager)
	Skeffling	High	High	Complete purchase of site (some already owned by EA)	Negotiate effectively with landowners and ensure funding is available	Philip Winn (Humber Strategies Manager)
			High	Obtain planning and consents	Appropriate effort in project development and consultation	Philip Winn (Humber Strategies Manager)

			Medium	Failure to develop appropriate habitats	Habitat creation work follows best practice and site development will be monitored to ensure any necessary modifications are incorporated to create appropriate habitat	Philip Winn (Humber Strategies Manager)
Whitton / Reeds Island	Medium	Low	Low	Complete purchase of site	Negotiate effectively with landowners and ensure funding is available	Philip Winn (Humber Strategies Manager)
		Low	Low	Obtain planning and consents	Appropriate effort in project development and consultation	Philip Winn (Humber Strategies Manager)
		Low	Low	Failure to develop appropriate habitats	Habitat creation work follows best practice and site development will be monitored to ensure any necessary modifications are incorporated to create appropriate habitat	Philip Winn (Humber Strategies Manager)
Goxhill	High/Medium	High	High	Complete purchase of site	Negotiate effectively with landowners and ensure funding is available	Philip Winn (Humber Strategies Manager)
		High	High	Obtain planning and consents	Appropriate effort in project development and consultation	Philip Winn (Humber Strategies Manager)
		Medium	Medium	Failure to develop appropriate habitats	Habitat creation work follows best practice and site development will be monitored to ensure any necessary modifications are incorporated to create appropriate habitat	Philip Winn (Humber Strategies Manager)
Sunk Island / Welwick	High / Medium	High	High	Complete purchase of site (parts are already in ownership)	Negotiate effectively with landowners and ensure funding is available	Philip Winn (Humber Strategies Manager)
		High	High	Obtain planning and consents	Appropriate effort in project development and consultation	Philip Winn (Humber Strategies Manager)
		Medium	Medium	Failure to develop appropriate habitats	Habitat creation work follows best practice and site development will be monitored to ensure any necessary modifications are incorporated to create appropriate habitat	Philip Winn (Humber Strategies Manager)

Part F

Procedures in place to review the RHCP and monitor losses

In view of the uncertainties about future climate change and processes affecting estuary evolution, and also because Government policy changes over time, the Strategy and CHaMP are reviewed approximately every 5 years.

Habitat compensation requirements will be reviewed to take account of the changes to the Strategy and CHaMP in future.

The RHCP will report back to Defra annually (by the end of the financial year) on the progress of the RHCP in delivering the habitat creation requirements of the Strategy. This annual report will confirm:

1. how much compensation habitat was required,
2. how much we expected to create in that year,
3. how much was actually created,
4. whether there is a short-fall/exceedance
5. how we plan to deal with any shortfall (if required).

Part G

Statement of agreed understanding/conclusions

The Humber FRM Strategy HRA Statement of Case identifies a need to compensate for the loss of intertidal habitat due to coastal squeeze, direct losses from improvement and maintenance works, cross estuary/synergistic impacts and temporary disturbance in the first 50 years of the Strategy. In the inner estuary and outer north estuary, predictions show that even in the face of sea level rise the intertidal area will increase due to estuary evolution processes.

We will seek to ensure that overall gains balance losses but during the life of the Strategy there may be short periods when the balance is in deficit. Ideally we would have created all habitat replacement within the zones of loss, however this is unlikely to be deliverable so we have designed a programme that is both realistic and effective, and that provides the best achievable outcomes, in the context of the considerable uncertainty surrounding the coastal squeeze loss figures.

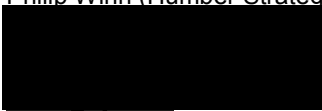
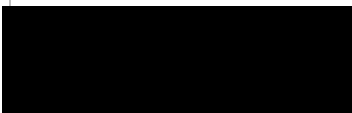
The results of monitoring at Paull Holme Strays and Alkborough Flats schemes show that high quality replacement habitat can be delivered through managed realignment within the estuary. There is a presumption that the new habitats will eventually become included within the European site boundary when they are of sufficient quality and there is sufficient monitoring data to support this.

We will continue to monitor actual losses and sea level rise to improve predictions over time. We will also review the habitat creation programme on a five yearly basis to confirm that it is meeting the habitat replacement requirements or to adjust as necessary in consultation with Natural England.

For FRM Strategies it is not necessary for all of the anticipated compensatory habitats to be in place at the time that the Strategy is approved. However, it is essential that the RHCP shows that the required compensation habitat can be provided in advance of losses/impacts occurring. In this instance due to circumstances beyond the Environment Agency's control the balance is likely to go into deficit for a period. However the RCHP shows how this will be redressed.

Part F

Sign-off

RHCP Manager	Philip Winn (Humber Strategies Manager)
	
Regional Director	

Appendix D Technical Note on Use of Outer (N) Estuary sites (e.g. Skeffling) as Compensation for Middle Estuary Losses



The Potential Value for Birds of a Realignment Site in the Outer North Section of the Humber Estuary

Document: Version: 4
Draft for review

Humber FRM Strategy: Skeffling Support Project

Environment Agency

22 February 2011

Document history

The Potential Value for Bird of a Realignment Site in the Outer North Section of the Humber Estuary

Humber Strategy: Skeffling Support Project

Environment Agency

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Halcrow Group Limited
Endeavour House, Forder Way, Hampton, Peterborough
Cambridgeshire PE7 8GX
tel 01733 560033 fax 01733 427988
halcrow.com

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Appendix A WeBS Core Count Data

Appendix B WeBS Low Tide Count Data

1 Introduction

The purpose of this report is to determine whether a proposed habitat creation site at Skeffling (Figure 1), in the Outer North section¹ of the Humber estuary (Figure 2), is likely to provide good quality compensation for losses of inter-tidal habitat in the Middle section² of the estuary caused by flood defence improvements and sea level rise over the 50 years of the Humber Flood Risk Management Strategy³.

The effects of sea level rise on an estuarine shore constrained by flood defences is to lower the overall shore profile through erosion of the upper shore and redistribution of sediments to the lower shore and subtidal channels⁴. It is likely, therefore, to result in a loss of upper shore habitat and landward migration of the lower shore, although it may also result in an overall loss of inter-tidal habitat through a rise in low tide levels.

A large area of land behind a 6km stretch of flood defences to the east and west of Patrington Haven has been identified as suitable for creating new inter-tidal habitat. The Environment Agency has already bought some of the land and plan to buy more in order to develop the site between 2010 and 2020. However, as the site is situated along the north bank of the outer Humber estuary, and is designed to compensate for losses in the middle section of the estuary, the issue is: **will the proposed habitat creation site provide the same functional habitat for bird⁵ species as the middle estuary does currently?**

The report therefore compares the avian communities of the Middle (North & South) and Outer North sections of the estuary and the communities of their invertebrate prey species in order to determine the degree of similarity between them.

Data from an operational realignment site at Paull Holme Strays have also been analysed as a possible predictor of the likely avian community of the proposed realignment site at Skeffling.

¹ The section of the estuary between Old Hall, Sunk Island to Spurn Head

² The section of the estuary from the Humber Bridge downstream to Old Hall, Sunk Island on the north bank, and Grimsby Dock Tower on the south bank

³ Over the 50 years, the estimated 399.5 ha losses of intertidal habitat represent approximately 4% of the total intertidal habitat within the Humber Estuary Special Area of Conservation (SAC) comprising 3% loss from coastal squeeze and estuary evolution; 0.6% from the encroachment of defences, maintenance and stoning; 0.2% from temporary losses; and 0.3% from cross-estuary impacts. (n.b. This calculation is based on Natural England's estimate of the present area of intertidal habitat: 10,213.62 ha. This comprises areas of intertidal mudflats and sandflats, *Salicornia* and Atlantic Salt Meadow communities from various datasets used by Natural England in supporting information for Humber Estuary SAC designation, September 2009.)

⁴ Crooks, S. (2004) The effect of sea-level rise on coastal geomorphology. *Ibis* 146 (Suppl.1), 18-20.

⁵ A generic term covering wildfowl (ducks, geese and swans) and waders or shorebirds.

2 Invertebrate communities

2.1 Introduction

Although many birds are frequently opportunistic feeders, some do have particular preferences, and their distributions may show significant relationships with the densities of their preferred prey. For example, densities of curlews *Numenius arquata* in south-east England estuaries have been shown to be correlated with combined densities of the ragworm *Hediste diversicolor* and the peppery furrow shell *Scrobicularia plana*⁶. Bird densities are, therefore, largely dependent on the densities and availability of their food organisms which, in turn, depend on shore morphology and sediments⁷.

This section will examine available evidence on the invertebrate prey preferences of waders or shorebirds in the Humber estuary, and on the distribution of the invertebrate communities and biotopes as indicators of the relative habitat quality of the Middle and Outer sections of the estuary for these bird species.

2.2 Invertebrate prey choice in the Humber estuary

The most abundant invertebrate species dominating the diets of birds in the Humber estuary have been found to be *Hediste diversicolor*, the Baltic tellin *Macoma balthica* and the mud shrimp *Corophium volutator* in the middle estuary, and cockle *Cerastoderma edule* and *Macoma balthica* in the outer estuary⁸. These are likely, therefore, to be key prey items determining site quality for waders on the Humber estuary, although other molluscs and annelid worm species are also important for certain wader species. In general, the prey preferences of waders in the Humber estuary⁹ are as follows:

- *Cerastoderma edule*: oystercatcher, knot and curlew;
- *Macoma balthica*: all waders except ringed plover;
- Mud snail *Hydrobia ulvae*: ringed plover, grey plover, dunlin, knot, redshank;
- *Corophium volutator*: ringed plover, dunlin, redshank;
- *Hediste diversicolor* and other annelid worms: all waders.

⁶ Goss-Custard, J.D., Kay, D.G. & Blindell, R.M. (1977) The density of migratory and overwintering Redshank *Tringa totanus* and Curlew *Numenius arquata* in relation to the density of their prey in south-east England. *Estuarine and Coastal Marine Science* 5, 497-510.

⁷ Austin, G.E. & Rehfisch, M.M. (2004) The likely impact of sea level rise on waders (Charadrii) wintering on estuaries. *Journal for Nature Conservation* 11(1), 43-58.

⁸ Stillman, R.A., West, A.D., Goss-Custard, J.D., McGrorty, S., Frost, N.J., Morrissey, D.J., Kenny, A.J. & Drewitt, A.L. (2005) Predicting site quality for shorebird communities: a case study on the Humber estuary, UK. *Marine Ecology Progress Series* 305, 203-217.

⁹ Stillman *et al.* (2005) *Op.cit.*

2.3 Broad scale assemblages

Four main intertidal macro-invertebrate assemblages have been identified¹⁰ on the basis of existing Environment Agency data¹¹ on the distribution of six key species: Baltic tellin *Macoma balthica*, mud shrimp *Corophium volutator*, common ragworm *Hediste diversicolor*, catworm *Nephtys hombergii* and the sludge worms *Tubificoides pseudogaster* and *T. benedii*.

These assemblages have been labelled A, B, C and D, and most of the Middle section of the estuary is characterised by Assemblage B (Figure 3), although it grades into Assemblage C at the eastern end – Sunk Island on the north bank and Killingholme to Pyewipe on the south bank. The Outer North section of the estuary is almost entirely characterised by Assemblage C, except for the tip of Spurn Head where it grades into Assemblage D which is otherwise characteristic of the Outer South section. Assemblage A is restricted to the Inner section of the estuary. Modelling of the predicted situation in 2050 indicated that these distributions are unlikely to change much over the period of the strategy.

Stillman *et al.* (2005) also found three distinct intertidal communities, corresponding broadly to the inner, middle and outer stretches of the estuary, and noted in addition that they were consistent across shore levels¹².

All six species occur in both the Middle and Outer sections of the estuary, and the difference between Assemblages B and C was based on the relative abundances of *Corophium*, which was higher in B, and *Nephtys*, which was higher in C. Although *Hediste*, *Macoma* and *Corophium* are important prey species for a range of bird species, *Tubificoides* spp. are not normally considered to be an important prey species. However, *T. benedii* has been reported to be the major prey item for dunlins *Calidris alpina* in The Wash¹³.

The highest densities of each species were found as follows:

- *Hediste diversicolor* and *Tubificoides* in the Middle (North) section of the estuary,
- *Macoma balthica* and *Corophium volutator* in the Middle (South)
- *Nephtys hombergii* in the Middle (North) and Outer North

2.4 Biotopes

A Biological Survey of the Intertidal Sediments of the Humber Estuary¹⁴ sampled invertebrate communities along 13 transects throughout the estuary and identified a large number of biotopes¹⁵.

¹⁰ ABP Mer (2003) *The Prediction of Invertebrate Species Distributions on the Humber Estuary*. Report No. R.1017

¹¹ Collected as part of ongoing Environmental Agency monitoring programme.

¹² Stillman *et al.* (2005) *Op.cit.*

¹³ Kelsey, M.G. & Hassall, M. (1989) Patch selection by Dunlins on a heterogenous mudflat. *Ornis Scand.* 20, 250-254.

¹⁴ ABP Mer (2010) *Biological Survey of the Intertidal Sediments of the Humber Estuary*. Report No. R.1607

A wide range of biotopes was identified in the Middle sector of the estuary, although they are predominantly sandy muds or muddy sands dominated by polychaete worms and bivalve molluscs. Generally, the most dominant biotope is HedMac (*Hediste diversicolor* and *Macoma balthica* in littoral sandy mud) along with NHomMacStr (*Nephtys hombergii*, *Macoma balthica* and *Streblospio shrubsolii*¹⁶ in littoral sandy mud) and HedMacEte (*Hediste diversicolor*, *Macoma balthica* and *Eteone longa*¹⁷ in littoral muddy sand). Many habitats in this area are fringed by saltmarsh, especially along the north shore.

The Outer North section of the estuary contains more extensive intertidal habitats, including wide areas of sandy mud with extensive networks of creeks and drainage channels. The Transects closest to the proposed Skeffling managed retreat site are Transect 11, situated off Patrington Haven, approximately 1km west of the Skeffling site, and Transect 12, approximately 1.5km east of the site. The biotopes present in this area are similar to those found in the Middle section of the estuary, both transects being predominantly composed of HedMac (*Hediste diversicolor* and *Macoma balthica* in littoral sandy mud) and HedMacEte (*Hediste diversicolor*, *Macoma balthica* and *Eteone longa* in littoral muddy sand). However, the upper shore of Transect 12 is characterised by MacAre (*Macoma balthica* and *Arenicola marina*¹⁸ in littoral muddy sand) which is only found in the Outer sections of the estuary.

The highest densities of *Macoma* were found on the upper shore of the Middle (outer) North and the Outer North sections of the estuary, and *Cerastoderma edule* was only found in the Outer estuary (Transects 10 -12 and at Cleethorpes on the south bank).

The realignment site at Paul Holme Strays, in the Middle section of the estuary, is characterised by the dominant biotope of this section, HedMac (*Hediste diversicolor* and *Macoma balthica* in littoral sandy mud). However, it also contains HedOl (*Hediste diversicolor* and oligochaete worms in littoral mud) as well as the less diverse Hed. (*Hediste diversicolor* in littoral mud).

2.5 Conclusion

On the basis of the prey preferences described above, and the distribution of invertebrate communities within the estuary, the north bank of the outer estuary appears to be similar to the middle section in terms of the biotopes present. However in general, the outer estuary appears to provide better feeding conditions for oystercatcher, knot and curlew as a result of higher densities of *Cerastoderma edule*, whilst the middle estuary appears to provide better feeding conditions for ringed plover, dunlin and redshank because of the higher densities of *Corophium volutator*.

