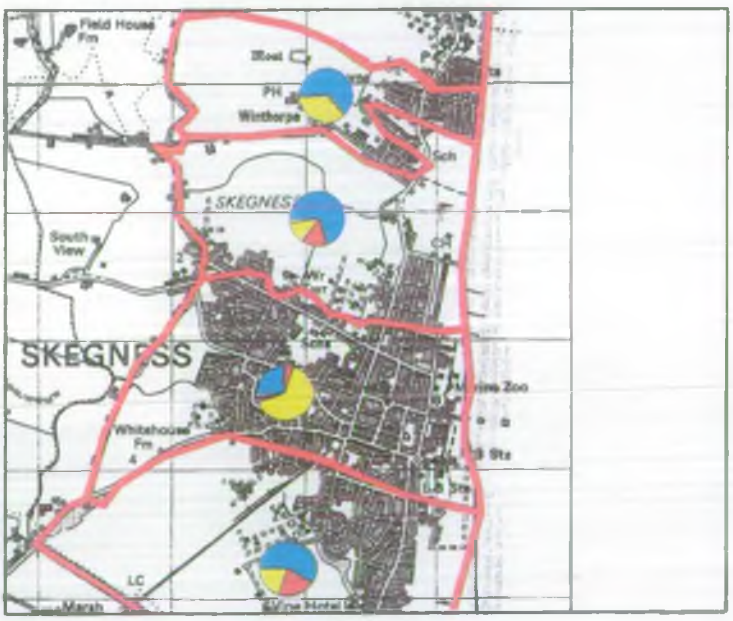
ENVIRONMENT AGENCY
Anglian Region

LINCOLNSHIRE SHORELINE MANAGEMENT PLAN

VOLUME I - CORE REPORT

DECEMBER 1996



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December 1996

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REFERENCES

GLOSSARY

ABBREVIATIONS

APPENDICES

I BREAKDOWN OF SCREENING PROCEDURE
II DETAILS OF ECONOMIC ASSESSMENT

SECTION 1

INTRODUCTION

1.1 BACKGROUND

1.1.1 Overview of Lincolnshire Coast

The Lincolnshire coast is formed from alluvial deposits composed mainly of sand but pockets of mud and fine material also occur. These deposits are underlain by clay. Wide sandy beaches exist to the north of Mablethorpe and to the south of Skegness and these are subject to accretion. Between Mablethorpe and Skegness the beaches comprise a thin layer of sand and are subject to erosion and steepening.

The coastal defences between Mablethorpe and Skegness are predominantly man-made sea walls whereas those to the north and south comprise natural sand dunes and salt marshes. The Environment Agency, Anglian Region (the Agency) are currently undertaking a scheme to nourish the beaches between Mablethorpe and Skegness. This is due for completion in 1998 and will provide a 200 year standard of defence.

The defences provide flood protection to an extensive area of low lying coastal plain. This area extends for up to 10km landward of the coast and much of the land is at or around mean sea level. Although the area is predominantly agricultural, the coastal fringe is extensively used for recreation and tourism and many of the towns are popular holiday resorts in addition to being residential and commercial centres. Tourism is a vital component of the coastal area and it is estimated that the East Lindsey district generates over £200 million in tourism spending each year with an estimated 5 million day visitors coming to the area. Fishing is another important industry.

The coast is an important area for wildlife. This is reflected by the numerous designations which have been made along the stretch of coast between Gibraltar Point and Donna Nook. Coastal habitats range from large expanses of saltmarsh, sand and mudflats, to scrub and grasslands with mature sand dune systems. Geological features are included within some of these designations and there are also sites of archaeological importance.

1.1.2 Introduction to Shoreline Management Plans

A Shoreline Management Plan is a document which sets out a strategy for coastal defence for a specific length of coast. The strategy takes into account natural coastal processes, human influences, land use and other environmental matters.

SMPs are under preparation or are to be undertaken for the entire coastline of England and Wales. In order to separate the coastline into manageable lengths it has been divided into eleven "sediment cells". A cell is defined as a length of coastline which is substantially self-contained as far as the movement of sand or shingle is concerned and where interruption to

such movement should not have a significant effect on adjacent sediment cells. In many cases even the sediment cells are too large for the production of workable SMPs and have therefore been divided into "sub-cells".

In June 1995 the Ministry of Agriculture, Fisheries and Food (MAFF) published guidance notes (MAFF, 1995) on the preparation of SMPs. These notes define the geographical boundaries for the sediment cells and sub-cells derived by HR Wallingford (HR Wallingford, 1993) and set out procedures for the production of an SMP.

1.1.3 Lincolnshire Shoreline Management Plan

The Lincolnshire coast between Donna Nook and Gibraltar Point is part of sediment cell 2 which extends from Flamborough Head to The Wash. It is designated sub-cell 2c and is bounded to the north by sub-cell 2b (Immingham to Donna Nook) and to the south by sub-cell 2d (Gibraltar Point to Snettisham). The location of these sub-cells is shown in Figure 1.1.

In addition to these coastline boundaries, offshore and hinterland (landward) boundaries have also been established for the SMP. These are illustrated in Figure 1.2.

The Agency is the local coastal defence authority for the Lincolnshire coast and as such is responsible for operating and coordinating the SMP. The Agency's predecessors, the National Rivers Authority (NRA), appointed Posford Duvivier as their consultants, in January 1995, to undertake the preparation of the Lincolnshire SMP.

SMPs are also being prepared for the adjacent lengths of coastline.

The aim of the Lincolnshire Shoreline Management Plan is to provide a framework for the development of sustainable coastal defence policies for the coastline between Donna Nook and Gibraltar Point and to set objectives for the future management of the shoreline.

The main objectives in developing the SMP were to:

- improve understanding of coastal processes operating within the sediment cell;
- predict the likely future evolution of the coast;
- identify the need for regional or site specific research and investigations;
- identify all the assets within the area covered by the SMP which are likely to be affected by coastal change;
- facilitate consultation between those bodies with an interest in the shoreline.

The main objectives of the SMP are to:

- agree a preferred approach based on an assessment of the range of strategic coastal defence options;
- outline future requirements for monitoring, management of data and research related to the shoreline;
- inform the statutory planning process and related coastal zone planning;
- identify opportunities for maintaining and enhancing the natural coastal environment, taking account of any specific targets set by legislation or any locally set targets;
- set out arrangements for continued consultation with interested parties.