¹⁵ Based on JNCC (2004) *Marine Habitat Classification for Britain and Ireland* (Version 04.05)

¹⁶ A polychaete worm belonging to the family Spionidae.

¹⁷ Paddleworm

¹⁸ Lugworm

3 Bird Communities

3.1 Introduction

An analysis has been undertaken of data on bird populations and communities of the Humber estuary, collected as part of the national Wetland Bird Survey (WeBS)¹⁹, in order to characterise the communities of the Middle (North & South) and Outer North sections of the estuary. Two collections of data are available, one set being based on high tide surveys and the other on low tide surveys, so that an analysis of both is necessary to obtain an overall perspective on bird distribution in the estuary. The WeBS Core Count data are based on annual surveys involving counts undertaken within two hours either side of high water, and therefore focussing on roosting birds; and the WeBS Low Tide count data are based on a one-year survey involving counts undertaken within two hours either side of low tide, and therefore focussing on the distribution of foraging birds. Further details of these data sets and their analysis are given in sections 3.2 and 3.3 below.

3.2 Data from high tide counts

For the purpose of the WeBS Core Count, the Humber Estuary is divided into 40 count sectors, from Goole downstream to Spurn Head on the north bank and Mablethorpe on the south bank. The Middle (North & South) and Outer North sections of the estuary are covered by 14 WeBS Core Count sectors as listed in Table 1 and shown on Figure 4. However, it should be noted that section 38201 does not include any intertidal habitat, and section 38442 straddles the boundary of the Middle (North) and Outer North sections, so data from this sector cannot be allocated to either section. The Outer South section of the estuary has not been included because it is not the focus of the proposed habitat creation project and has quite different sediment and bird community characteristics from the north bank.

Table1: WeBS Core Count sectors covered by this study.

Middle (North)	Middle (South)	Outer North
38436 Hessle to Hull	38414 Barrow to Barton	38442 Stone Creek to
38440 Hull to Paull	38413 New Holland to Barrow	Patrington (<i>part only</i>)
38441 Paull to Stone	38412 Goxhill to New Holland	38443 Patrington to
Creek (Cherry Cob	38411 Goxhill Marsh	Easington
Sands)	38407 Halton Marshes	38444 Spurn Head
38442 Stone Creek to	38201 North Killingholme	
Patrington (<i>part only</i>)	Haven Pits	
	38408 Killingholme Marshes	
	38905 Immingham Docks	

¹⁹ The Wetland Bird Survey (WeBS), is a joint scheme of the British Trust for Ornithology, The Wildfowl & Wetlands Trust, Royal Society for the Protection of Birds and Joint Nature Conservation Committee (the last on behalf of the Countryside Council for Wales, the Environment and Heritage Service, Natural England and Scottish Natural Heritage).

WeBS Core Count data for 2002-2007 were obtained from the British Trust for Ornithology²⁰, and the mean annual peak winter counts for each species over the six year period were used for the assessment. This is based on the convention used by WeBS for ranking sites in terms of their importance using the five-year peak mean (actually covering five winters or six years), in line with recommendations of the Ramsar Convention.

Table 2 summarises these data to compare the avian communities of the Middle (North and South) and Outer North sections of the estuary, and full details for each individual sector can be found in Appendix 1. Figures 5 and 6 present these data in the form of pie charts linked to the appropriate count sectors, the pie chart size being proportional to the total numbers of birds counted in each sector. As sector 38442 straddles the boundary between the Middle (North) and Outer North sections of the estuary, the data for this sector has been presented separately. As a result, the data for both the Middle and Outer North estuary sections are incomplete. The highest number for each species is emphasised in **bold** type, where this is at least 5% higher ²¹ than in the other section (or sector 38442), as an indication of which is the more important section of the estuary for each species.

Table 2: Sum of Mean 5-year Winter Peaks 2002/03 to 2006/07 for the Middle (North & South) and Outer North Sections of the Humber Estuary, and WeBS Count Sector 38442 which straddles both sections. Data from WeBS Core Counts taken at HW +/- 2 hours. Numbers in bold are the highest (by at least 5%).

	Middle (North & South)	Sector 38442	Outer North*
Pink-footed goose	9	97	148
Dark-bellied brent goose	8	70	506
Shelduck	2406	672	1644
Wigeon	764	439	155
Teal	1458	61	73
Mallard	1877	333	192
Pintail	7	11	92
Shoveler	85	0	3
Tufted duck	1	0	0
Pochard	326	0	3
Goldeneye	492	1	5
Oystercatcher	241	117	1575

²⁰ Austin, G.E., Calbrade, N.A., Rehfisch, M.R. & Wright, L.J. (2008) *Humber Estuary SPA Waterbird Populations: Trend analysis by count sector*. BTO Research Report No.497. British Trust for Ornithology, Thetford.

²¹ To provide some allowance for sampling error.

	Middle (North & South)	Sector 38442	Outer North*
Ringed plover	182	1	30
Golden plover	37941	3552	5076
Grey plover	840	414	598
Lapwing	17109	2178	1158
Knot	733	1778	23810
Dunlin	9026	1614	8814
Black-tailed godwit	2413	97	65
Bar-tailed godwit	724	206	1522
Curlew	1947	471	1613
Redshank	3040	304	1431
TOTAL	81714	12418	48515

* See comment below about the Middle section having a much greater length of shoreline than Outer North.

The data in Table 2, and Figures 5 & 6, show that 22 avian species occur regularly in both the Middle (North and South) and Outer North sections of the estuary, with 16 (73%) species being more abundant in the Middle section of the estuary; and 6 (27%) species more abundant in the Outer North section. Note, however, that tufted duck, pochard and goldeneye are diving ducks that are found in the open water of the estuary or on water bodies such as Barrow and Barton Pits and North Killingholme Haven Pits. They may occur in shallow water along the intertidal fringe, and in the past there were congregations around an effluent outfall at New Holland²², but they do not feed on the mudflats themselves. As tufted duck was represented by only one individual, it was excluded from further analysis.

It should be noted, however, that the Middle section of the estuary is over twice the length of the Outer North section, and the combined shoreline of both banks of the Middle section is almost six times the length of the Outer North shoreline (see Figure 4). Consequently, the area of intertidal mud available for birds varies between the two sections of the estuary (as well as between count sectors), and this is likely to affect the numbers of birds that can be accommodated in each sector or section.

In an attempt to facilitate a comparison of the value of the two sections of the estuary for birds, taking account of these different dimensions, an analysis of relative density of each species was undertaken. However, although the areas of mudflat available at low tide are known for each sector and section, the Core Counts are undertaken at or around high tide (+/- 2 hours) when the intertidal area available for birds is considerably reduced and the area available at the time of

²² Mander, L. and Cutts, N. (2005) *Humber Estuary Low Tide Count Programme 2003-2004*. English Nature Research Report No.656, English Nature, Peterborough.

the counts is not known. Many of the birds counted are likely to be roosting birds excluded from feeding on the lower shore by the tide, plus some feeding on any areas of upper shore still uncovered. In addition, it does not necessarily follow that the birds counted in a sector actually feed in that sector, as birds may move between sectors from foraging sites to roosting sites. Consequently, it has been decided that the only practicable measure that can be used in this analysis is a linear one, based on the shore length of the count sectors, and densities are therefore expressed as numbers of birds per kilometre. Table 3 summarises these relative densities (see Appendix 2 for full details) and shows that 8 (38%) species reach a higher overall density in the Middle section of the estuary; 11 (52%) species reach a higher overall density in the Outer North section; one species (ringed plover) reach very similar densities in both sections; and one species (wigeon) reaches a higher density in the “trans-boundary” sector 38442.

Table 3: Density of birds per km based on Mean 5-year Winter Peaks 2002/03 to 2006/07 for the Middle (North & South) and Outer North Sections of the Humber Estuary, and WeBS Count Sector 38442 which straddles both sections. Data from WeBS Core Counts taken at HW +/- 2 hours. Numbers in bold are the highest (by at least 5%).

	Middle (North & South)	Sector 38442	Outer North
Length of shore	55.6km	10.8km	9.4km
Pink-footed goose	0.16	8.98	15.74
Dark-bellied brent goose	0.14	6.48	53.83
Shelduck	43.27	62.22	174.89
Wigeon	13.74	40.65	16.49
Teal	26.2	5.6	7.8
Mallard	33.8	30.83	20.43
Pintail	0.1	1.0	9.8
Shoveler	1.5	0	0.3
Pochard	5.9	0	0.3
Goldeneye	8.8	0.1	0.5
Oystercatcher	4.32	10.83	167.55
Ringed plover	3.27	0.09	3.19
Golden plover	682.4	328.89	540.00
Grey plover	15.11	38.33	63.62
Lapwing	300.16	201.67	123.19
Knot	13.18	164.63	2532.98
Dunlin	162.3	149.44	937.66
Black-tailed godwit	43.4	8.98	6.91

	Middle (North & South)	Sector 38442	Outer North
Bar-tailed godwit	13.02	19.07	161.91
Curlew	35.0	43.61	171.60
Redshank	54.7	28.15	152.23

It should be noted, however, that there was wide variation in the densities of species between count sectors within both sections of the estuary (see Appendix 1 and Figures 5 & 6), so that one sector may have higher or lower densities than adjacent sectors, or than the overall density for the section. In addition, the populations of some species were highly localised, and there is evidence that some of the high numbers of birds (eg. golden plover) in the Middle section of the estuary were associated with the Paull Holme Strays realignment site rather than the intertidal zone (see section 3.4).

Consequently, it can be concluded that all regular intertidal species counted during the WeBS Core Counts occur in both the Middle and the Outer North sections of the estuary. However, 16 (73%) species are more abundant in the Middle section of the estuary and 6 (27%) species more abundant in the Outer North section. In contrast, 11 (52%) species reach a higher overall *density* in the Outer North section of the estuary compared with 8 (38%) species in the Middle section. Nevertheless, for all species, there is a large degree of overlap in numbers and densities between count sectors in both the Middle and Outer North sections of the estuary.

3.3 Data from low tide counts

In addition to the WeBS core counts, there are specific data concerning low tide distribution on the intertidal mudflats throughout the estuary, based on a low tide survey undertaken from 2003-2004^{23,24}. For the purposes of the low tide survey, the WeBS Core Count sectors were subdivided into the low tide survey sectors shown in Table 4 and Figure 7, to give more detailed information on bird distribution. In contrast to the WeBS Core Count sectors, the low tide count sectors divide neatly between the two estuary sections – Middle North and Outer North, so the data for both the estuary sections are complete.

²³ Mander and Cutts. *Op.cit.*

²⁴ The results of a previous low tide survey in the winter of 1998/99 were not available for this report but a review and dot-density maps of a selection of species are included in Musgrove *et al.* (2003) *Op.cit.*

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Table4: WeBS Low Tide Count sectors covered by this study

Core Count Sector	Low Tide Sector
Middle (North)	
38436	NE Humber Bridge to Hull
38440	NF1 Hull to Alexandra Dock NF2 Alexandra Dock to Paull
38441	NG1 Paull to Paull Battery NG2 Paul Battery to Paull Holme NG3 Paull Holme to Little Humber NG4 Little Humber NG5 The Outstray to Cherry Cob NG6 Cherry Cob to Stone Creek
38442	NH1a Stone Creek to West Bank (Lower shore) NH1b Stone Creek to West Bank (Upper shore) NH1c West Bank to Old Hall
Middle (South)	
38414	ISF2 Barton Haven to Barrow Haven
38413	ISF3 Barrow Haven to New Holland Pier
38412	ISG New Holland Pier to Goxhill Haven
38411	ISH Goxhill Haven to East Halton Skitter
38407	ISI East Halton Skitter to North Killingholme Haven
38201	ISJJ North Killingholme Haven Pits
38406	ISJ North Killingholme Haven to South Killingholme Haven
38905	ISK South Killingholme Haven to first factory past Immingham Dock
38405	MSA Factory south of Immingham Dock to Grimsby Dock Tower
Outer North	
38442	NH2a Old Hall to Newlands NH2b Newlands to Outstray Farm NH2c Outstray Farm to Patrington Channel
38443	NJ1 Patrington Channel to Skeffling Clough NJ2 Skeffling Clough to Kilnsea
38444	NK Kilnsea to Spurn Head (includes Spurn Bight)

Although five-year mean annual peak winter counts were used in the case of the core count sector, the low-tide survey only covered one twelve month period and the data used in this analysis are the peak winter counts given in Mander & Cutts (2005).

Table 5, and Figures 8 & 9, summarises these data to compare the avian communities of the Middle (North & South) and Outer North sections of the estuary, and show that 19 intertidal feeding avian species occur regularly in both the Middle and Outer North sections of the estuary.

Table 5: Low Tide Peak Winter Counts 2003/04 for the Middle (North & South) and Outer North Sections of the Humber Estuary. Data from WeBS Low Tide Counts taken at LW +/- 2 hours. Numbers in bold are the highest (by at least 5%).

	Middle (North & South)	Outer North
Dark-bellied brent goose	0	225
Shelduck	5391	1277
Wigeon	150	1296
Teal	787	56
Mallard	1647	615
Oystercatcher	132	2447
Avocet	4	1
Ringed plover	490	139
Golden plover	46230	16100
Grey plover	1349	1129
Lapwing	24644	4633
Knot	6882	39670
Sanderling	106	3
Dunlin	16365	13938
Black-tailed godwit	2385	6
Bar-tailed godwit	2087	1773
Curlew	2579	1921
Redshank	8455	2894
Turnstone	890	60
TOTAL	120573	88183

As the survey only covered a twelve month period, the results should be treated with a certain amount of caution, but they do give an indication of the value of the intertidal area for birds. As in the case of the Core Counts, the numbers of these species vary between the sections, so that 15 (79%) species are more abundant in the Middle section of the estuary, 4 (21%) are more abundant in the Outer North section. This pattern was more skewed to the Middle section than that produced by the Core Count data, although dark-bellied brent goose was only found in Outer North during the low tide survey. Other differences included the presence of avocet, sanderling and turnstone which reached highest numbers in the Middle section, although avocet numbers totalled only 5 and have been excluded from further analysis. The number of sanderling recorded is surprising, as it is normally a species restricted to the sandy shores of the Outer South section of the estuary, and the distribution of turnstone appears to be linked to the presence of fucoid covered boulders at the foot of flood embankments²⁵.

In addition, as mentioned in section 3.3, the populations of some species were highly localised, and the counts of golden plover and lapwing probably included many birds feeding or roosting on adjacent agricultural fields, even at low tide²⁶. Some of the high numbers of birds in the Middle section of the estuary were associated with the Paull Holme Strays realignment site rather than the intertidal zone. This applies to approximately 47% of teal and 45% of mallard, 64% of the Middle (North) population of black-tailed godwits²⁷, and also golden plover. A recently modified mudflat area at Saltend, in sector 38440, supported 80% of the ringed plover of the Middle estuary section, and 77% of black-tailed godwits were counted in sector 38405²⁸. Note also that maps in Mander & Cutts (2005) show that the main concentration of wigeon in sector 38442 was in the outer estuary side of the sector.

The only species that were more abundant in the Outer North section were brent goose, wigeon, oystercatcher and knot. This may be explained by a link between oystercatcher and knot distribution and cockle densities (see section 2.5), and between brent goose, wigeon and key saltmarsh sites.