The key issues addressed in the preparation of the SMP are:

- coastal processes;
- coastal defences;
- land use and the human and built environment;
- the natural environment.

1.2 THE DOCUMENTS COMPRISING THE SMP

The Lincolnshire SMP has been developed in two stages. Stage 1 dealt with the collection and presentation of data and Stage 2 with the integration of all information which, together with the results of consultation, led to the preparation of the coastal defence strategies.

The procedure leading to the production of the SMP is shown in Figure 1.3.

The completion of this work has culminated in the production of the SMP in three volumes:

- Volume I: Core Report
- Volume II: Atlas
- Volume III: Supporting Document

At the beginning of Stage 1 (March 1995) a Scoping Document was issued to over 100 interested parties to advise them of the project and to request relevant information. Data collected was used in the preparation of draft editions of the Atlas and Supporting Document. At the end of Stage 1 (August 1995) these documents were issued for consultation.

During Stage 2 the Atlas and Supporting Document were revised in the light of the consultation and a draft of the Core Report prepared. These three documents formed the draft SMP which was issued for consultation in December 1995. Finally, comments from this consultation were incorporated into the three documents and the SMP was published in December 1996.

A list of those consulted during the preparation of the SMP together with a summary of responses received during the preparation of the SMP together with a summary of responses received during the Stage 1 and Stage 2 consultation is provided in Appendix A of Volume III.

The scope of the three documents is outlined below:

Core Document: This Core Document describes how the Lincolnshire coast has been considered as a number of so called "management units"; these are lengths of coast with coherent characteristics in terms of natural coastal processes and land use. It sets out the specific objectives of the SMP with regards to the whole coast and these management units. The coastal defence options are then appraised in terms of these objectives and in terms of their economic viability. Preferred strategic options are thus derived.

The remainder of the Core Document is concerned with recommendations for future research and monitoring of the coast, and recommendations for the future review procedures for the SMP.

Volume II - Atlas: The Atlas comprises 18 maps accompanied by short descriptions of the information presented and the sources of the data. A list of the maps included in this summary document is provided in Table 1.1.

Volume III - Supporting Document: The Supporting Document provides further background and details to the information contained in the Atlas.

Some diagrams and tables are repeated between documents to avoid excessive cross-reference.

1.3 USE OF LINCOLNSHIRE SMP

The SMP provides the basis for the implementation of sustainable coastal defence policies for the Lincolnshire shoreline. It also sets out the objectives relating to coastal defence, land use, the human and built environment, and the natural environment which were used to establish these policies and which should be used in the future management of the shoreline. As such the SMP is not only an important reference for the implementation of any coastal defence strategy but also for any initiative which interacts with the shoreline.

TABLE 1.1

MAPS INCLUDED IN ATLAS

Map No	Title	No of Sheets
1	Introduction to Lincolnshire Coast	I
2	Sea Bed Contours	1
3	Sedimentology	1
4	Geomorphology	1
5	Beach Sediment Sizes	1
6	Shoreline Evolution	3
7	Wave Conditions	1
8	Tidal Conditions	1
9	Net Longshore Transport	1
10	Coastal Defences	3
11	Land Use	3
12	Planning Framework	1
13	Commercial Fishing Activities	1
14	Tourism and Recreation	1
15	Habitats	1
16	Conservation Sites	1
17	Archaeology	1
18	Management Units	1

SECTION 2

MANAGEMENT UNITS

2.1 DEFINITION

In order to develop sustainable strategic coastal defence options within the SMP area, it is necessary to divide the coastline into a number of management units.

A management unit is defined as a length of coastline with coherent characteristics in terms of both natural coastal processes and land use (MAFF, 1995).

It should be noted that SMPs are only concerned with coastal defence policies and the management of the shoreline. Individual management units do not, therefore, include tidal defences along rivers which enter the sea within the sub-cell.

2.2 SELECTION OF MANAGEMENT UNITS

The selection of individual management units has been based on the identification of lengths of coastline with similar characteristics in terms of coastal processes and land use.

From studies of the coastal processes (Volume III - Chapter 3.0) it is evident that the coast can be divided into three distinct zones: advance or accretion (build up) of the beach to the north of Mablethorpe, retreat or erosion of the beach between Mablethorpe and Skegness, and advance of the beach to the south of Skegness. However, from the description of land use and the natural and human environment (Volume III - Chapter 5.0) it is also evident that within these "coastal process zones" there are significant changes in land use (between the rural areas and residential areas of Mablethorpe, Skegness, Anderby Creek etc).

These changes in coastal processes and land use have led to the management units identified on Map 18 (reproduced herein as Figure 2.1) and detailed in Table 2.1. The basis for the location of the unit boundaries is described as follows:

north of Unit 1	-	boundary with sediment sub-cell 2b
Unit 1/Unit 2	-	change in land use; Unit 2 is essentially rural whereas Unit 1 includes the residential areas of North Somercoates and Saltfleet.
Unit 2/Unit 3*	-	change in land use; Unit 3 includes the residential and recreational areas of Mablethorpe, Sutton-On-Sea and Sandilands together with the Theddlethorpe Gas Terminal and pipelines whereas Unit 2 is essentially rural.
	-	change in coastal processes; in Unit 3 the beaches are retreating whereas in Unit 2 they are advancing.

Unit 3/Unit 4	-	change in land use; Unit 4 is essentially rural whereas Unit 3 includes the residential and recreational areas of Mablethorpe, Sutton-on-Sea and Sandilands.
Unit 4/Unit 5	-	change in land use; Unit 5 includes the residential and recreational area at Anderby Creek whereas Unit 4 is rural.
Unit 5/Unit 6	-	change in land use; Unit 6 is essentially rural whereas Unit 5 contains Anderby Creek.
Unit 6/Unit 7	-	change in land use; Unit 7 includes the residential and recreational area of Chapel St Leonards whereas Unit 6 is rural.
Unit 7/Unit 8	-	change in land use; Unit 8 is essentially rural whereas Unit 7 contains the residential and recreational area of Chapel St Leonards.
Unit 8/Unit 9	-	change in land use; Unit 9 includes the residential and recreational areas of Ingoldmells, Seathorne and Skegness whereas Unit 8 is rural.
Unit 9/Unit 10*	-	change in coastal processes; in Unit 10 the beaches are advancing whereas in Unit 9 they are retreating.
Unit 10/11	-	change in land use; Unit 11 is essentially rural whereas Unit 10 contains the residential area of Seacroft.
south of Unit 11	-	boundary with sediment sub-cell 2d

* The boundaries between Units 2 and 3 and Units 9 and 10 are not clearly defined. There will be a need to review carefully the location of these boundaries in each subsequent revision of the SMP. As noted, the boundary between Units 2 and 3 is based on both land use and coastal processes. In the future the land use boundary is unlikely to change significantly. The coastal process boundary, however, is more likely to be redefined and may result in the introduction of a new management unit in subsequent editions of the SMP.

TABLE 2.1
MANAGEMENT UNITS FOR SUB-CELL 2c: DONNA NOOK TO GIBRALTAR POINT

Management Unit		Boundary Demarcation	Coastal Processes			Principal Land Use	Existing Defences
No.	Name		Beach Sediment Type	Likely Drift Direction	Evolution		
1	Donna Nook to Saltfleet	Sub-cell 2b	Sand	Uncertain	Advancing	Rural Residential Nature Conservation	Embankment Dunes
		South of Saltfleet Haven (459 932)					
2	Saltfleet to Mablethorpe		Sand	NW to SE	Advancing	Rural Nature Conservation	Dunes
		South of Theddlethorpe St Helens (489 882)					
3	Mablethorpe to Sandilands		Sand	NW to SE	Retreating	Rural Residential Recreational Industrial Nature Conservation	Dunes Concrete Seawall
		Sea Lane (528 808)					
4	Sandilands to Anderby Creek		Sand	NW to SE	Retreating	Rural	Revetment, Concrete Seawall, Concrete Seawall with rock armour toe
		North of Anderby Creek (549 767)					
5	Anderby Creek		Sand	NW to SE	Retreating	Rural Residential	Revetment
		South of Anderby Creek (554 756)					
6	Anderby Creek to Chapel St Leonards		Sand	NW to SE	Retreating	Rural	Revetment
		Chapel Point (563 733)					
7	Chapel St Leonards		Sand	NW to SE	Retreating	Rural Residential Recreational	Concrete Seawall, Concrete Seawall with rock armour toe
		Trunch Lane (566 710)					
8	Chapel St Leonards to Ingoldmells		Sand	NW to SE	Retreating	Rural	Concrete Seawall, Concrete Seawall with rock armour toe
		Vickers Point (571 698)					
9	Ingoldmells to Skegness		Sand	N to S	Retreating	Rural Residential Recreational	Concrete Seawall with rock armour toe, Concrete Seawall
		South end of Lagoon Walk (570 624)					
10	Skegness to Seacroft		Sand	N to S	Advancing	Residential Rural Nature Conservation	Dunes
		Seacroft (566 610)					
11	Seacroft to Gibraltar Point		Sand	N to S	Advancing	Rural Nature Conservation	Dunes Embankment
		Sub-cell 2d					

SECTION 3

MANAGEMENT OBJECTIVES

3.1 GENERAL

The purpose of this section is to set objectives for the management of the Lincolnshire shoreline. These objectives were formulated during Stage 1 of the project and confirmed following consultations.

3.2 GENERAL MANAGEMENT OBJECTIVES

In addition to the specific management objectives set out in Section 3.3, there are general management objectives defined by government policy which apply to all SMPs and coastal defences. These are, that the chosen strategic option for each management unit must be:

- sustainable
- compatible with the preferred options identified for adjacent management units
- compatible with the processes at work within the sediment cell and, hence with adjacent sub-cells.

3.3 SPECIFIC MANAGEMENT OBJECTIVES

Management objectives relating to coastal defence, land use, the human and built environment, and the natural environment are listed below.

Coastal Defence:-

- to reduce the risk of flooding to acceptable levels thereby:
  - protecting human life
  - protecting property
  - allaying undue anxiety caused by the risk of flooding
- wherever possible, to conserve and enhance environmental assets without increasing risks to people.

Land Use, Human and Built Environment:-

Planning

- to provide protection from flooding and erosion in a manner consistent with the policies and objectives established within the planning framework

Agriculture

- to protect agricultural land from erosion or flooding where appropriate
- to enhance the rural economy (farm diversification, maintenance and enhancement of the countryside) wherever possible

Fisheries

- to minimise any adverse effects that coastal defence works may have on the coastal fishing activity during the construction phase
- to minimise any adverse effects that coastal defence works may have on the long term viability of the fishing industry
- to ensure that coastal defence structures and works continue to provide adequate access for the fishery activities

Tourism and Recreation

- to retain and, where possible, enhance all areas and accesses presently used for recreation and amenity purposes
- wherever possible, to retain recreational facilities, activities and accesses during construction
- to minimise risk to seaside users during and after construction

Archaeology

- to minimise and mitigate against any adverse impacts that coastal defence works may have on the archaeological resource

Military Use

- to consider military interests, in terms of safety and access, during the planning and construction of coastal defence works
- to minimise any adverse effects that coastal defence works may have on the MOD's present activities

Offshore Activity

- to develop a strategic framework which considers in full the relationships between coastal defence and offshore extraction and development.

Natural Environment:-

Biological and Geological

- to develop a strategic framework of coastal defence options to sustain biodiversity and the integrity of the natural environment by maintaining a favourable conservation status in accordance with the EU Habitats Directive
- to identify means by which shoreline management will create, conserve and enhance the natural environment
- wherever possible, to conserve features of geological interest
- to allow natural processes, which sustain areas of nature conservation, to continue
- to implement an effective monitoring scheme to determine the effect of the coastal defence activities on the nature conservation value of the coastal zone

Landscape

- to sustain and, where possible, improve the existing landscape character of the area
- to apply the Countryside Commission's principles for Heritage Coasts, wherever possible

Land Drainage and Water Quality

- to ensure that coastal defence works do not affect water quality in the coastal waters, in accordance with the relevant EC Bathing Water Directive
- to ensure that coastal defence works, where possible, do not adversely affect the dispersion of effluent from waste management operations
- to maintain the ability of the pumping stations and gravity discharges to work effectively during and after the construction of coastal defence works.