An analysis of density of the bird species was undertaken using the low tide count data and, as the counts were undertaken at or around low tide (+/- 2 hours) when the intertidal area available for birds is fully available, it is possible to express density as numbers of birds per square kilometre or hectare (Table 6) based on area information published in Mander & Cutts (2005). This is an accepted practice that has been used by Musgrove *et al.* (2003)²⁹, Mander & Cutts (2005) and by the British Trust for Ornithology in their WeBS annual reports to produce dot-density maps of bird distribution in the Humber and other estuaries. In calculating densities, adjustments are made for broad species-specific habitat associations by subdividing

²⁵ Mander & Cutts *Op.cit.* pp. 91 & 120.

²⁶ Based on personal observations (L. Batty) during low tide counts at Halton Marshes in winter 2008/9 when there were up to 600 golden plovers and 500 lapwings on the adjacent fields.

²⁷ *Ibid.*

²⁸ *Ibid.*

²⁹ Musgrove, A., Langston, R., Baker, H. & Ward, R. (Eds.) (2003) *Estuarine Waterbirds at Low Tide: The WeBS Low Tide Counts 1992-93 to 1998-99*. International Wader Studies 16. WSG/BTO/RSPB/JNCC, Thetford.

count sectors into broad habitat areas eg. mudflat, saltmarsh and sand. However, area data available in Mander & Cutts (2005), for densities calculations in this report, covered the whole of each count sector and were not further subdivided into broad habitat types. In addition, although bird densities in each sector are published in Mander & Cutts (2005), they are based on mean seasonal counts rather than peak winter counts and are not, therefore, comparative with the core count data. Moreover, these density analyses, and presentations of the distribution of bird species found in the literature, assume a regular distribution across the intertidal area. However, in reality, there is not a simple relationship between bird numbers and area as most birds are not evenly distributed across the intertidal zone. Grey plovers, for example, show a preference for feeding at mid to upper tide levels, where deep creeks provide shelter from wind which disturbs their feeding technique³⁰. Other species which tend to prefer feeding at upper shore levels include ringed plover, lapwing, brent goose and wigeon, whilst knot, dunlin, bar-tailed godwit and black-tailed godwit tend to prefer lower levels³¹. Nehls & Tiedman (1993)³² have divided waders into dispersal foragers, tide line foragers and preferred area foragers, and Granadeiro *et al.* (2006)³³ divided them into tide followers (black-tailed godwit, dunlin and avocet) and non-followers (grey plover, redshank and bar-tailed godwit), whilst other non-followers include oystercatcher, ringed plover and sanderling³⁴. Unfortunately, sufficient information has not been compiled on the detailed low tide distribution of bird species on the Humber estuary to facilitate an accurate assessment of the effects of coastal squeeze on the different species.

Consequently, and to be consistent and comparative with the analysis of core count data, the low tide densities have been calculated on a shore length basis and expressed in peak winter number per kilometre (Table 6). Nevertheless, these still provide a useful indication of the low tide distribution of bird species between the sections.

Table 6 shows that the densities of these species vary within the estuary, so that 6 (33%) species reach a higher overall density in the Middle section of the estuary, and 12 (67%) species reach a higher overall density in the Outer North section. However, as in the case of the Core Count data, there is substantial variation in numbers between sectors in the same estuary section, so that one sector may have higher or lower densities than adjacent sectors, or than the overall density for the section. (Note that there is a 1.5km or 1.9% difference in total shore length between the core and low tide count data analyses, as a result of small differences or errors in measurement, but these are not considered sufficient to cause a significant error in the results.)

³⁰ Townshend, D.J., Dugan, P.J. & Pienkowski, M.W. (1984) The unsociable plover – use of intertidal areas by Grey Plovers. In: Evans, P.R., Goss-Custard, J.D. & Hale, W.G. (Eds.) (1984) *Coastal Waders and Wildfowl in Winter*. Cambridge University Press. Pp.140-159.

³¹ Fuller, J. (1982) *Bird Habitats in Britain*. Poyser, Calton.

³² Nehls, G. & Tiedemann, R. (1993) What determines the densities of feeding birds on tidal flats – a case study on dunlin *Calidris alpina* in the Wadden Sea. *Netherlands Journal of Sea Research* 31 (4), 375-384.

³³ Granadeiro, J.P., Dias, M.P., Martins, R.C. & Palmeirim, J.G. (2006) Variation in numbers and behaviour of waders during the intertidal cycle: implications for the use of estuarine sediment flats. *Acta Oecologia* 29, 293-300.

³⁴ Vanerman, N., De Meulenaer, B. & Stienen, E.W.M. (2006) *Shorebirds and their Abiotic Environment*. INBO Report No. 169

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Table 6: Peak Low Tide Density (numbers/km) 2003/04 for the Middle (North & South) and Outer North Sections of the Humber Estuary. Data from WeBS Low Tide Counts taken at LW +/- 2 hours. Numbers in bold are the highest (by at least 5%).

	Middle (North & South)	Outer North
Shore length	61km	16.3km
Dark-bellied brent goose	0.0	13.8
Shelduck	88.4	78.3
Wigeon	2.5	79.5
Teal	12.9	3.4
Mallard	27	37.7
Oystercatcher	2.2	150.1
Ringed plover	8	8.5
Golden plover	757.9	987.7
Grey plover	22.2	69.3
Lapwing	404.0	284.2
Knot	112.8	2433.7
Sanderling	1.7	0.2
Dunlin	268.3	855.1
Black-tailed godwit	39.1	0.4
Bar-tailed godwit	34.2	108.8
Curlew	42.3	117.9
Redshank	138.6	177.5
Turnstone	14.6	3.7

Consequently, it can be concluded that all except one regular intertidal species counted during the WeBS Low Tide Counts were found in both the Middle and the Outer North sections of the estuary, the exception being dark-bellied brent goose which was only found in Outer North. However, 15 (79%) species were more abundant in the Middle section of the estuary, 4 (21%) were more abundant in the Outer North section. In contrast, only 6 (33%) species reach a higher overall density in the Middle section of the estuary, and 12 (67%) species reach a higher overall density in the Outer North section. Nevertheless, for all species, there is a large degree of overlap in numbers and densities between count sectors in both the Middle and Outer North sections of the estuary.

3.4 Paull Holme Strays

The use of Paull Holme Strays managed realignment site by birds for foraging and roosting occurred rapidly once inundation occurred in 2003, and it remains a key function of the site. Ornithological monitoring of the site and adjacent intertidal zone commenced in January 2002, before the flood embankment was breached, and has continued annually since then. The data presented below summarise the situation, up to and including the 2008-9 monitoring season³⁵.

The avian assemblage is typical of that present on the upper shore of the middle to outer Humber Estuary, with redshank dominating the assemblage on the realignment site, and reaching higher foraging densities than on the adjacent intertidal area. Mean winter densities have peaked at 3.69 birds / ha, whilst the mean winter density is 2.06 birds / ha.

Other key species occurring in high numbers at Paull Holme Strays include golden plover, lapwing, dunlin, black-tailed godwit, bar-tailed godwit, teal and mallard. Nationally important numbers of golden plover occur on the site, predominantly for roosting / loafing, with numbers around an average of approximately 4,000 birds. During the first four years, the realignment site, developed as a major roosting/ loafing site for black-tailed godwit, supporting on many occasions flocks of national importance in autumn, as well as increasing numbers of foraging birds. Densities of foraging birds were greater than on the adjacent intertidal in autumn and winter, averaging 0.9 birds / ha. The numbers of teal using the realignment site appear to have shown a steady upward trend since realignment, peaking at 502 birds in 08/09, a density of 6.28 birds / ha.

The total of mean counts for each of all key species does not appear to have changed significantly since the realignment, although the numbers of some foraging wildfowl, particularly shelduck, have fallen.

³⁵ Mander, L., Phelps, A. Thomson, S & Cutts, N. (2010) *Waterbirds Monitoring at Paull Holme Strays: Annual Report #7, September 2008 to August 2009*. Report to Halcrow Group Ltd. Institute of Estuarine and Coastal Studies, University of Hull.

4 Summary and Conclusion

4.1 Summary

There is a large degree of overlap between the invertebrate communities of the Middle and Outer North sections of the Humber estuary, although the outer estuary appears to provide better feeding conditions for oystercatcher, knot and curlew as a result of higher densities of *Cerastoderma edule*, whilst the middle estuary appears to provide better feeding conditions for ringed plover, dunlin and redshank because of the higher densities of *Corophium volutator*. Consequently, oystercatcher and knot reach their highest numbers in the Outer North section, and curlew reaches its highest densities. Nevertheless, all middle estuary bird species do occur in the Outer North section of the estuary, and are clearly utilising the other invertebrate prey species that are abundant in that area.

Analyses of the WeBS Core Count and Low Tide Count data show that there is a large degree of overlap in bird communities, with 25 bird species occurring regularly in both estuary sections. However, there are differences in relative densities, and Table 7 presents a summary of data and comments concerning the 11 species which reach lower densities in the Outer North section of the estuary compared with the Middle section, according to one or both of the data sets.

Table 7: The eleven species of birds that reach lower densities in the Outer North section of the Humber estuary compared with the Middle section. Where density is lower in the Outer section, a negative value is applied, and where density is greater, a positive value is applied. (nc = not recorded)

Species	Difference in bird densities between the two sections of the estuary		Maximum total count	Comments
	Core count	Low tide count		
Shelduck	+75.3%	-11.4%	6668	The difference may reflect variations in distribution between high and low tide, or seasonal changes ^{36,37} .
Teal	-70.3%	-73.6%	1592	Teal are mainly distributed in the upper and middle Humber.
Mallard	-39.6%	+28.4%	2402	May reflect a seasonal or inter-annual change in distribution ³⁸ or the continuing decline in this species on the Humber and

³⁶ Mander & Cutts *Op.cit.* p.38-39.

³⁷ Catley, G. (2000) *Humber Estuary wetland bird survey: Twelve months of high and low tide counts, September 1998 to August 1991 – Part 1*. English Nature Research Report N. 339. English Nature, Peterborough.

³⁸ Mander & Cutts *Op.cit.* p.52.

³⁹ Holt, C., Austin, G., Calbrade, N., Mellan, H., Thewlis, R., Hall, C., Stroud, D., Wotton, S. & Musgrove, A. (2009) *Waterbirds in the UK 2007/08: The Wetland Bird Survey*. BTO/WWT/RSPB/JNCC, Thetford.

				nationally since 1990 ³⁹ .
Shoveler	-80%	nc	88	Restricted to saline lagoons and clay pits ⁴⁰ .
Pochard	-94.9%	nc	329	Mainly occurring on clay pits or at New Holland sewage outfall ⁴¹ .
Goldeneye	-94.3%	nc	498	A fully aquatic species, not feeding on the intertidal.
Golden plover	-20.9%	+23.3%	62330	Use mudflats primarily for roosting. Also use surrounding fields.
Lapwing	-59.0%	-29.7%	29277	Use mudflats primarily for roosting. Also use surrounding fields.
Sanderling	nc	-88.2%	109	Anomalous. Main population on sandy shores of Outer South section of estuary ⁴² . (Possible error in data?)
Black-tailed godwit	-84.1%	-99.0%	2575	Main concentrations in the Killingholme area, Pyewipe and Paull Holme/Stone Creek.
Turnstone	nc	-74.7%	950	Middle estuary distribution reflects distribution of boulder strewn upper shores with brown algal covering.

Of these 11 species, shoveler, pochard and goldeneye are unlikely to be affected by sea level rise because of their fully aquatic nature and use of the open water of the estuary and/or associated clay pits and other water bodies. The densities of both shelduck and mallard are higher in the outer estuary according to one of the data sets, so their preference for either of the estuary sections may be variable and show diurnal (tidal), seasonal or longer term changes. Golden plover and lapwing use the intertidal zone mainly for roosting, as well as using surrounding fields, and many of the birds included in the counts are actually likely to have been using the fields behind the flood embankments, even at low tide (see page 14, section 3.3). The data for sanderling is anomalous, in that the main population is on the sandy shores of the Outer South section of the estuary, and the birds counted on the low tide count may have been a temporary flock. In addition, the sanderling is a tide-follower and the impact of sea-level rise on its behaviour and distribution is likely to be low.

The three species that do show a consistent preference for the intertidal zone in the Middle section of the estuary are teal, black-tailed godwit and turnstone. The distribution of teal on the Humber estuary tends to be associated with creeks and saltmarshes, where they feed on seeds and other vegetable matter, and, as mentioned in section 3.4, they have

⁴⁰ Catley, G. (2000) *Humber Estuary Wetland Bird Survey: Twelve months of high and low tide counts September 1998 to August 1999*. English Nature Research Report Number 339. English Nature, Peterborough.

⁴¹ Mander & Cutts *Op.cit.* p.125.

⁴² Mander & Cutts *Op.cit.* p. 91.

made good use of the realignment site at Paull Holme Strays⁴³. Black-tailed godwit are very localised in their distribution on the Humber, but as they tend to be tide-followers and show a preference for the lower shore, any effect of sea-level rise during the period of the Humber Strategy is likely to be low as the area of habitat available to them may be maintained through landward migration of the lower shore. Nevertheless, they have also made good use of Paull Holme Strays realignment site and could, therefore, potentially make use of the proposed realignment site at Skeffling. Finally, the distribution of turnstone is linked to the distribution of furoid covered boulders and cobble habitat in the Middle section of the estuary. As much of this habitat is anthropogenic in origin, there is potential to recreate it in the area of the proposed new realignment site.

4.2 Conclusion

In conclusion, therefore, it is considered that **the proposed habitat creation site at Skeffling, in the Outer North section of the Humber estuary, does have the potential to provide the same functional habitat, for bird species displaced by sea-level rise and flood defence improvements, as the Middle section of the estuary does currently.** The current invertebrate and bird communities are sufficiently similar to indicate that a site on the north bank of the outer Humber estuary could provide compensation for losses in the middle section of the estuary. Comparisons with the existing managed realignment site at Paull Holme Strays suggest that it would potentially improve the habitat quality for some of the bird species.

The Environment Agency propose to work with Natural England and other stakeholders in designing the Skeffling managed realignment site so that it has the necessary features to encourage the key species that may be displaced from the middle estuary as a result of coastal squeeze, particularly teal, black-tailed godwit and turnstone, as well as shelduck, mallard, golden plover and lapwing.

Much has been learned from the successes and monitoring of other managed realignment and habitat creation projects on the Humber. It is intended that this knowledge and experience be applied to ensuring, as far as possible, that the proposed realignment site at Skeffling meets the requirements of the species concerned. In addition, a new low tide survey will be undertaken over the 2011-2012 season and this aims to gather behavioural information as well bird numbers, which will help to give us a greater understanding of bird distribution on the Humber and the potential effects of coastal squeeze.

As managed realignment sites are located in the upper shore and tend to be sheltered from wave action, they are more likely to accumulate fine sediments than coarse sediments and, in this way, a managed realignment site at Skeffling is likely to develop similar characteristics to Paull Holme Strays and other middle estuary sites. Specific habitat features could be incorporated in the design of the site, for species of concern, such as boulders and cobble habitat for turnstone; areas of wet mud for shelduck and black-tailed godwit; and dykes and lagoons for teal and mallard. The site would also be designed in such a way as to limit the potential long-term encroachment of saltmarsh over the avian foraging habitats.