SECTION 4

APPRAISAL OF STRATEGIC COASTAL DEFENCE OPTIONS

4.1 GENERAL

This section covers the appraisal of available strategic coastal defence options for each management unit. The procedure adopted for the appraisal involves the following steps:

(i) **Screening of options against the general and specific management objectives**

This step involves screening the possible strategic options against the general and specific management objectives set during Stage 1 of the SMP and detailed here in Section 3. These objectives take account of the technical and environmental issues associated with the management of the shoreline.

The outcome is a shortlist of options for each management unit which are technically and environmentally acceptable.

The screening procedure is described in Section 4.3.

(ii) **Economic assessment of the shortlisted options**

This step involves an economic appraisal of the benefits and costs of each option shortlisted during the screening procedure. The purpose of the appraisal is to confirm the economic viability of these shortlisted options.

The economic assessment is described in Section 4.4.

(iii) **Selection of the preferred options**

For each management unit, those options which are technically, environmentally and economically acceptable are reviewed and one is selected as the "preferred option".

The selected options are set out in Section 5.

4.2 SUMMARY OF STRATEGIC OPTIONS

The strategic coastal defence options available are:

- **do nothing**; this would involve no coastal defence activity apart from safety measures and monitoring
- **hold the existing defence line**; this would involve, by intervention, holding the existing defence line at its present location

- **advance the existing defence line**; this would involve, by intervention, moving the existing defence line seawards of its present location

- **retreat the existing defence line**; this would involve, by intervention, moving the existing defence line landwards of its present location.

The existing defence line within each management unit is shown on Map 10. It may be defined as follows:

- **Management Unit 1** - the crest of the clay embankment which extends from Donna Nook to south of Saltfleet Haven.

- **Management Unit 2** - the highest or most westerly crest of the natural dune system which extends from south of Saltfleet Haven to north of Mablethorpe.

- **Management Units 3 to 9** - the crest of the seawalls/revetments which extend from north of Mablethorpe to south of Skegness.

- **Management Unit 10** - the crest of the east dune line which extends from the southern end of Lagoon Walk/South Bracing (south of Skegness) to Seacroft.

- **Management Unit 11** - the crest of the east dunes as far south as Bulldog Bank; the clay embankment (known as Bulldog Bank) and the west dunes to Gibraltar Point.

4.3 SCREENING OF OPTIONS

4.3.1 Procedure

A strategic coastal defence option selected for a management unit should comply with the general and specific management objectives set out in Section 3.

In order to determine which of the possible options satisfy the management objectives the following was undertaken for each management unit:

(i) **Completion of the tables presented in Appendix I**

The criteria identified in Table 4.1 (for the general management objectives) and Table 4.2 (for the specific management objectives) have been used to test whether each option satisfies the management objectives for a particular management unit. The outcome of this test procedure is shown in Tables I.1 to I.11 contained in Appendix I.

(ii) **Shortlisting of options**

Using the results from Tables I.1 to I.11 (held in Appendix I) those options which meet the management objectives have been shortlisted. These shortlisted options are

identified in Section 4.3.5.

Sections 4.3.2 and 4.3.3 discuss the criteria used to screen the options against the general and specific management objectives respectively.

An objective - by - objective description of the results of the screening is not given. Instead a summary which outlines the significant issues leading to the acceptance or rejection of a particular option is provided in Section 4.3.4.

4.3.2 Criteria for Screening against General Management Objectives

The general management objectives identified in Section 3 are repeated in Table 4.1. The table also states the criterion used during the screening procedure to determine whether the option satisfies the objective.

TABLE 4.1

GENERAL MANAGEMENT OBJECTIVES: TESTING PROCEDURE

General Management Objective	Option satisfies objective if:
▪ The option must be sustainable[1]	▪ It is viable for at least the next 55 years.
▪ The option must be compatible with the preferred options identified for adjacent management units.	▪ There are no adverse effects on shoreline processes in adjacent units.
▪ The option must be compatible with the processes at work within the sediment cell and, hence, with adjacent sub-cells.	▪ It is compatible with the current and likely future shoreline evolution

Note

[1] Sustainable options are those which take account of the inter-relationships with other defences, developments and processes within the coastal sub-cell, and which avoid as far as possible tying future generations into inflexible and expensive options for defence (MAFF, 1995).

4.3.3 Criteria for Screening against Specific Management Objectives

The specific management objectives identified in Section 3 are repeated in Table 4.2. The table also states the criterion used during the screening procedure to determine whether the option satisfies the objective.

TABLE 4.2

SPECIFIC MANAGEMENT OBJECTIVES: TESTING PROCEDURE

Objective	Option satisfies objective if:
Coastal Defence	
▪ To reduce the risk of flooding to an acceptable level thereby: - protecting human life - protecting property - allaying undue anxiety caused by the risk of flooding.	▪ Option provides an acceptable level of protection.
▪ Wherever possible, to conserve and enhance environmental assets without increasing risks to people.	▪ Option conserves and enhances the environment without increasing the risks to people
Planning	
▪ To provide protection from flooding and erosion in a manner consistent with the policies and objectives established within the planning framework.	▪ Option complies with the relevant planning policies.
Agriculture	
▪ To protect agricultural land from erosion or flooding where appropriate.	▪ Option provides an acceptable level of protection to agricultural land.
▪ To enhance the rural economy (farm diversification, maintenance and enhancement of the countryside) wherever possible.	▪ Option assists with the enhancement of the rural economy.
Fisheries	
▪ To minimise any adverse effects that coastal defence works may have on the coastal fishing activity during the construction phase	▪ Option helps to ensure that potential adverse effects during construction are reduced to a negligible level.
▪ To minimise any adverse impacts that coastal defence works may have on the long term viability of the fishing industry	▪ Option enables adverse long term effects to be reduced to a negligible level.
▪ To ensure that coastal defence structures and works continue to provide adequate access for the fishery activities	▪ Option does not preclude adequate access for fishing activities.