The Environment Agency would also intend to progress a risk-based approach to development of the site and to development of the wider habitat creation programme. It is

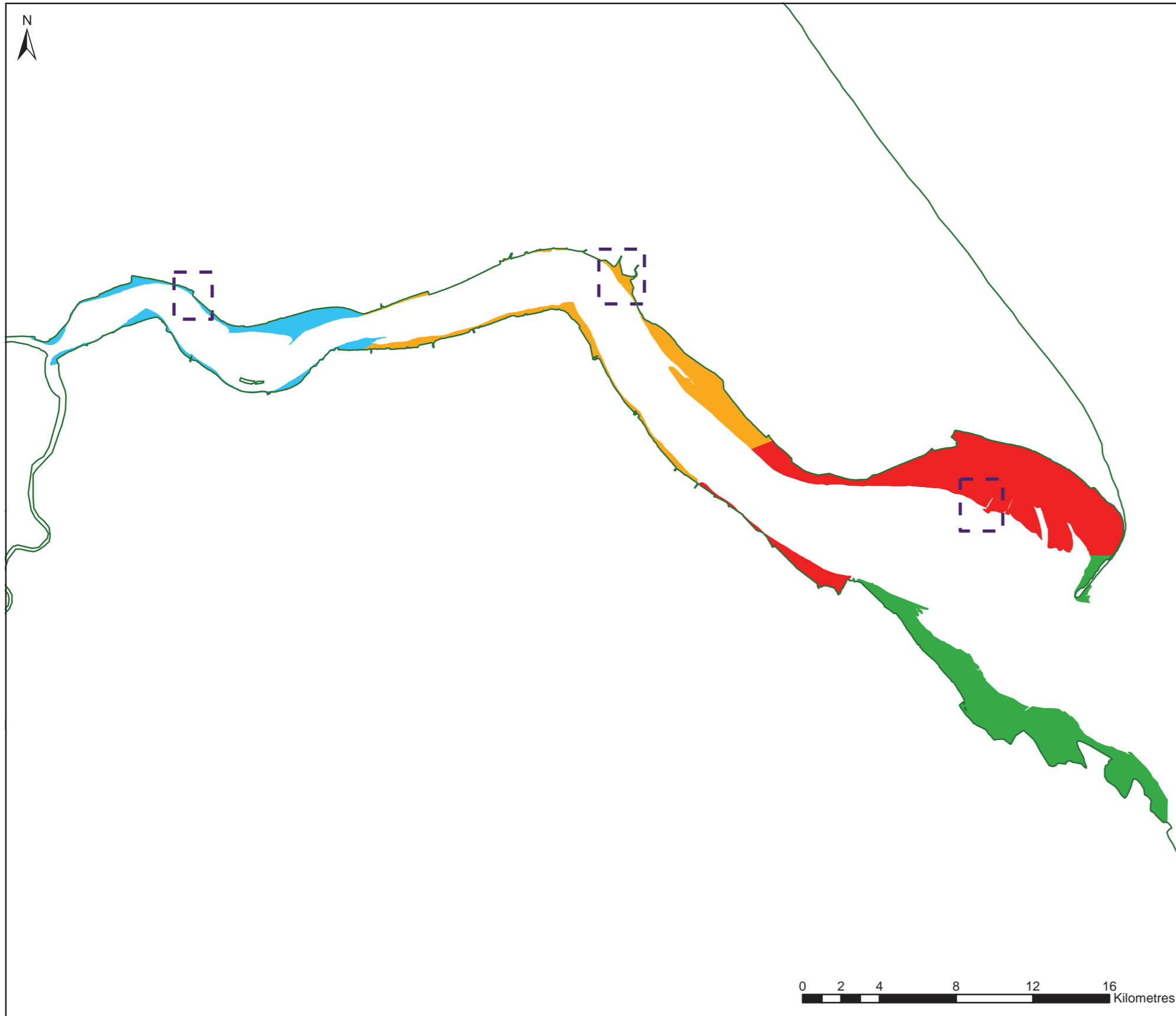
⁴³ *Ibid.* p. 47.

intended that the managed realignment sites will be monitored to assess whether they are meeting the objectives (detail to be agreed with Natural England) set. If this does not prove to be the case sites will be adjusted if appropriate or additional sites will have to be found. This monitoring and assessment would form part of the regular (c. 5 yearly) Strategy review.



Figures





Assemblages

- A
- B
- C
- D
- ABPmer sample sites

Please note that all invertebrate data was supplied by Environment Agency

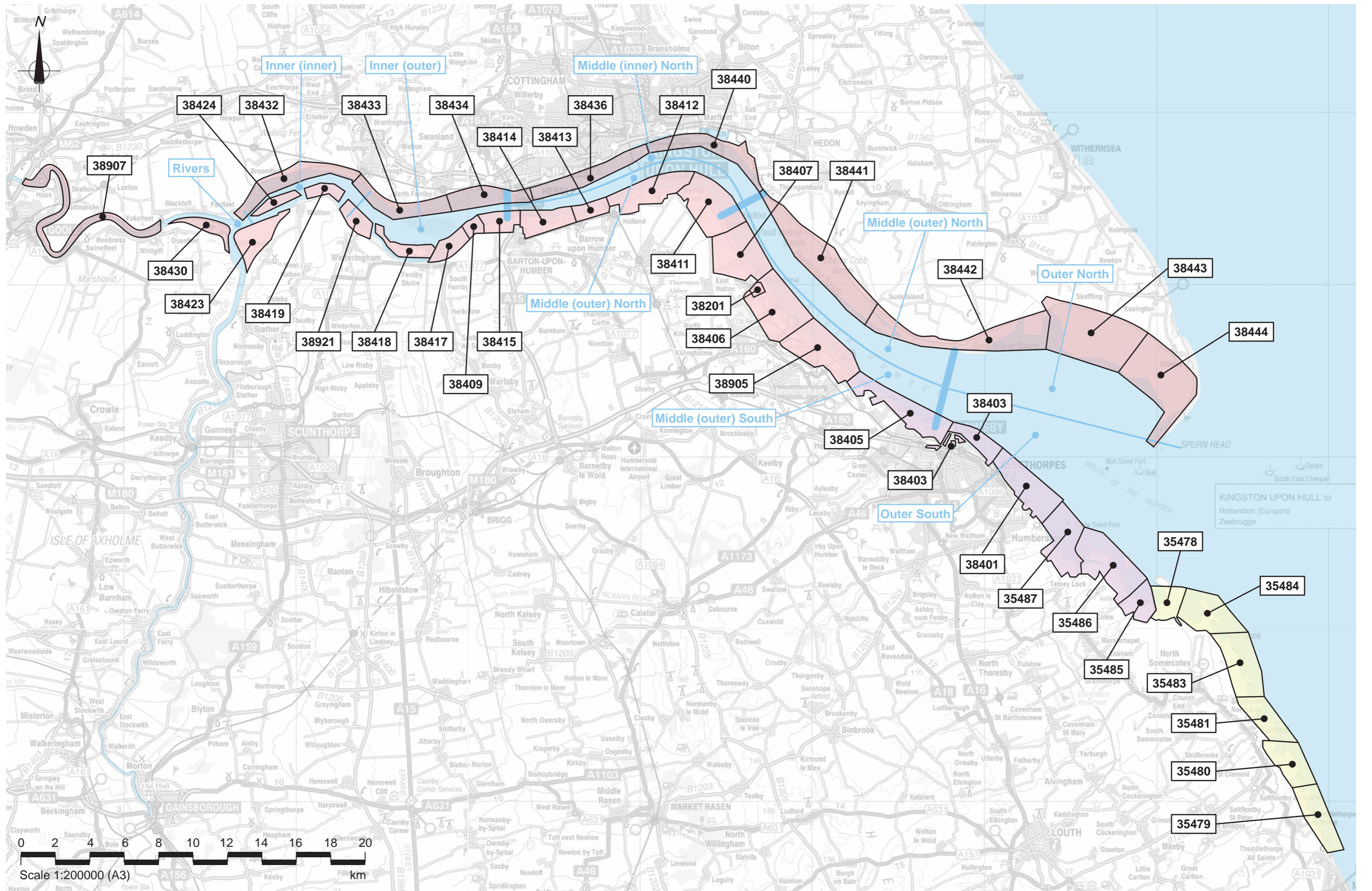
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Figure 4: Humber Estuary Coastal Habitat Management Plan
Spatial Variations in Intertidal Macrobenthic Assemblages

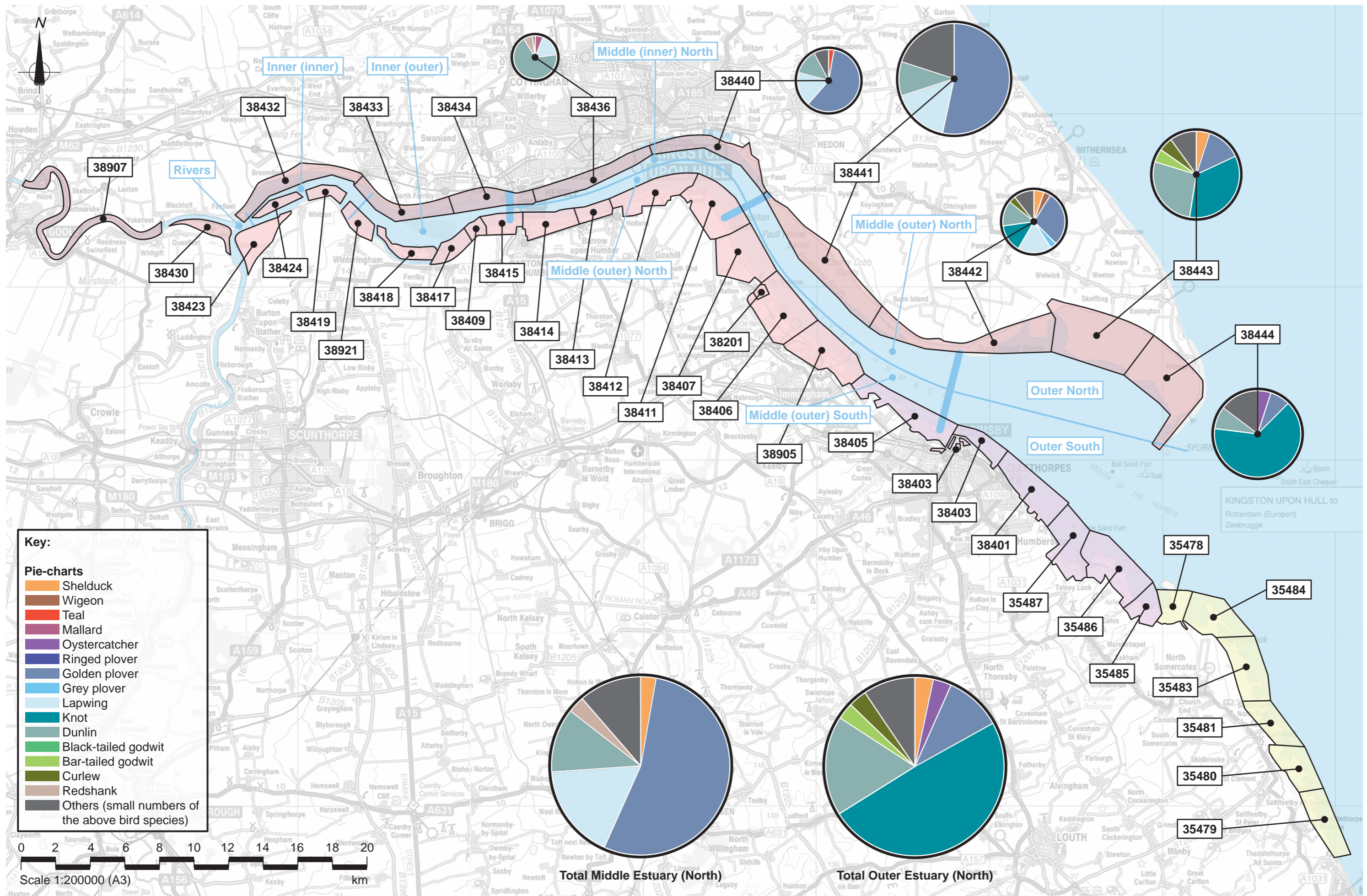


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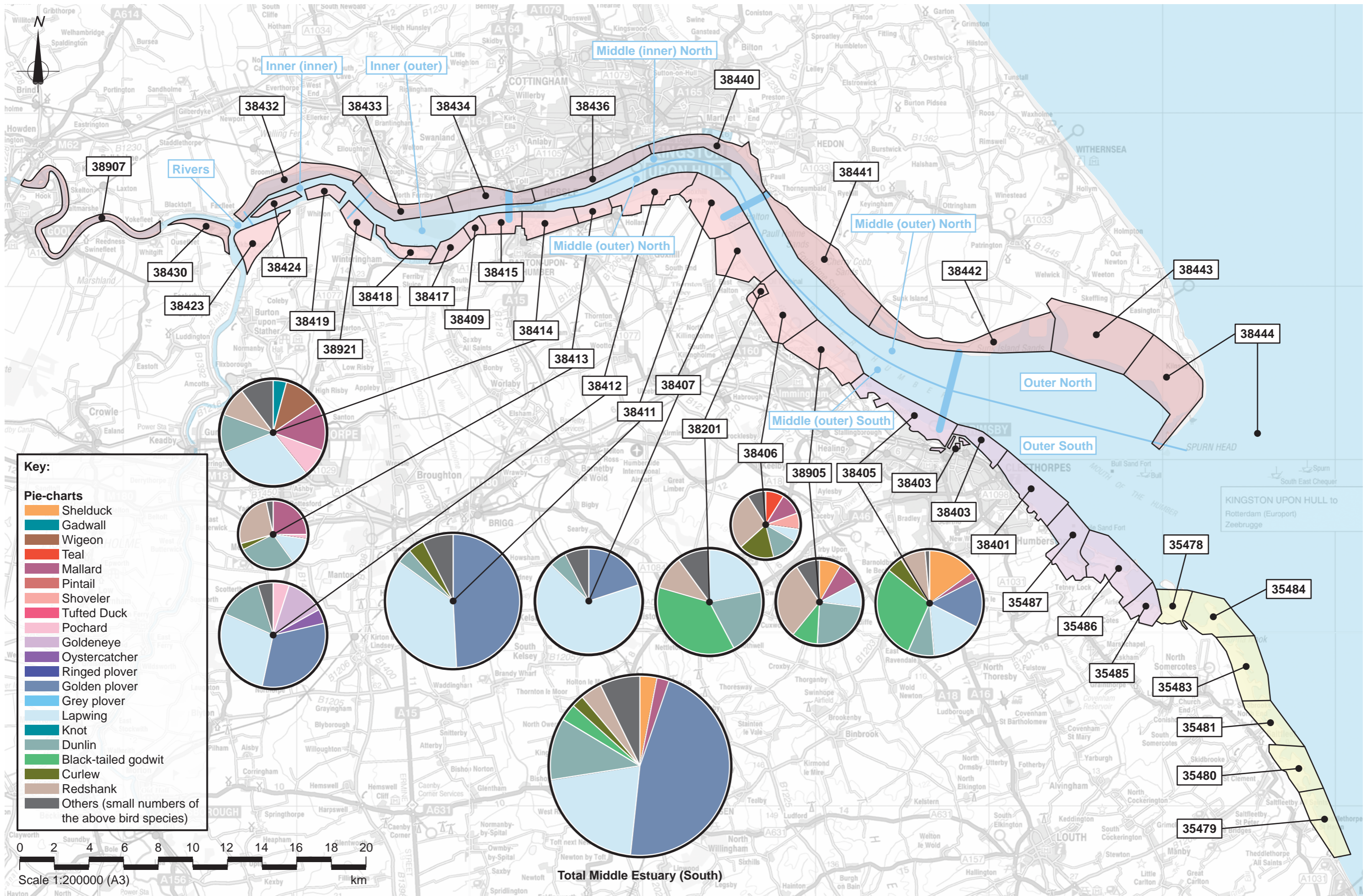
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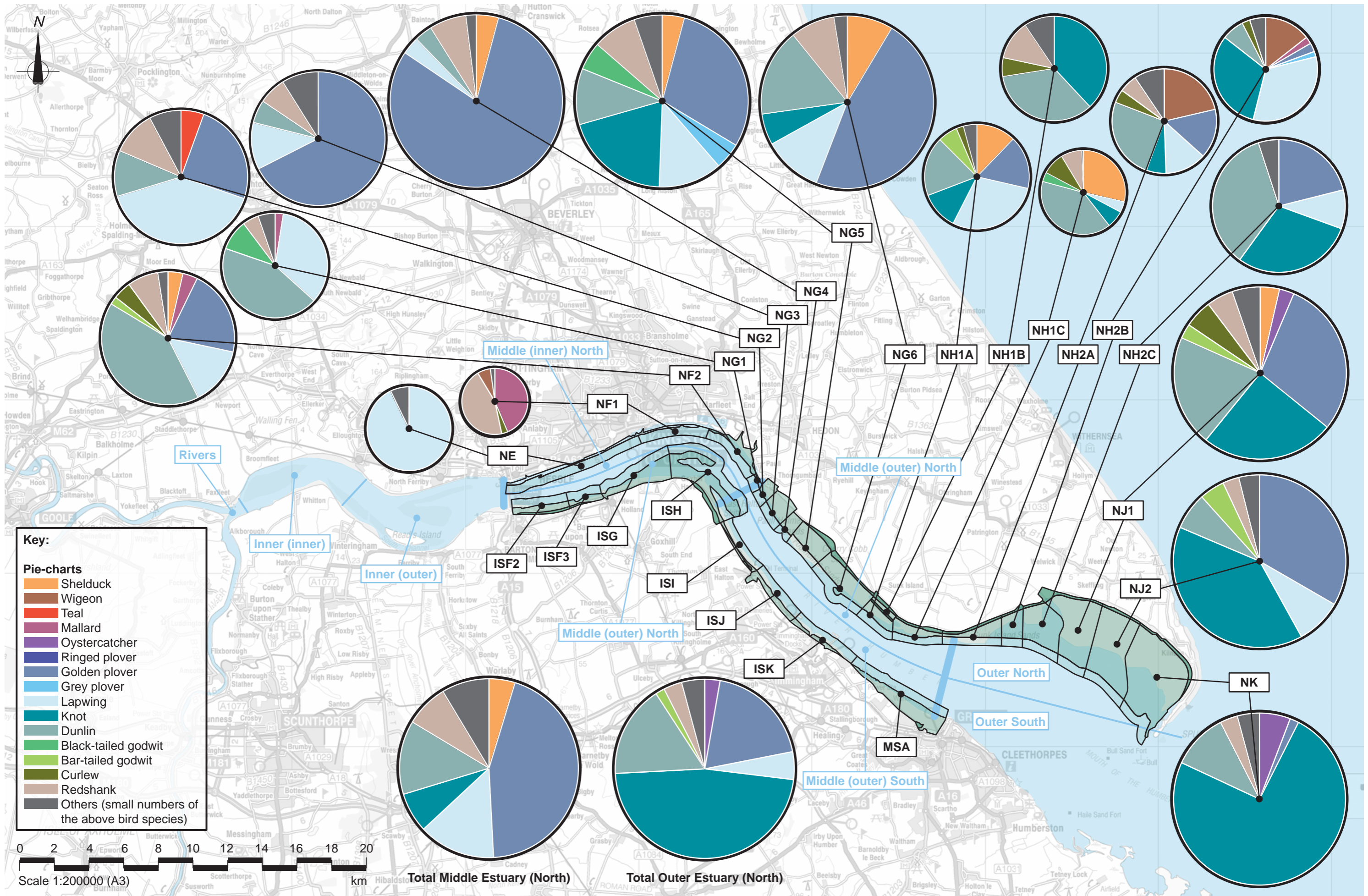
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Humber Strategy: Skeffling
 Populations of Key Species by WeBS Core Count Sectors (North Bank) - Figure 5



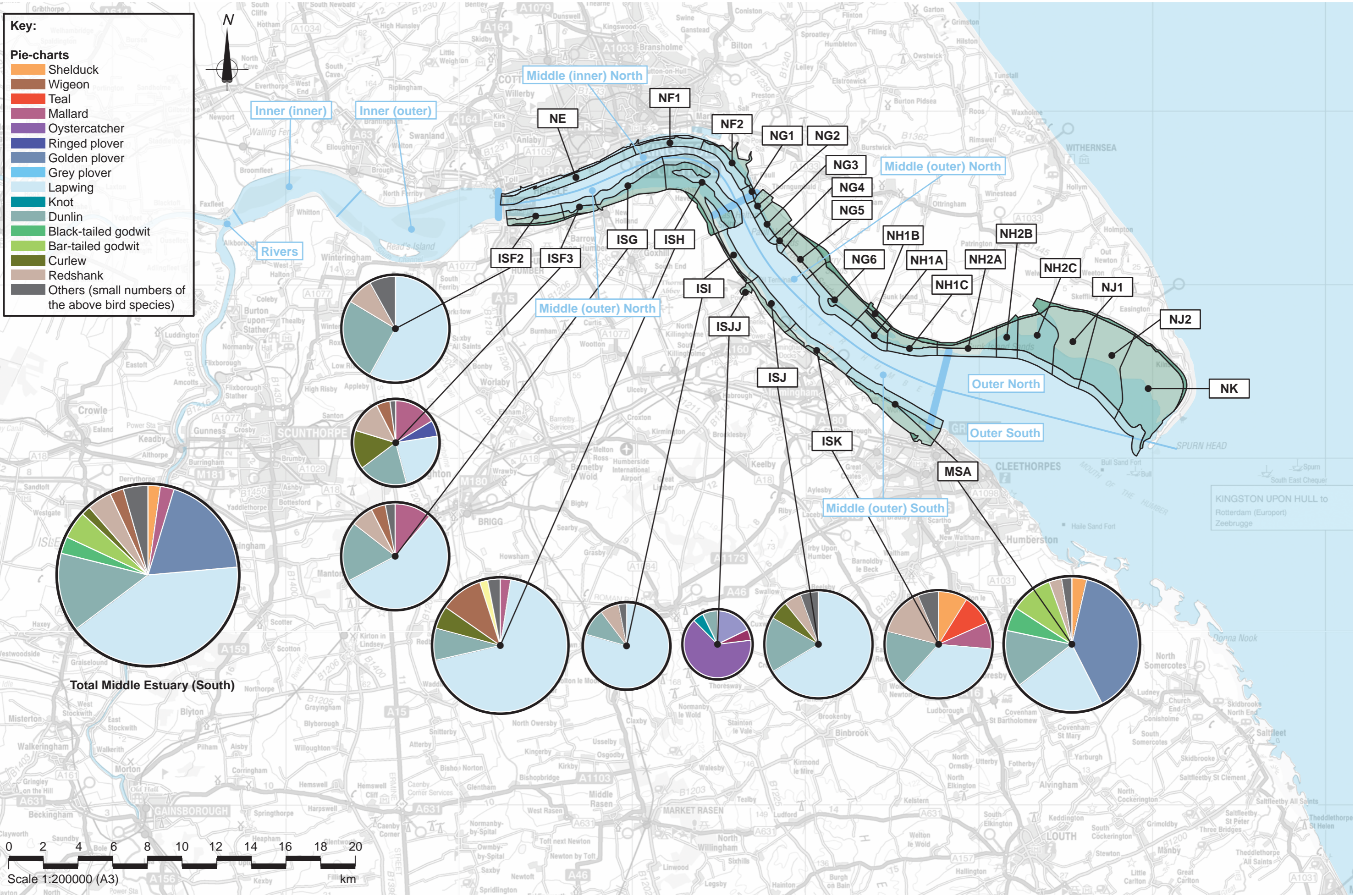


Populations of Key Species by WeBS Core Count Sectors (South Bank) - Figure 6



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Humber Strategy: Skeffling
Populations of Key Species by WeBS Low Tide Count Sectors (North Bank) - Figure 8



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Humber Strategy: Skeffling
Populations of Key Species by WeBS Low Tide Count Sectors (South Bank) - Figure 9



Appendix A

WeBS Core Count Data

Appendix A: Humber Estuary Core Count Data

	Middle Estuary (North)			Middle Estuary (South)									Total Middle	Transition	Outer Estuary		Total Outer North
	Sector 38436	Sector 38440	Sector 38441	38414	38413	38412	38411	38407	38201	38406	38905	38405		Sector 38442	Sector 38443	Sector 38444	
	Pink-footed goose			8				1							9	97	
Dark-bellied brent goose			5				3						8	70	85	421	506
Shelduck	2	169	1453	9	3	2	22	5	9	4	67	670	2415	672	1223	421	1644
Gadwall			8	53	2	2	5	1	1	4			76	2		2	2
Wigeon			515	148		61	39			1			764	439	54	101	155
Teal		471	653	29	9	11	168	6	53	16	37	5	1458	61	15	58	73
Mallard	51	131	834	189	124	11	276	25	43	19	70	104	1877	333	90	102	192
Pintail			7										7	11	90	2	92
Shoveler			3	26	2	2	4		34	14			85			3	3
Tufted duck									1				1				0
Pochard				112	11	186		12		5			326			3	3
Goldeneye				29		446	17						492	1		5	5
Oystercatcher		2	42	2	1	166	1	1	1		1	24	241	117	417	1158	1575
Ringed plover	14	146	6	5		1	4					3	182	1	4	26	30
Golden plover		9553	21741	1		1184	4350	405	37			670	37941	3552	3247	1829	5076
Grey plover			821									19	840	414	301	297	598
Lapwing	155	2869	6852	379	64	1049	3156	1356	420	11	78	720	17109	2178	558	600	1158
Knot		2	722	0			2				1	6	733	1778	8560	15250	23810
Dunlin	607	2151	4079	152	136	505	320	110	394	23	189	360	9026	1614	6800	2014	8814
Black-tailed godwit		103	187			5	16	1	718	2	81	1300	2413	97	25	40	65
Bar-tailed godwit		68	646				7					3	724	206	1248	274	1522
Curlew	2	294	879	30	16	31	346	45	13	31	32	228	1947	471	1291	322	1613
Redshank	60	337	1356	117	129	50	103	54	202	50	237	345	3040	304	624	807	1431
TOTAL	891	16296	40817	1281	497	3712	8840	2021	1926	180	796	4457	81714	12418	24777	23738	48515



Appendix B

WeBS Low Tide Count Data

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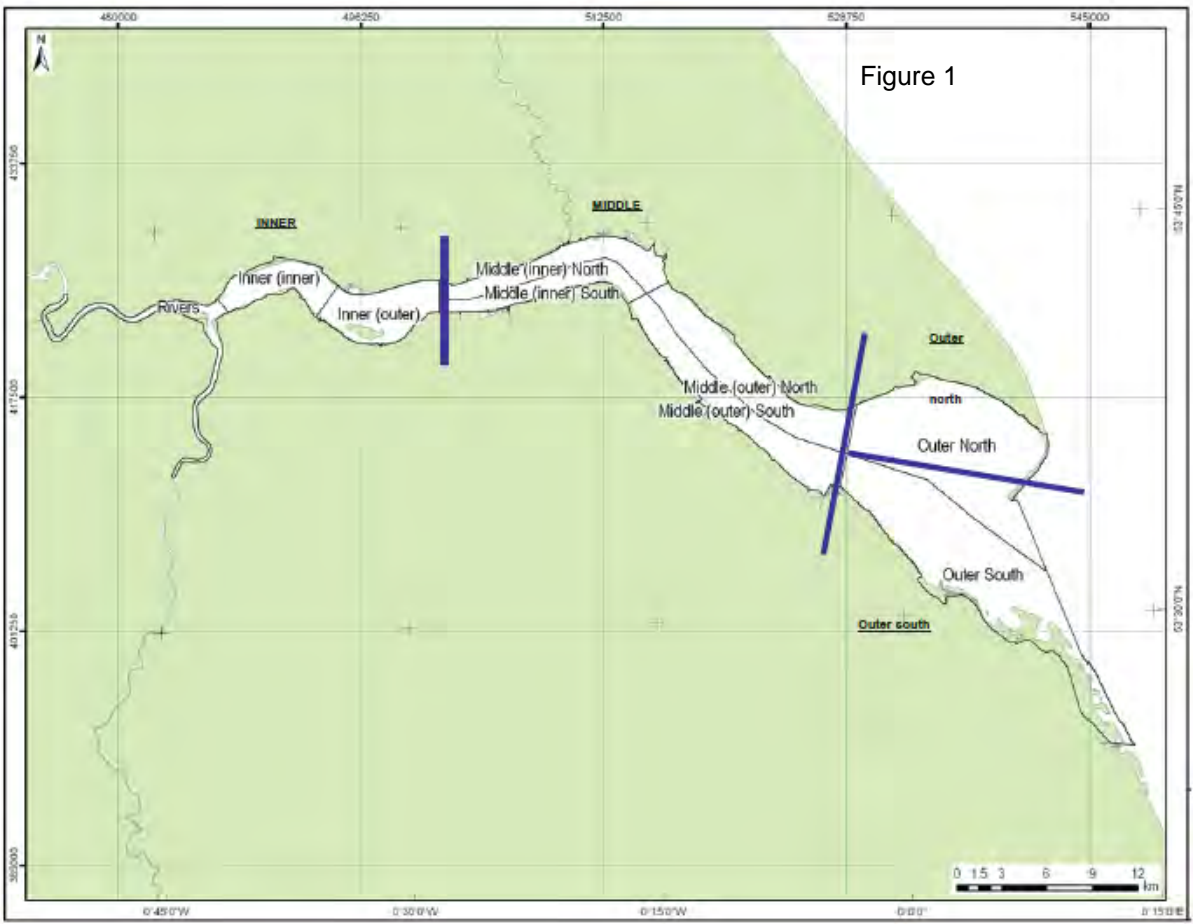
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APPENDIX B

Humber Areas



APPENDIX C

Dredging Pilot Studies Report



Dredging pilot studies report

A report on our work to consider dredging and associated watercourse maintenance at six locations.

We are the Environment Agency. We protect and improve the environment and make it a better place for people and wildlife.

We operate at the place where environmental change has its greatest impact on people's lives. We reduce the risks to people and properties from flooding; make sure there is enough water for people and wildlife; protect and improve air, land and water quality and apply the environmental standards within which industry can operate.

Acting to reduce climate change and helping people and wildlife adapt to its consequences are at the heart of all that we do.

We cannot do this alone. We work closely with a wide range of partners including government, business, local authorities, other agencies, civil society groups and the communities we serve.

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Tel: 0117 934 4000
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Foreword

The Environment Agency routinely considers dredging and other types of watercourse management, such as de-silting and vegetation removal, to reduce flood risk. We spend over £20 million per year on dredging, de-silting, removing gravel and obstructions along with weed control to clear channels. As with all our work, it has to be prioritised and justified technically, environmentally and economically.

We are aware of concerns from some landowners and the public that we are not carrying out enough channel maintenance. This report is a summary of six pilot studies we undertook in consultation with local communities to test our understanding of the benefits of watercourse maintenance, in particular whether it reduces the probability and extent of floods and its cost effectiveness. The pilots confirm that watercourse maintenance can reduce flood risk but will not be suitable in all locations.

We review regularly our work, plans and guidance to make sure that we are making best use of available information. As a result of the pilots, we are providing further guidance for our staff to support them as they work with others to create a better place for people and wildlife.