Objective	Option satisfies objective if:
Tourism and Recreation	
▪ To retain and, where possible, enhance all areas and accesses presently used for recreation and amenity purposes.	▪ Option ensures that there are no adverse effects on existing recreational and amenity areas or that any such effects are reduced to a negligible level.
▪ Wherever possible, to retain recreational facilities, activities and accesses during construction.	▪ Option helps to ensure that there are no adverse effects on recreational and amenity areas during construction or that any such effects are reduced to a negligible level.
▪ To minimise risk to seaside users during and after construction	▪ Any risks to beach users during and after construction are eliminated.
Archaeology	
▪ To minimise and mitigate against any adverse impacts that coastal defence works may have on the archaeological resource	▪ Option enables any potential adverse effects on the archaeological resources to be reduced to a negligible level.
Military Use	
▪ To consider military interests, in terms of safety and access, during the planning and construction of coastal defence works	▪ Option does not compromise military interests.
▪ To minimise any adverse effects that coastal defence works may have on the MOD's present activities	▪ Option enables any potential adverse effects on military activities to be reduced to an acceptable level.
Offshore Activity	
▪ To develop a strategic framework which considers in full the relationships between coastal defence and offshore extraction and development.	▪ Option enables satisfactory balance between coastal defence requirements and offshore activities.
Biological and Geological Environment	
▪ To develop a strategic framework of coastal defence options to sustain biodiversity and the integrity of the natural environment by maintaining a favourable conservation status in accordance with the EU Habitats Directive.	▪ Option ensures that favourable conservation status is maintained.
▪ To identify means by which shoreline management will create, sustain and enhance the natural environment	▪ Option enables the natural environment to be sustained and enhanced.

Objective	Option satisfies objective if:
▪ Wherever possible, to conserve features of geological interest	▪ Option conserves the geological interests.
▪ To allow natural processes, which sustain areas of nature conservation, to continue	▪ Option allows the natural processes to continue.
▪ To implement an effective monitoring scheme to determine the effect of the coastal defence activities on the nature conservation value of the coastal zone	▪ Monitoring can be undertaken, where appropriate.
Landscape	
▪ To sustain and, where possible, improve the existing landscape character of the area	▪ Option sustains and, where possible, improves the existing landscape character of the area.
▪ To apply the Countryside Commission's principles for Heritage Coasts, wherever possible	▪ Option allows consideration to be given to the Countryside Commission's principles.
Land Drainage and Water Quality	
▪ To ensure that coastal defence works do not affect the water quality in the coastal waters, in accordance with the relevant EC Bathing Water Directive	▪ Option sustains and, where possible, improves water quality.
▪ To ensure that coastal defence works, where possible, do not adversely affect the dispersion of effluent from waste management operations.	▪ Option sustains and, where possible, improves dispersion of effluent.
▪ To maintain the ability of the pumping stations and gravity discharges to work effectively during and after the construction of coastal defence works.	▪ Option enables any adverse effects on land drainage to be reduced to an acceptable level.

4.3.4 Discussion of Screening Procedure

The following paragraphs provide, for each management unit, a summary of the most significant issues which led to the acceptance or rejection of a particular option. Reference is also made to the tables in Appendix I which provide the full results of the screening procedure. The outcome of the screening procedure is shown in brackets following each option heading.

Management Unit 1 (Appendix I, Table I.1)

- **Do Nothing (Rejected)**

  Technically, the do nothing option is considered to be incompatible with current and future evolution of the shoreline. The option conflicts with the SMP coastal defence objective and the Agency's duties under the Water Resources Act (1991) to provide satisfactory flood protection to residential areas (e.g. North Somercotes and Saltfleet).

- **Retreat the Line (Rejected)**

  Retreating the line of defences would not be compatible with the objectives of the SMP within this management unit. Primarily, this option would not provide flood protection to residential, agricultural and amenity areas left in front of any new line of sea defences. This will in turn conflict with the legal duties of the Agency under the Water Resources Act (1991) and local planning authority policies concerning maintaining flood defence.

- **Hold the Line (Viable)**

  This option fulfils the objectives of the SMP for this management unit. If adopted, however, this option should be reviewed in accordance with the updating procedure described in Section 7, particularly with regard to the influence of "coastal squeeze" (See Section 6.2.3).

- **Advance the Line (Rejected)**

  This option conflicts with the SMP objectives (Table 4.2) since it would result in the loss of part of the saltmarsh and mudflats of the adjacent North Lincolnshire Coast SSSI and Humber flats, marshes and coast SPA and Ramsar site. Therefore, this would not maintain a favourable conservation status at the site. This would in turn bring this option into conflict with the national and international legal obligations engendered by the designation of these sites under the Wildlife and Countryside Act (1981), the EC Birds Directive (79/409/EEC) and the Ramsar convention to protect these sites from development. In addition it will not conform to planning policies to maintain sites with conservation status.

Management Unit 2 (Appendix I, Table I.2)

- **Do Nothing (Viable)**

  The do nothing option may be appropriate to this management unit, provided that the level of accreted sediment sustains an acceptable standard of flood protection. It is, however, recommended that additional studies and ongoing monitoring are conducted to confirm that natural accretion will continue to maintain the standard of flood defence required to meet the Agency's duties under the Water Resources Act (1991).

(See Sections 6.2.3 and 6.3.3).

- **Retreat the Line (Rejected)**

  Retreating the line by intervention is not compatible with the existing coastal processes since the coast is naturally accreting and at present provides a natural form of flood defence.

- **Hold the Line (Viable)**

  This option is only considered to be acceptable within this management unit if any necessary maintenance of the natural line involves only the use of dune management and saltmarsh enhancement techniques. The use of so-called "hard engineering" options (eg. construction of seawalls or embankment) are not acceptable since they would damage or destroy the Saltfleetby to Theddlethorpe Dunes SSSI and NNR. It is recommended that liaison takes place between the Agency, English Nature and the Lincolnshire Trust for Nature Conservation to determine the most appropriate management measures.

- **Advance the Line (Rejected)**

  This option conflicts with the SMP objectives (Table 4.2) since constructing a new line to seaward will necessitate the loss of part of the adjacent Saltfleetby to Theddlethorpe Dunes SSSI and NNR, causing the loss of a nationally important habitat for birdlife. This will bring this option into conflict with legal obligations under the Wildlife and Countryside Act (1981). In addition it will not conform to local authority policies to maintain sites with conservation status. Advancing the line will also remove an area of amenity value and have a significant negative impact on the landscape of this management unit.