David Rooke
Director of Flood and Coastal Risk Management

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Executive summary

1.1 Introduction

The Environment Agency spends more than £20 million each year on removing silt and vegetation from watercourses. We carry out watercourse maintenance along with a number of organisations and individuals, including internal drainage boards, local authorities, and landowners. The main reason we do this is to reduce the risk of properties being flooded and the impact on people.

There are a number of steps we take to identify the need for dredging. We focus our maintenance on current and future needs rather than just doing what we have always done. Some people and organisations are concerned that we do not do enough dredging and watercourse maintenance. In response to this, and to test our understanding of the evidence, we arranged pilot studies in our South West, Thames and North East Regions. The aim of the studies was to confirm to what extent watercourse maintenance or dredging would reduce the likelihood or severity of floods.

1.2 Watercourse maintenance

Dredging is one of a number of activities classed as watercourse maintenance. Others include weed control, blockage removal and de-silting. Maintenance can improve the flow capacity of the river and reduce water levels as well as provide other potential benefits, such as land drainage, controlling invasive species and maintaining navigations. We also ensure that our work protects and, if possible, enhances the environment.

1.3 Pilot sites

We selected six pilot sites. Each site represented a typical type of watercourse we manage, and demonstrated aspects of routine maintenance work. We have focused on locations where work was already planned or agreed with local communities. The sites were:

- Hinksey Stream, Ladygrove Brook and River Windrush in Oxfordshire;
- North Drain and South Drain in Somerset;
- Burstwick Drain in East Yorkshire.

1.4 What we have learned

Work at the pilot sites showed that the maintenance work reduced flood risk locally. But in some areas the maintenance work was not cost effective - the flood risk benefit of the work did not justify the expenditure. We had to consider the whole catchment (that is, the whole river system) including the purpose of any watercourses in the catchment. Each pilot site was different and decisions have to be made on a case-by-case basis, using evidence and engineering knowledge to make judgements. Working with local communities to discuss the work and agree if it is the best flood risk management measure for them was beneficial.

2 Introduction

2.1 Why have we carried out the pilot studies and produced this report?

The Environment Agency spends more than £20 million each year on removing silt and vegetation from watercourses. This work is important to manage flood risk and has always been a highly visible aspect of our work giving both flood risk benefits and reassurance to local communities.

As with all our work, we must prioritise, taking technical requirements and environmental outcomes into account, and justify what we spend. Legislation, such as the Water Framework Directive, has to be considered before work is carried out. We prioritise investment in activities that provide the greatest return, usually a reduction in the risk of flooding. In some cases, we have had to reduce the amount of work we do, or even stop clearing some watercourses. We make these difficult decisions based on sound evidence.

Some people and organisations are becoming increasingly concerned that we do not do enough to maintain watercourses. Various groups have raised these concerns, including the public, landowners and farmers. The groups have different reasons for concern, but the main ones are to do with flood risk and land drainage. Some groups, such as Non-Governmental Organisations (NGOs) interested in the water environment and anglers, are concerned that we do too much dredging and maintenance work to the detriment of the environment.

In response to these concerns, and to test our understanding of the evidence we already have about the pros and cons of dredging, we arranged pilot studies of watercourse maintenance in our South West, Thames and North East Regions. The pilots have helped us to understand more about the impact that our watercourse maintenance work has on flood risk. We selected sites that represent a variety of typical watercourses.

The pilots were a combination of the observation of the results of physical watercourse maintenance and computer modelling. We wanted to learn more about how maintenance can help to reduce flood risk. The pilots help us to better understand:

- flows and water levels;
- flood risk in the immediate area and wider catchment areas;
- the environmental impact and financial cost of the activities.

During the pilots we considered:

- what impacts maintenance activities have on the potential for flooding, and how this is influenced by other factors that may affect the flow of water in the channel (such as bridges, river control structures and pumping stations);
- the environment and compliance with environmental legislation;
- land use and agricultural practices.

The evidence from these pilots will help us to:

- improve our approach to managing flood risk and watercourse maintenance;
- demonstrate the impact of watercourse maintenance on the flow of the water;
- tell us what effect there is on local ecology;
- carry out our work in the most cost effective and least bureaucratic way.

This report outlines the main results and conclusions of the pilot studies. Further information on the work at each site, the modelling completed to assess the effect of the work and the supporting science are included in the appendices.

3 What is watercourse maintenance and when do we do it?

3.1 The purpose of watercourse maintenance

We estimate that the protection provided by flood and coastal risk management assets benefits people and properties in England and Wales by around £6 billion annually¹. Watercourse maintenance makes a significant contribution to this. The main reason we carry out watercourse maintenance is to reduce the risk of flooding. There are other potential benefits such as navigation, land drainage, controlling invasive species and improving habitats.

3.2 What we do to maintain watercourses

Dredging is one of a number of activities classed as watercourse maintenance. Others include weed control, vegetation management, blockage removal and de-silting. Our annual maintenance programme which includes watercourse maintenance, is available on our website².

We carry out watercourse maintenance along with other organisations and individuals, including internal drainage boards, local authorities, and landowners. We have powers that allow us to carry out work on watercourses that are designated as 'main rivers'. There are 42,224 kilometres of main river across England and Wales.

We are further developing ways of targeting watercourse maintenance more effectively, so that we do work where it will have the greatest benefits.

3.3 How do we decide where to do watercourse maintenance?

We dredge and clear channels as part of our maintenance regime when we assess it will improve a river's ability to carry more water and reduce flood risk. In some circumstances, watercourse maintenance is not the best long-term solution and it can be costly. In these circumstances, other flood risk measures can be more effective, such as building walls or embankments to protect property, providing storage upstream or changing land use or land management practices. Its effectiveness also differs between areas, so we consider it on a location-by-location basis.

Dredging, de-silting and removing other channel obstructions can be effective in some places. When combined with other measures they can form part of a sustainable flood risk solution.

We prioritise dredging and other watercourse maintenance according to level of risk. We carry out such work where it is:

- technically sound;

¹ Information from Halcrow System Asset Management Plans 2008 - 2009 Comparison Report

² <http://www.environment-agency.gov.uk/homeandleisure/floods/109548.aspx>

- economically viable;
- environmentally acceptable and sustainable.

Our overall aim is to reduce flood risk to people and property while protecting, and where possible, improving the natural environment. We work closely with nature conservation bodies such as Natural England and the Countryside Council for Wales to ensure we minimise the impact that river management has on the environment. We plan the work and carry it out sensitively to meet the needs of both people and the environment.

A full explanation of how we decide when and where to do watercourse maintenance is on our website³.

3.4 Science on watercourse maintenance

Watercourse maintenance has long been a topic for research and development work. This is reflected in the Defra/ Environment Agency Joint Flood and Coastal Erosion Risk Management research and development programme, which has provided new knowledge on aspects of watercourse maintenance.

Readers interested in more detailed information can follow the links and references in Appendix B to find published work on watercourse maintenance, notably sediment management.

³ <http://www.environment-agency.gov.uk/homeandleisure/floods/31740.aspx>

4 The pilot sites

4.1 Location

We have reviewed work at six locations that demonstrate aspects of our day-to-day watercourse maintenance.



Figure 1 The pilot sites

4.2 Site selection

We chose places where work was already planned because of ongoing maintenance and local initiatives. The sites represented a range of the types of watercourses that we manage. We can apply many of the lessons we learnt from the pilots to other watercourses we maintain.

4.3 Pilot studies of watercourse maintenance

4.3.1 Hinksey Stream

The Hinksey Stream is part of the complex network of watercourses that run through and around Oxford. The pilot site starts at North Hinksey where the Seacourt Stream splits into two, forming the Hinksey Stream and the Bulstake Stream.

Our draft Oxford flood risk management strategy recommends carrying out de-silting work at Hinksey Stream. This will allow the flow of water to be taken away from North Hinksey, where there was flooding in 2007. We added this part of the drainage system for Oxford to our maintenance programme for this year, planning to clear vegetation and de-silt the channel to improve the capacity.

We used river corridor and walkover surveys to minimise environmental impacts. The bank tops were well vegetated with scrub and grasses and a semi-continuous line of trees on either side of the river. The bank faces were mostly well vegetated with grass and scrub, with some exposed areas displaying evidence of animal burrows. A survey for Biodiversity Action Plan (BAP) species was undertaken and no evidence of species activity was found.

We cleared obstructions from a 1.8km channel using chainsaws and hedge cutters before using an excavator to cut the thicker vegetation. A number of willows were cut with a tree lopper attachment on the excavator.

Once the channel was accessible, we used the excavator to remove the silt and place it a machine's arm-length away from the watercourse. We removed approximately 1,500 tonnes of silt which we left to dry out. We then spread it thinly and sowed it with grass seeds.

4.3.2 Ladygrove Brook

Ladygrove Brook has a low-level channel that carries the normal flow, within a wider channel that is only used during higher flows. It drains a large area of land to the south east of Didcot, picking up run-off water from the farmland and surface water from the Ladygrove Estate. When the Ladygrove Estate was built between 1988 and 2003, the watercourse was channelled into a culvert for approximately 500 metres. This discharges into the open brook at the start of the pilot site area.

The two-stage channel provides extra water storage during high flows, such as the ones experienced in 2007 when floods affected two properties and a number of roads and gardens on the estate. The estate has about 20 surface water gullies running into the channel. The majority were not effective as their capacity was reduced by silt deposits.

There was heavy vegetation along the whole of the pilot section, which adds to the surface roughness of the stream. Before we started the clearance work, we carried out a walk over ecology survey.

The channel was overgrown and had to be cleared before any de-silting could be carried out. Because of the limited access, we used a remote-controlled flail mower followed by an excavator weed cutter.

Once the vegetation was cleared, we used a small excavator to remove the silt and place it a machine's arm-length away from the watercourse. We then spread it thinly and sowed it with grass seeds.

4.3.3 River Windrush

We reviewed the River Windrush at Witney as part of our investigations after the 2007 floods. We found that the bridge on Bridge Street was a key pinch-point in the town, and that capacity through the bridge should be regularly maintained. We worked with Oxfordshire County Council to de-silt the channel under the bridge in July 2008.

A topographical survey showed that there might be a need for de-silting downstream. We examined this in more detail and discussed the options with the Witney community and other interested parties. Our further investigations have shown that work is not required at this location. Concerns were also raised that the work could increase the flood risk downstream and damage fish habitat.

4.3.4 Burstwick Drain

Burstwick Drain passes through the town of Hedon to the east of the city of Hull. It was chosen as a pilot site following consultation with an external steering group set up to agree a site in the East Riding area of Yorkshire. The drain was selected because local perception was that lack of maintenance meant it was heavily silted and causing a flood risk. The steering group comprised councillors, technical officers from East Riding of Yorkshire Council, representatives from internal drainage boards (IDBs) and from local flood action groups.

The pilot site extended from Burstwick New Clough at Saltend, as far as the eastern extent of Hedon where Forkerleys Drain discharges into Burstwick Drain – a total length of approximately 3.4km. Doors on the downstream end prevent tidal water entering the drain.

We carried out walkover ecological surveys and found water vole populations and evidence of otters. Work was designed to minimise any disturbance such as working in February and early March when water voles are in hibernation and before the bird breeding season. Ecological surveys along Burstwick Drain have confirmed there has been no adverse impact on water voles, otters or invertebrates.

We used a variety of equipment to clear vegetation, including weeds, trees and bushes that had become overgrown on the banks and within the channel. Surveys showed there was limited silt in the drain which was removed from the bed, in particular from the section immediately upstream of the tidal gates at Burstwick New Clough. Having discussed the work with representatives of the steering group, we decided to carry out a further survey of the tidal section downstream of Burstwick New Clough. We are currently working with key partners to determine the flood risk, land drainage and surface water drainage benefits of clearing soft silt deposits downstream of the tidal gates. This work was last carried out in January 2008.

4.3.5 North and South Drains

The North and South Drains are in central Somerset, which has some of the lowest-lying land in the South West. The Drains flow westerly for 15km through several moors designated as being of international importance for wildlife.

On the Somerset Levels and Moors, the Environment Agency, Natural England and the Somerset Drainage Board Consortium formed a multi-agency partnership project and produced the 'Somerset Levels and Moors Action Plan for Delivering Favourable Condition'. Over the last four years we have been working with the partnership to improve the condition of Sites of Special Scientific Interest (SSSIs). A number of reasons for the

sites failing to achieve Favourable Condition have been identified; poor water level management (dry ditches or an inability to evacuate floodwaters effectively), poor land management and poor water quality.

The perception in the community is that since we stopped regular dredging and de-silting 15 years ago there has been an unacceptable reduction in capacity and this has affected the performance of both drains' functions and harmed the environment. It was felt that dredging would improve conveyance, the effectiveness of water level management and the evacuation of floodwaters. Following consultation with local interested parties, we agreed to consider four South West sites for de-silting. North and South Drain are two of these sites and were included in the National Pilots. We will continue to monitor the impact of our de-silting work on water levels within the drains with the aim of optimising their maintenance and operation for their flood risk and land drainage roles.

Being man-made, the drains have no intrinsic geomorphology. Our judgement is that the 'silt' largely comprises material derived from the organic soils adjacent to the drains and from decomposition of vegetation along the drains. We found nationally-rare freshwater depressed mussels lying in the silt, as well as fish and eels in the watercourses on the North and South Drains. The de-silting works could potentially adversely affect these species so we minimised potential impacts by retrieving live mussels from the silt and placing them back into the drain after the dredging was done.

Our prior inspections determined access routes, services and riparian ownership. We also held a series of public meetings for local communities and sent over 500 consultation letters. Prior to de-silting we improved access and removed vegetation. We removed over 70,000 tonnes of accumulated silt and placed the material on the drain banks.

	Burstwick	Hinksey	Ladygrove	Windrush	South Drain	North Drain
Reason for selection	Selected by local Steering Group	Part of the Oxford Strategy	To regain the storage capacity of the two stage channel	To take high flows away from Witney quicker	Manage water levels	Manage water levels
Length of watercourse	11.1km	3.4km	1.4 km	4.2km	9.9km	10.3km
Average watercourse width (m)	3 - 25	3 - 5	0.5 - 2	3 - 6	18	11.5
Catchment size km ²	65	30	23	47	207 for both	
Gradient	1 in 3,500 - 7000	1 in 2000	1 in 1700	1 in 2200	1 in 10000	1 in 10000

Table 1 Summary physical characteristics for the pilot sites

4.4 Assessing the impact of our work at these sites

We used computer modelling to assess the short term impact on flows at Hinksey Stream, Ladygrove Brook and Burstwick Drain. For this work, the modelling was proportionate to the scale of the work and was sufficient to demonstrate changes in flow before and after maintenance.

To assess the longer term impact, we have collated baseline information for all pilot sites. This will help us assess the impact of the work now and in the future. We took expert advice from external engineering consultants to ensure we collected data most relevant to watercourse maintenance. We have already carried out further surveys to allow us to assess the immediate impact of the work, notably topographical surveys to show the change in the cross-sectional profile of each watercourse. This has allowed us to carry out hydraulic modelling at some of the pilot sites so that we can assess the change in water level, flood extent and conveyance resulting from the work.

We considered each pilot site against the following criteria

- technically sound;
- economically viable;
- environmentally acceptable and sustainable.