Management Units 3 to 9 (Appendix I, Tables I.3 to I.9)

Management Units 3 to 9 are considered together since they have similar characteristics.

- **Do Nothing (Rejected)**

  The do nothing option is not considered to be compatible with the objectives of the SMP for these management units, particularly with regard to preventing increased risk of flooding to residential and leisure/recreational areas (Mablethorpe, Sutton on Sea, Anderby Creek, Chapel St Leonards, Ingoldmells and Skegness), industrial facilities (the gas terminal and pipeline), and agricultural land. In addition, this option is neither consistent with the Agency's flood defence duties under the Water Resources Act (1991) nor with planning policies which seek to provide protection from flooding and erosion.

- **Retreat the Line (Rejected)**

  The option of retreating the line is not considered to be acceptable since it would not conform to several of the SMP objectives. Primarily, this option would not then provide flood protection to residential, agricultural and amenity areas left in front of a new line of sea defences. In addition, retreating the line could lead to the permanent loss of sites of conservation interest due to coastal erosion. These include the Seabank Clay Pits SSSI, Sutton on Sea Foreshore Regionally Important Geological Site (RIGS) and Chapel Point Geological Conservation Review site (GCR). Retreating the line could also be detrimental to any hidden archaeological remains since increased erosion may lead to exposure of layers (clays and peats) with a significant archaeological potential. Finally, this option would have to provide alternative facilities for fishing and recreational boating access to replace those lost due to retreating the line.

- **Hold the Line (Viable)**

  Holding the line of the existing coastal defences meets the objectives of the SMP. It will maintain flood defences which protect centres of population, agricultural land and industrial facilities. Holding the line would be achieved through a continuing programme of beach nourishment, which began in 1994. The scheme is sustained by future periodic renourishment.

  This option will ensure the protection of the amenities and conservation sites, although continued erosion to the Sutton on Sea Foreshore RIGS could occur. This erosion could be prevented by the continued use of beach material under the Mablethorpe to Skegness beach nourishment scheme which will overlay and thus protect this geological site. Recreational and fishing access will also be maintained.

- **Advance the Line (Rejected)**

  Advancing the line of flood defences to seaward of their present position is not appropriate since it is unlikely that this option will be sustainable on what is an eroding coastline. This option is also not compatible with processes at work within the cell, or options for adjacent management units. It is likely that by advancing the line, the coastal processes that sustain Gibraltar Point would be interrupted, preventing the application of the do nothing option to Management Unit 11.

Management Units 10 and 11 (Appendix I, Tables I.10 and I.11)

The line of the defences with Management Units 10 and 11 is described in Section 4.2.

- **Do Nothing (Rejected)**

At present there is an area of erosion at the boundary between Management Units 9 and 10 (ie at the southern end of Lagoon Walk). This erosion may, in the future, cause significant damage to the dunes and saltmarsh which provide protection to the natural defence line with Management Unit 10. This would lead to an increased flood risk to Seacroft and damage to the northern part of the Gibraltar Point SSSI, NNR, Ramsar, SPA and candidate SAC. This concern, combined with the uncertainty over the precise location of the change from an eroding to an accreting coastline to the south of Skegness, indicates that the do nothing option for Management Unit 10 is not appropriate.

The coastal defence line in Management Unit 11 is similar to that for Management Unit 10 (stable dunes fronted by mobile dunes and an intertidal area). It also includes a short length of man-made clay embankment (Bulldog Bank). A survey of the defence line indicates that there are minor gaps within the dune system. These gaps in the natural defence line could allow flooding to the rural area behind and possibly the southern part of Skegness. Since the do nothing option will not allow these gaps to be removed it is rejected.

- **Retreating the Line (Rejected)**

Retreating the line by intervention is not appropriate for two reasons. Firstly, within Management Unit 10 there is little space available to retreat the line unless residential properties adjacent to Drummond Road, Skegness, are removed to build the new line or left undefended in front of the new line. Secondly, within Management Unit 11 there is little cause to retreat the line since the shore is naturally accreting.

- **Hold the Line (Viable)**

Hold the line is considered to be appropriate only if any maintenance of the natural line involves the use of dune management and saltmarsh enhancement techniques. So called "hard engineering" options (eg. the construction of seawalls or embankments) are not acceptable under the international and national legal obligations engendered by the designation of Gibraltar Point as a SSSI, NNR, SPA, candidate SAC and Ramsar site. It is recommended that liaison takes place between the Environment Agency, English Nature and the Lincolnshire Trust for Nature Conservation to determine the most appropriate management measures.

- **Advance the Line (Rejected)**

This option conflicts with the SMP objectives (Table 4.2) since it will cause the damage to or loss of the Gibraltar Point SSSI, NNR, SPA, candidate SAC and Ramsar site. This important area for conservation is dependent upon an uninterrupted supply of sediment and periodic tidal inundation. Advancing the line in Unit 10 could interrupt the sediment supply to Gibraltar Point and therefore prevent the

accretion of intertidal habitat. Advancing the line in Unit 11 would require construction works within the SSSI, NNR, SPA, candidate SAC and Ramsar site. Given the international conservation importance of this site, such works could not be justified unless there is overriding public interest. Since Unit 11 is the frontage for a largely rural area, such justification does not exist. This option would therefore not be consistent with the national and international legal obligations of the site provided by the Wildlife and Countryside Act (1981), EC Birds and Habitats Directives (79/409/EEC and 92/43/EEC) and the Ramsar convention. Similarly it will not conform to planning policies which seek to protect these designated wildlife sites. Loss of this internationally important wildlife site would also reduce the amenity value of the area causing a significant negative impact on recreational activity within this management unit.

4.3.5 Shortlisted Options

The screening procedure described in Sections 4.3.1 to 4.3.4 has reduced the potentially viable options for each management unit to the following:

Management Unit 1: **Hold the Line**

Management Unit 2: **Do Nothing**
Hold the Line

Management Units 3-9: **Hold the Line**

Management Units 10-11: **Hold the Line.**

4.4 ECONOMIC ASSESSMENT

4.4.1 Introduction

The guidance notes published by MAFF (MAFF, 1995) on the preparation of SMPs require the costs and flood damages associated with each viable strategic option to be compared with the damages that would occur with the "without project" option. The "without project" option is a hypothetical case which assumes that the defences are abandoned and no expenditure is incurred in the future. The benefits of undertaking a particular strategic option are the value of the damages that would result from the "without project" case less the value of the damages that would still occur with the strategic option in place.