	Technical	Economic	Environmental
Burstwick	Work completed successfully. Access limited due to development close to the watercourse.	Silt removal is not effective in the channel but can have an impact on flood risk and land drainage downstream of the tidal doors.	No adverse impact to date.
Hinksey	Work completed successfully.	Benefit to the immediate area was not economic. Wider benefit identified in Oxford strategy.	No adverse impact on habitat to date.
Ladygrove	Work completed successfully.	A benefit cost ratio greater than one.	No adverse impact on habitat to date.
Windrush	Possible increase in downstream flood risk so work not carried out.	Limited benefit due to restriction of existing bridges.	Possible damage to fish spawning identified, so work not carried out.
South Drain	Work completed successfully.	Work not economic for flood risk, justified by favourable condition requirement. Benefit to land drainage.	Small short term impact. Work will benefit SSSI.
North Drain	Work completed successfully.	Work not economic for flood risk, justified by favourable condition requirement. Benefit to land drainage.	Small short term impact. Work will benefit SSSI.

Table 2 Summary of technical, economic and environmental tests

We have monitoring plans to identify how often we need to do further surveys at each of the pilot sites. These will help us to assess what we need to do to maintain these watercourses in the future. On the North and South Drains, we have installed water level gauges to measure how water level management within the pumped system is affected by the changes in the drains due to dredging.

5 Watercourse maintenance and the environment

When carrying out watercourse maintenance, we must comply with environmental law, which can be complex.

Certain frequent maintenance works, such as grass cutting and weed control, tree works, bank clearance, removal of obstructions and debris and river de-silting operations to maintain the river channel are not covered by statutory environmental impact assessment. This was the case for each of these dredging pilots. However, even where statutory environment impact assessment does not apply there are often environmental issues that we still have to consider.

We have to comply with the Habitats Regulations⁴ for maintenance works that occur within or adjacent to internationally designated conservation sites. We must establish whether the work will have an adverse impact on the integrity of an internationally designated site where any maintenance works might affect it. If this is the case, then we lose our permitted development rights for the work and normal planning rules apply. The East Yorkshire pilot at Burstwick Drain is near the Humber Estuary, a designated Special Protection Area (SPA), Ramsar Site and Special Area of Conservation (SAC). In consultation with Natural England, we assessed the implications for these designated sites. We concluded that because of the nature of the works and the distance from the designations, no significant effects on the sites were likely. We concluded for the Somerset Levels and Moors SPA / Ramsar Site that positive effects on component Sites of Special Scientific Interest (SSSIs) were in line with the objective to achieve favourable condition. The Thames sites did not involve any issues with designated sites.

The Water Framework Directive⁵ (WFD) sets a number of environmental objectives, to prevent deterioration of the status of surface water bodies, and to protect, enhance and improve the ecology of water bodies⁶. Changes or “new modifications” which would stop us meeting the required standard or preventing deterioration are not permitted except where the impact is temporary, or where it can be justified according to a number of specific criteria (referred to as Article 4.7 obligations). We concluded that all the proposed pilots constituted new modifications which could have an impact but there would be no deterioration. Therefore, an assessment under Article 4.7 of the WFD was not required.

We also looked at other environmental issues potentially affected by the maintenance works. We identified any features of heritage interest within or adjacent to the watercourses, and avoided activities such as silt spreading within these areas. We also looked for contaminants within the sediment of the watercourses, and where needed, applied appropriate silt control methods to minimise adverse impacts on water quality.

⁴ Conservation of Habitats and Species Regulations 2010, SI No. 490.

⁵ The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003, SI No. 3242.

⁶ Good Ecological Potential (GEP) for Heavily Modified / Artificial water bodies.

6 Key learning from the work at the sites

6.1 Introduction

We have described below what we have learned from the work at the sites. In some cases we have been able to use research and information from other sites and organisations to support the results of our pilots.

Other work, such as sediment control, could reduce the need for maintenance. Such alternatives to dredging have not been considered as the purpose of the pilots was to confirm whether watercourse maintenance or dredging would reduce the likelihood or severity of floods.

6.2 Flood flows and water levels

We used computer modelling to assess the impact of the maintenance work on flood flows and water levels at Burstwick Drain, Ladygrove Brook and Hinksey Stream. Further information on the modelling work is included in appendix C. Summary results were:

Burstwick Drain

- The maintenance work has increased the watercourse's carrying capacity.
- Small change in water levels.

Hinksey Stream and Ladygrove Brook

- The maintenance work has increased the watercourses' carrying capacity.
- Water flows faster in the section where the work was carried out.
- The maintenance work reduces the water level for flows that stay within the channel.

South Drain and North Drain

- Outflow from the drains is limited by the pumping station capacity at the downstream end.

The removal of vegetation and obstructions has reduced friction and water flows faster in the sections where the work was carried out. Most of the work at Ladygrove Brook was vegetation management. The amount of vegetation is dependant on the season, with some vegetation dying back over the winter. The extract below from appendix C shows the percentage change in conveyance after maintenance work.

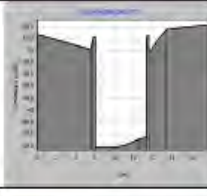
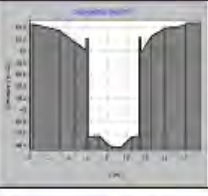


Node	Pre-Dredge		Post-Dredge		Percentage change in conveyance		
813		Left Bank Level (mAD)	50.22		Left Bank Level (mAD)	50.21	48 %
		Right Bank Level (mAD)	50.23		Right Bank Level (mAD)	50.22	
		Bed Unit Roughness (Zone – Bed 3)	0.151		Bed Unit Roughness (Zone – Bed 8)	0.048	
		Bank Unit Roughness (Zone – Bank 4)	0.02		Bank Unit Roughness (Zone – Bank 4)	0.02	
		Floodplain Unit Roughness (Zone – Floodplain 2)	0.029		Floodplain Unit Roughness (Zone – Floodplain 2)	0.029	
	Bankfull Flow Capacity (m ³ /s)	3.8	Bankfull Flow Capacity (m ³ /s)	7.0			
	Upper value (m ³ /s)	10.4	Upper value (m ³ /s)	10.5			
	Lower value (m ³ /s)	3.4	Lower value (m ³ /s)	4.5			

Figure 2 Comparison of effect of maintenance on flow

We calculated the reduction in water level for varying return period flows to simulate different severity of floods. The results indicate that for low return period flows (that is, the more regular flows) the maintenance work reduces the water level in the channel. The reduction is less noticeable for higher return periods.

The figure below highlights the effect that dredging at Hinksey has had on water levels for a high and low flood flows.

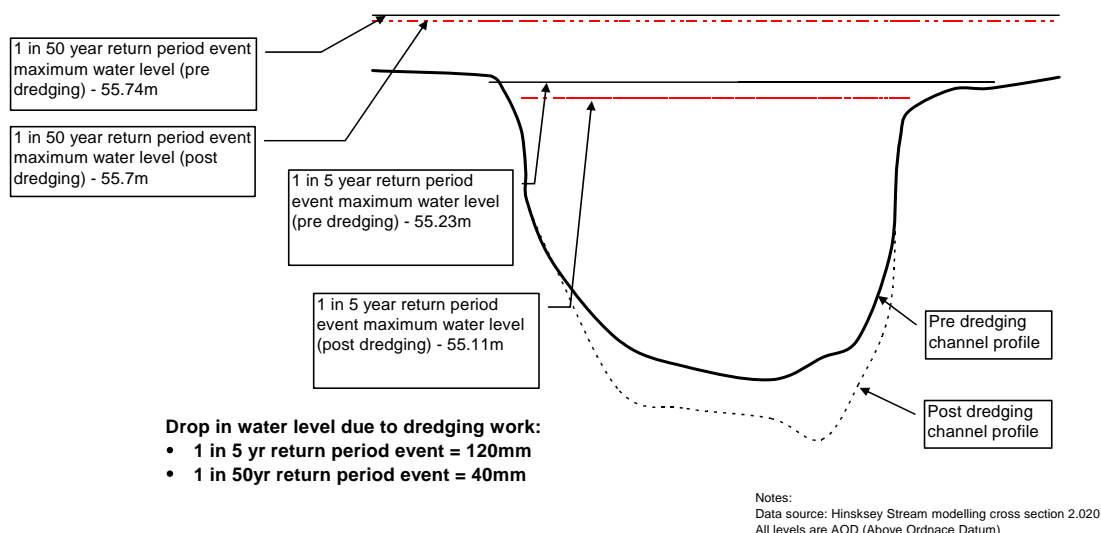


Figure 3 Hinksey Stream modelling results. Cross section showing change of channel profile and water level

When the capacity of the channel is exceeded, water flows out of the channel into the flood plain. When this occurs at the pilot sites the modelled differences in water level and flow due to dredging are very small and are at the limits of the accuracy of the models.

The North and South Drains are part of pumped drainage systems whose overall capacity is determined by installed pump capacity. We are monitoring the performance of the two

drains in order to quantify the effectiveness of dredging. The qualitative view of those consulted during the pilot is that:

- The maintenance work has increased the drains' carrying capacity.
- The responsiveness of water level at further distances upstream of the pumping stations and the ability to evacuate floodwater accumulating on the moors has improved.

6.3 Flood risk in the local area and wider catchment

As water flow increases, eventually it will exceed the capacity of the channel and flood the surrounding land. We assessed the impact of the maintenance work on the flood risk. Summary results were

Burstwick Drain

- No significant reduction to flood risk from in channel works
- Downstream silt removal provides greater benefit than silt removal in the pilot area

Hinksey stream

- Flood extent reduced but only a small resultant reduction in local flood risk
- Benefit to upstream area

Ladygrove Brook

- Flood risk reduced due to maintenance works

River Windrush

- Work could increase the risk of flooding downstream

Within the modelled area, the reduction in water levels means that flows overtop the banks slightly less frequently (that is, the return period increases). The reduction in flood frequency is too small for the pilot models to calculate accurately.

The reduction in water level does not necessarily result in reduced flood risk. Using modelling we calculated the extent of flooding from the channel before and after the work. The reduction depends on the topography of the surrounding land. At South Hinksey, the reduction in the area reached by floodwaters (that is, the extent of the flood) benefited some currently undeveloped land. One of the results of our modelling on the Hinksey Stream is shown in the plans below. The reduced flood extent has not reduced the risk to buildings and homes in the immediate area. Therefore, the benefit from work to this part of the watercourse is small compared to the cost. The benefit of the work to the wider catchment has also been assessed in the Oxford Strategy and was considered economically and technically viable and to be a low environmental risk. It is part of a package of measures that are estimated to reduce the extent of flooding to 800 properties and remove 49 properties from the risk of flooding in a 1:20 flood year event.

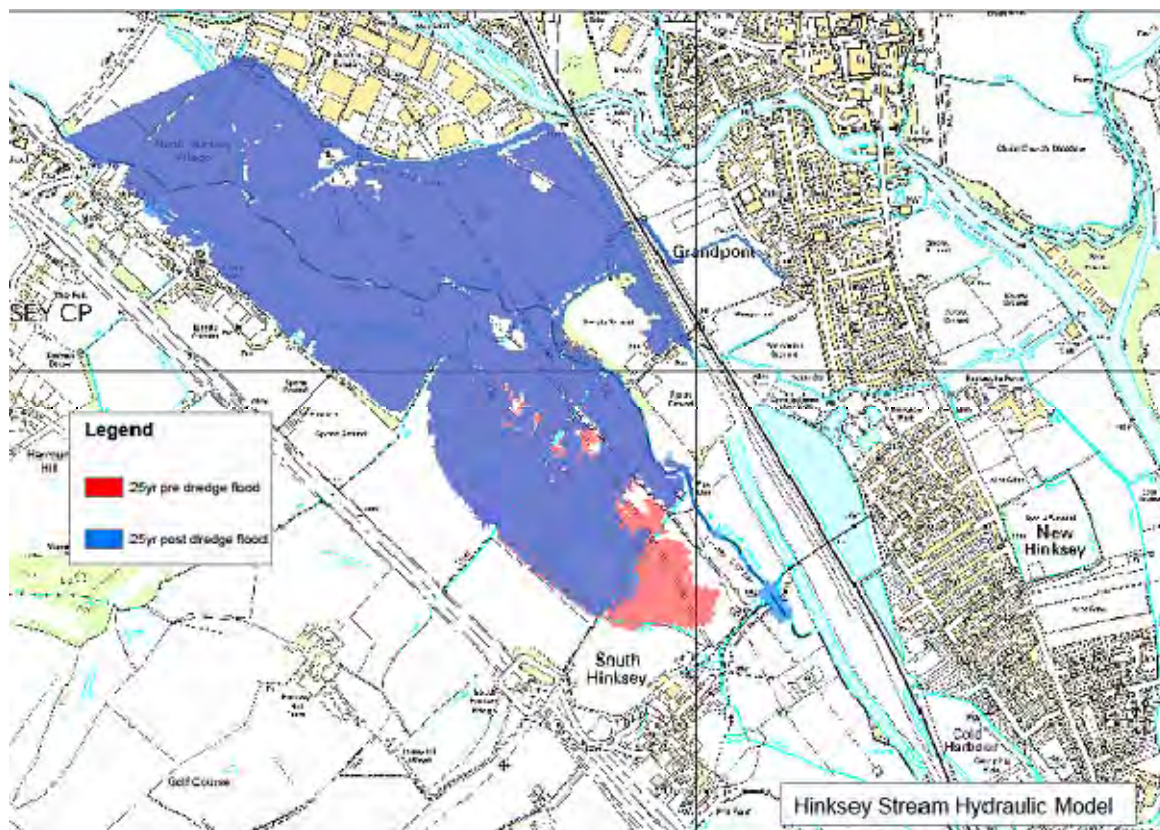


Figure 4 Change in flood extent on the Hinksey stream

Residents downstream of the work on the Windrush raised concern that the maintenance work would increase their flood risk. Where maintenance work has reduced the flood extent, the water which would previously have flowed onto the flood plain will now flow downstream. Therefore, the volume, and possibly the speed, of water arriving downstream will increase. The change in risk depends on what is at risk downstream. We assessed the work and found it would have a small impact on the risk to their properties, estimated to be up to 10mm. We agreed that if the maintenance work was carried out, further work would be carried out in the downstream village to offset the small increase in risk. This can affect the cost effectiveness of any maintenance work. The downstream effects of maintenance work need to be fully considered before any maintenance work is carried out. The need to consider downstream effects was highlighted in the recent PAMS⁷ (Performance based Asset Management System) research and development project. This requires an understanding of the catchment.

⁷ PAMS summary report <http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4ca1c60b02a16d5c273fc0a8029606b0/Product/View/SCHO1209BRR-E-E>

6.4 The financial costs of maintenance

We calculated and recorded the financial costs of the maintenance at each site. The direct costs associated with dredging at each site are shown in table 3 for comparison purposes. These costs inform the judgement as to whether dredging is cost effective or not at each site.

Activity (costs in £)	Hinksey	Ladygrove	Burstwick	North & South Drain
Preparation	1015	765	3480	12250
On site set up	747	431	1835	2500
Clearance	4644	2376	11179	
Dredging	3456	8370	5920	50036
Re-instatement	1935	4315	1735	3340
Total	11797	16257	24149	68126

Table 3 Summary of costs of dredging⁸

The modelling has shown that work within the upper channel at Burstwick Drain had little impact. Dredging work downstream of the tidal doors would be of greater benefit⁹.

For the most likely maintenance frequency the work was cost effective on the Ladygrove Brook. The cost effectiveness of the work is dependent on future maintenance frequency, which is affected by the rate of siltation and vegetation growth. If more maintenance is required than currently anticipated, the cost effectiveness of the work is less. If maintenance ceased completely the channel would silt up and become overgrown, increasing the flood risk significantly.