There are two economic parameters which are used to test the viability of an option; net present value (NPV) and benefit cost ratio (B/C). NPV is the benefits of the option less the costs of the scheme. The B/C is the ratio of benefits to costs. For an option to be economically viable, it must have a positive NPV and have a B/C greater than one.

MAFF have published guidance notes (MAFF, 1993) describing the approach that should be adopted for the economic appraisal of options. The general principles of this document have

been used for this economic assessment, however, it should be noted that the assessment carried out is a strategic rather than a detailed economic appraisal of the options.

4.4.2 Approach to Economic Appraisal

A continuous line of sea defences, either man-made or natural, is required throughout the Lincolnshire sub-cell to prevent inundation of the Lincolnshire area.

It is, therefore, not appropriate to undertake an economic appraisal of the strategic options for each management unit as the protection of assets behind one unit is dependent upon the defences in all the other units. The correct approach is to consider the sub-cell as a whole.

The do nothing option has been selected for Unit 2 as the natural defences provide satisfactory flood protection without the need for intervention.

From the shortlisted options identified in Section 4.3.5, and in view of the above statement, an economic appraisal of the sub-cell has been undertaken on the following basis:

- Management Unit 1: Hold the Line
- Management Unit 2: Do Nothing
- Management Units 3 to 11: Hold the Line

In the remainder of the report this is referred to as the "combined strategy" for the sub-cell.

The assessment of benefits and costs are briefly described in Sections 4.4.3 and 4.4.4; further details are provided in Appendix II. The results of the economic appraisal are presented in Section 4.4.5.

4.4.3 Benefits

The assessment of damages and benefits has been based on the use of House Equivalents (HEs). This concept was developed by the Flood Hazard Research Centre at Middlesex University to allow a "broad brush" approach for prioritising flood defence schemes. This approach is appropriate for use within the Lincolnshire Shoreline Management Plan.

An HE is the average cost of damage to the average house when flooded. HE units have been used to convert the land use types identified on Map 11 into a common unit of measure eg. arable farmland and industrial areas as well as residential properties into the equivalent average residential property. A damage value is then assigned to an HE to enable the flood damages to be assessed.

Further details on the use of HEs to assess benefits and damages is given in Appendix II together with a comparison of this approach with the economic appraisal completed for the Agency's Mablethorpe to Skegness Beach Nourishment Scheme. The appraisal for the beach nourishment scheme was limited to the assessment of flood damages that would occur to residential properties. The use of HEs, therefore, has the advantage of taking into account

all types of properties and land that are at risk of flooding.

A brief explanation of the calculation of without project damages and option damages is provided below.

Without Project Damages - In assessing these damages it is assumed that a breach in the defences at any location along the Lincolnshire coast would (eventually) cause flooding of the entire low lying hinterland area. It is considered that all property and other assets within the hinterland area at risk would be "written off".

Total without project damages amount to £2,798,640,000.

Option Damages - A 200 year standard of defence has been adopted for the assessment of option damages. A storm event with a return period of 200 years would cause multiple breaching of the defences. Hence it is expected that all property and other assets within the hinterland area would be damaged.

Total damages from a 200 year event amount to £377,019,000.

4.4.4 Option Costs

The cost of holding the line has been assessed as follows:

Unit 1: costs have been based on the improvement (where necessary) and maintenance of the existing clay embankments.

Units 3 to 9: costs for these units have been based on prices from the Agency's ongoing beach nourishment scheme.

Units 10 and 11: costs for these units have been based on minor improvements (where necessary), management and monitoring of the dunes. Within Management Unit 11, an additional cost has been included for the maintenance of the clay embankment (Bulldog Bank).

For **Units 2:** the cost of the do nothing option is zero.

4.4.5 Results of Economic Appraisal

The results of the economic appraisal are presented in Table 4.3.

TABLE 4.3

ECONOMIC APPRAISAL OF COMBINED STRATEGY

ITEM	WITHOUT PROJECT £	COMBINED STRATEGY £
Cost PVc		66,512,000
Flood Damage PVd	1,861,200,000	40,375,000
Benefits PVb		1,820,825,000
NPV		1,754,313,000
Average Benefit-Cost Ratio		27.4

Note: See Section 4.4.2 for definition of "combined strategy".

The economic appraisal has shown that the combined strategy is justified for the Lincolnshire sub-cell as the NPV is positive and the benefit cost ratio exceeds unity.

SECTION 5

SUMMARY OF PREFERRED STRATEGIC COASTAL DEFENCE OPTIONS

5.1 PREFERRED STRATEGIC OPTIONS

The screening procedure and economic assessment described in Section 4 has identified the following preferred strategic options for the Lincolnshire coast:

Management Units 1: **Hold the Line**

Management Units 2: **Do Nothing**

Management Units 3 to 11: **Hold the line**

SECTION 6

RECOMMENDATIONS FOR FUTURE RESEARCH AND MONITORING

6.1 GENERAL

The information gathered and analysed during the preparation of the SMP is summarised in Volume II - Atlas and further background details are provided in Volume III - Supporting Document.

The sources of data used for the preparation of these documents have included:

- reports and data available within the Agency's archives, particularly work completed for strategic study and design of the Mablethorpe to Skegness Sea Defences
- literature review
- discussions with Agency personnel
- information supplied by consultees following the issue of the Scoping Document and drafts of the Core Report, Atlas and Supporting Document.

A full list of references and also a list of those consulted during the preparation of the SMP are included in Volume III.

Overall the data collection exercise has provided more information on the coastline between Mablethorpe and Skegness and rather less to the north and south of this length. This is inevitable given the built-up nature of the Mablethorpe to Skegness frontage which has, by that token, attracted more attention and study, not least because it is also contained within the eroding length of coastline.

Nevertheless, it is considered that there are no major gaps in the information collected. There are, however, areas of uncertainty and these are identified in Section 6.2. Sections 6.3 and 6.4 recommend future monitoring and research that should be undertaken to reduce these uncertainties.

6.2 AREAS OF UNCERTAINTY

6.2.1 Coastal Processes

There is a good understanding of the processes at work along the coastline between Mablethorpe and Skegness. The processes operating along the coast to the north and south however, are less well understood.