Method	Present Value Damage	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Multi Coloured Manual Assessment - without climate change	£129,000	0.7	1.3	1.6	2.3

Table 4 Cost benefit assessment on Ladygrove Brook

The four scenarios used (see appendix A for more information)

1. High maintenance
2. Regular maintenance. This is considered to be the most likely based on historic practice.
3. Maintenance on a five yearly cycle
4. Maintenance on a ten yearly cycle

⁸ See appendix A for more detail of costs at each site

⁹ See Appendix C for modelling information

For the North Drain and South Drain pilot sites, we agreed with landowners that we would place dredged material on the banks, which was appropriate at this location. Managing dredged material has a significant impact on the cost effectiveness of watercourse maintenance. Dredged material can be placed on the side of the river but where this is not possible the material has to be transported for disposal at a licensed site. The costs of disposal compared to the total cost of the works are proportionately very large. These costs can outweigh the benefits and the maintenance work becomes unviable.

The costs of the preparatory work were factored in to costs and benefits calculations of the work.

6.5 Environment and compliance with environmental legislation

Before starting work we collected information at each site. The collection was tailored to the individual site.

Survey/data	Pilot sites					
	Hinksey Stream	Ladygrove Brook	River Windrush	North Drain	South Drain	Burstwick Drain
Topographical survey	✓	✓	✓	✓	✓	✓
Bathymetric survey				✓	✓	✓
Hydraulic modelling	✓	✓	✓			✓
Geomorphological stream reconnaissance (mapping)	✓					✓
River corridor survey	✓	✓	✓			
River habitat survey						✓
Repeat photography	✓	✓	✓	✓	✓	✓
Sediment sampling				✓	✓	✓
Protected species surveys ¹⁰ such as water vole, otter, crayfish and lamprey	✓	✓	✓	✓	✓	✓
Fisheries survey				✓	✓	
Macroinvertebrate surveys				✓	✓	✓
Macrophyte survey				✓	✓	
Diatom survey				✓	✓	
Water quality survey				✓	✓	
Cultural heritage study				✓	✓	

Table 5 A list of some datasets we collected prior to starting work at each site.

We adapted the way we worked to minimise or mitigate any impacts on the environment. For instance, we considered the limitations or seasonal restrictions on when work can be carried out. Suitable mitigation is described in the WFD Mitigation Measures Manual for Flood Risk Management and Land Drainage Activities¹¹.

¹⁰ such as water vole, otter, crayfish and lamprey

¹¹ <http://evidence.environment-agency.gov.uk/FCERM/MMM/en/FloodRiskScience/MitigationMeasures.aspx>

Maintenance was planned to protect habitat. Maintenance can have an impact on fishing and fisheries through increases in silt in the water during de-silting operations, potential disturbance and loss of important fish habitat. It can also affect vegetation and mammals, such as otter and water vole, birds and other protected species that use the watercourse.

To make sure that work is carried out without long term adverse effects on the environment we used different methods in different locations.

In order to establish impacts on ecology, we carried out monitoring before and after the de-silting and bank clearance works on Burstwick Drain. We surveyed for water voles, otters, invertebrates and general habitat (river habitat survey).

So far, results of the survey do not show any detrimental impact of the works on water voles, otters or invertebrates. Data from river habitat surveys before the maintenance works show that Burstwick Drain is a severely modified watercourse with poor habitat quality. Habitat quality was reduced in surveys after the work, because there was less vegetation in the stream and on the bank. To assess whether this was an effect of the works or a seasonal influence, further surveys were carried out. These showed no lasting effects on water voles, otters or invertebrates.

The results demonstrate that our methods of working and mitigation have minimised any potential impacts on the ecology. The results cannot be extrapolated to all watercourses, since environmental sensitivities, habitat types and species present, and channel clearance methods will vary.

6.6 Structures in the channel

We considered the effect of structures in the channel such as gates, pumping stations and artificial hard beds. Summary results were:

Burstwick Drain

- Hard sills on the bed determine the dredged profile
- Downstream tidal doors determine the flow

Ladygrove Brook

- Flows limited by upstream culvert

North Drain

- Outflow from drain limited by pumping station capacity at downstream end

South Drain

- Outflow from drain limited by pumping station capacity at downstream end

Flow in the watercourses can be constrained by physical structures such as weirs and bridges rather than the size of the channel. For example, water levels upstream of bridges can be noticeably higher than those downstream. On Burstwick Drain hard sills on the river bed fix the bed level at certain locations, for example at bridges. Removing soft silt at levels deeper than these sills would only create a series of depressions or ponds, without increasing the flow. In these circumstances dredging or silt removal may not necessarily change the flood risk. If structures in the channel constrain the flow, maintenance may not increase it.

The North and South Drains use pumps to discharge their flow. The flow in the drains is limited by the discharge capacity of the pumps. It is also likely that the volume of water

arriving at the pumping station is progressively limited by conveyance of the upstream drain system. Burstwick Drain discharges into the Humber through tidal doors. We are currently working with the local steering group to determine the best time to remove soft silts deposited from the Humber Estuary downstream of the Burstwick Drain doors. Tidal sections may need to be kept clear for the watercourse to discharge. The discharge conditions are often the determining factor.

6.7 Land use and agricultural practices

During discussion and consultation on the pilots, concern about the impact of changes to watercourse maintenance, including the impact on agriculture, have been re-iterated. Summary results were:

Burstwick Drain

- Concern about the impact of maintenance on land drainage

North and South Drains

- Concern about the impact of maintenance on land drainage and irrigation via the system of small ditches

Land drainage is the main concern. Our focus is on reducing the risk of flooding to people and property. However, land drainage can be improved as a consequence of our work. We discussed these concerns with the Association of Drainage Authorities' Technical and Environmental Committee. The Committee recognised that watercourse maintenance could have a limited impact on reducing flooding, especially for higher return period floods. However, they explained that less frequent watercourse maintenance of main rivers could adversely affect land drainage at lower return periods, as the drainage relies on the water level and capacity of the main river.

In addition, land owners may need to invest in further work on land drainage upstream to benefit from the watercourse maintenance. For example, to benefit from land drainage at the pilots on South Drain and North Drain, landowners will have to continue to clear adjacent and upstream ditches.

There is a lack of clarity on the different benefits and who should fund the work. Flood risk management and land drainage link and overlap. We focus our maintenance work on reducing the risk of flooding to people and property. Our maintenance work can also provide other secondary benefits, such those described above in relation to land drainage.

6.8 Public confidence

Analysing the benefits and disadvantages of watercourse maintenance is a complicated process. Whilst our position on maintenance is available to the public on our website, feedback from communities and interested parties clearly shows us that we need to review and where possible simplify the ways we communicate with others about channel maintenance and our maintenance programme.

In some cases, communities can be unaware of the watercourse maintenance work that is planned or being regularly carried out. For instance, members of the public thought some of our work at Burstwick Drain was being carried out for the first time, but it is a regular part of the maintenance programme. Also, local perception was that the drain was heavily silted but surveys showed there were only small quantities of silt.

The pilot sites have benefited from the experience of local individuals and organisations in preparing and carrying out the work. The liaison group for the Burstwick pilot site provided

information about the drain, including a locally commissioned report on flooding.¹² This demonstrates the benefit of working more closely with communities.

We have received positive comments about the work at the pilot sites. In some cases this appears to be independent of a demonstrable flood risk benefit. It is possible that the work itself reassures some people, but we cannot currently give a monetary value to this.

¹² See the report Burstwick Drain Second opinion regarding causes and possible remedies of the overtopping of the Burstwick drain by DHV

7 A review of the effectiveness of the pilot studies

The pilots provide us with valuable information to inform our future maintenance of channels. The information will be used to improve our decisions, the cost effectiveness of our work and our engagement with communities whilst protecting the environment.

The direct costs associated with dredging at each site are detailed in table 3. The pilots required considerable additional investment, such as project management, modelling and surveys. We also worked with local and national groups to discuss and develop the pilot studies. All of these costs are presented in table 6. This level of additional cost would not normally be incurred when carrying out dredging.

Activity (costs in £)	Hinksey	Ladygrove	Burstwick	North & South Drain
Survey and monitoring	8500	3900	51900	8900
Technical support including modelling	2250	1500	30300	5000
Stakeholder engagement	500	400	24000	3000
Project Management	2000	2500	25800	5000
Total	13250	8300	132000	21900

Table 6 Summary of total additional costs for undertaking the pilots

The results from the pilots will help us to prioritise work where it has the greatest benefit, making sure we get the best return for the money invested. Information from the pilots is being used in new guidance for our staff.

The pilot studies demonstrated the benefit of working more closely with communities (see section 6.8). We will use information from the pilots to improve the way we work with others. We anticipate that this will improve our work as we benefit from the experience of local individuals, organisations and communities in preparing and carrying out our work. From our discussions with national groups, the pilots have also helped us develop our understanding of the issues related to watercourse maintenance that affect them.

The models developed as part of the pilots will be used to assist us in deciding the appropriate level of modelling required at other locations. The models and surveys completed at the individual sites will also continue to be used to assist future decisions at these locations.

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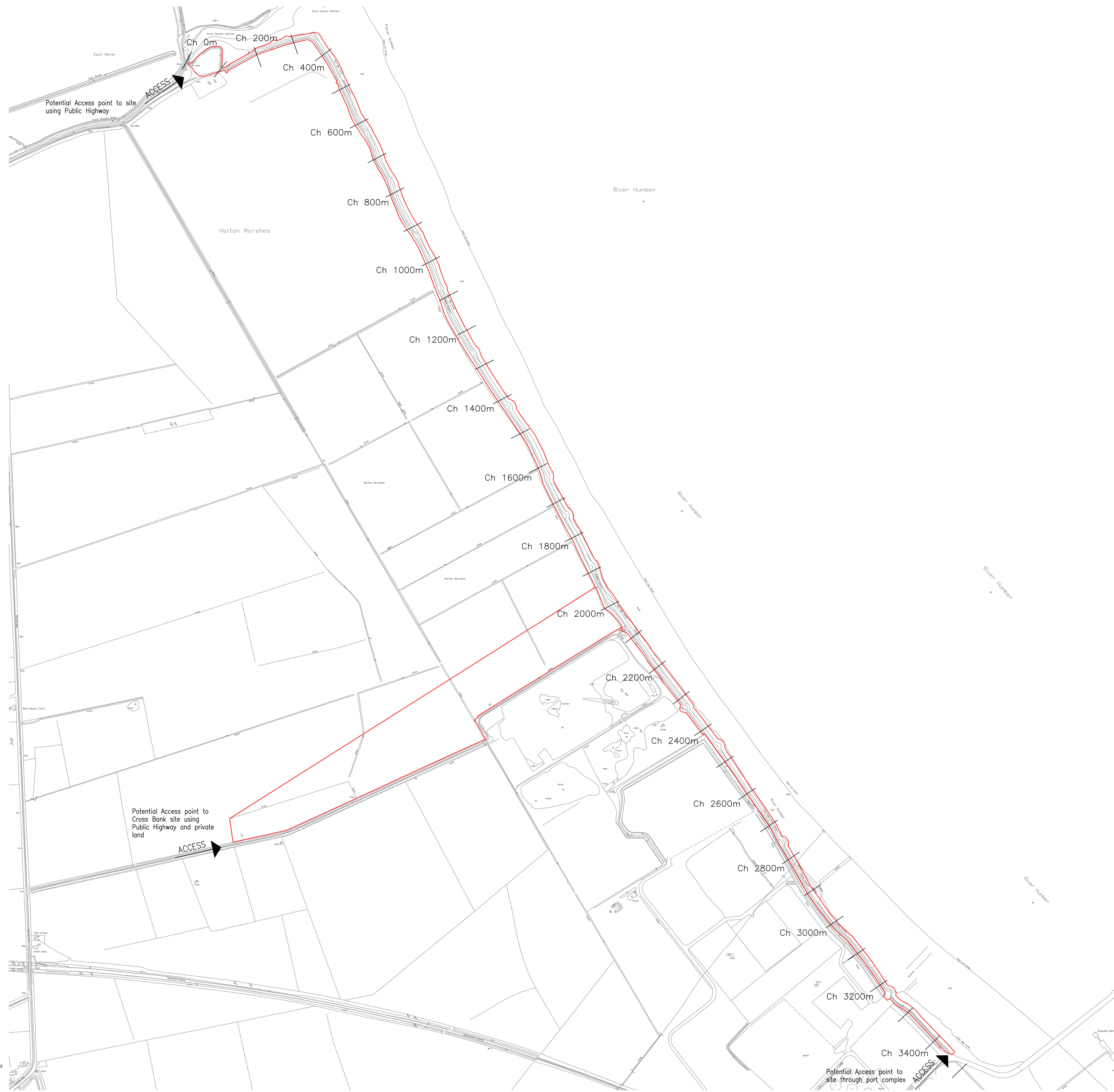
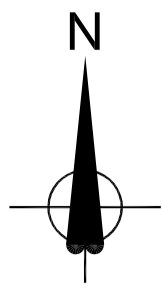
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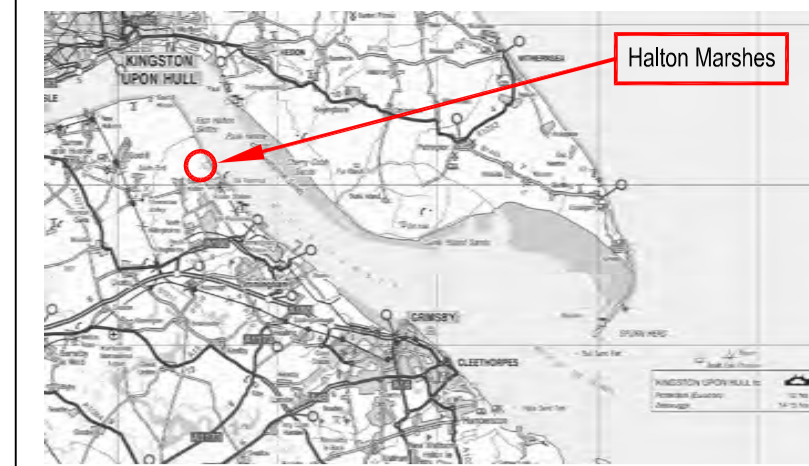
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APPENDIX D

Environment Agency Indicative Cross Bank Plan for ALP

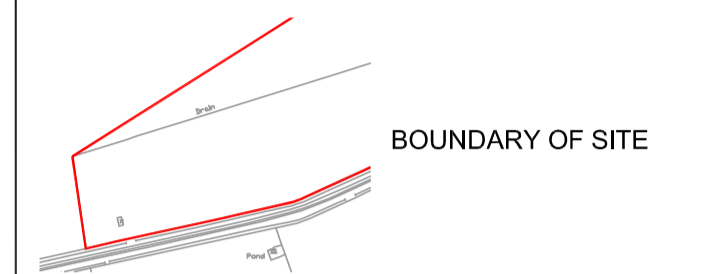


Key Plan:



Notes:

- 1. DO NOT SCALE FROM THIS DRAWING.



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Rev	By	Chkd	Apprvd	Date	Description

Client
Environment Agency
 Environment Agency
 North East Region
 Phoenix House
 Global Avenue
 Leeds LS11 8PG
 Tel 0133 2134797
 Fax 0133 2134609

Halcrow Group Limited
 Endeavour House, Forder Way, Cynnet Park, Hampton, Peterborough, Cambs, PE7 8GX
 Tel +44 (0)1733 560033 Fax +44 (0)1733 427988
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Project
HUMBER ESTUARY FLOOD RISK MANAGEMENT

Drawing
HALTON MARSHES TIDAL DEFENCE IMPROVEMENTS SITE PLAN

Drawn by: ApC Date: 15.04.08
 Checked by: RH Date: 22.04.08
 Approved by: CW Date: 24.04.08

Drawing No. **CEDAHD/002** Revision -

Drawing Scale: NTS

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