To the north of Mablethorpe the following is either not known or not fully understood:

- why the coastline is accreting
- the relevance of the offshore sand banks as a source of sediment for the beaches
- whether the Holderness coastline is a source of sediment for the Lincolnshire coast
- an estimate of longshore transport rates
- an indication of the grading of the beach sediment

To the south of Skegness, considerable research (Dugdale, 1995) has been undertaken into the behaviour of the nearshore sandbanks and the interaction between these features and the shoreline. The following information is, however, not known:

- whether sediment is migrating into the Wash from the Lincolnshire coast
- an estimate of longshore transport rates
- an indication of the grading of the beach sediments
- a description of the seabed sediments

The evolution of the coastline over the last twenty years has not been quantified. Beach profile data, collected by the Agency and others, is available and an analysis could be undertaken.

6.2.2 Land Use, Human and Built Environment

The following section describes those areas relating to land use, human and built environment where there is, at present, insufficient information to make management decisions with regard to the future review and implementation of the Lincolnshire SMP.

- **Flood Defence**

  Little information exists on how coastal processes will sustain the level of flood defence on apparently accreting parts of the coastline, where the do-nothing or hold the line options are thought to be appropriate. Given the important need to develop and maintain public confidence and hence reduce stress and worry, further information about these coastal processes is considered essential.

- **Archaeology**

  At present there is limited information regarding potential archaeological exposures within the study area due to the mobile nature of the overlying beach material. This is of particular importance where the present coast is retreating, and, in the process, exposing archaeological features within Management Units 3 to 9 and possibly the northern part of Management Unit 10.

- **Recreation Access**

  Section 6.2.1 indicates that there is an area of uncertainty regarding sediment transport into the Wash from the Lincolnshire coast. If this movement of sediment does occur, there is concern that navigation into and within Wainfleet Haven may be affected.

6.2.3 Natural Environment

The following section describes those areas relating to the natural environment where there is, at present, insufficient information to make management decisions with regard to the future review and implementation of the Lincolnshire SMP.

- **Coastal Squeeze**

  Coastal squeeze is a process whereby coastal habitats and natural features are progressively lost or drowned, caught between coastal defences and rising sea levels. There is concern that habitats along the Lincolnshire coastline could be at risk from this process. Given the statutory designations within these management units (SSSI, NNR, SPA, candidate SAC and Ramsar), it is recommended that future studies should be undertaken to evaluate the implications of this issue. In particular, future work should be undertaken to determine whether or not the level of accretion in Management Units 1, 2 and 11 will be outstripped by sea level rise leading to coastal squeeze.

- **Statutory Sites**

  Previous work indicates that the coastline north of Mablethorpe (Management Units 1 and 2), is accreting and thereby sustaining the sites of nature conservation

importance within these areas. Concern, however, has been voiced by the Lincolnshire Trust for Nature Conservation and English Nature that coastal processes have recently changed in this area, and that the foreshore is retreating, threatening the integrity of the North Lincolnshire Coast SSSI, Humber Estuary SPA and Ramsar, together with the Saltfleetby - Theddlethorpe Dunes SSSI and NNR.

- **Critical Natural Capital and Constant Natural Asset**

English Nature have recommended that the concepts of Critical Natural Capital (CNC) and Constant Natural Asset (CNA) should be included within the SMP framework as an aid to coastal defence management decision making.

According to English Nature, sites of conservation interest, or other environmental assets can be classified as either CNC or CNA, their definitions for which are as follows:

Critial Natural Capital (CNC) is used to describe those elements of the natural environment whose loss would be serious, or which would be irreplaceable, or which would be too difficult or expensive to replace in human timescales. CNC should therefore be preserved.

Basic criteria for selecting areas of CNC are:

- the site or population of species is of national or international importance;
- the site or population of species is essentially irreplaceable within the lifespan of the SMP (25 - 50 years) because of economic or technical considerations, or both.

In practice the identification of CNC will generally be on the basis of existing or proposed designations but there may also be CNC which falls outside the statutory designation system and this should not be ignored. Examples of CNC for habitats and species might be internationally important sites for geological conservation, or habitats supporting nationally rare or endangered species.

Constant Natural Assets (CNA) are those elements which are not irreplaceable but whose loss should be fully and directly compensated for (eg. by habitat recreation).

CNA should be conserved in order to maintain the stock or extent overall, preferably within the coastal sub-unit but not necessarily in the current location(s). An example of a CNA may be the intertidal sand or mudflats which support internationally important waterfowl populations or nationally important freshwater wetlands in the coastal zone.

Generally, intertidal habitats are regarded as being fundamentally recreatable (English Nature, 1995) and hence can be regarded as CNA. However, CNA also needs to fulfil the following criteria:

- it is replaceable within the life of the SMP
- it can be replaced at a reasonable cost
- there is sufficient funding available to allow replacement
- it can be replaced within the coastal sub-cell
- the coastal processes permit replacement
- the removal of a "replaceable" habitat will not result in changes to coastal processes which may in turn disrupt or destroy an adjacent habitat which is considered to be irreplaceable (e.g. CNC)

Both CNC and CNA can be independent of existing conservation designations.

CNC and CNA are evolving concepts in shoreline management planning which will need to be refined and tested over the lifetime of the SMP. In applying the above criteria, a precautionary approach should be adopted. If for any reason it is not clear that a proposed course of action which damages the intertidal environment can be fully and directly compensated, then that action should be reviewed.

To provide guidance for this SMP, the environmental assets in the SMP area should be classified as CNC or CNA at the first review period of the SMP. This classification should subsequently be reviewed in the light of any new information. At present, little information exists to explain exactly how areas of conservation importance are sustained by coastal processes or if they could be replaced. Coastal defence management decisions using the concepts of CNC or CNA (i.e. can a conservation site be replaced if damaged by a potential coastal defence option) will, at present, be based on some degree of uncertainty.

- **Fisheries**

MAFF and local fishing interests have indicated that there are a number of uncertainties concerning the impact of coastal protection work on fishing grounds. Principally, those concern the potential impact of dredging operations and the movement of sediment from beach recharge to fishing and spawning grounds.

- **Sediment Supply to Conservation Sites**

The RSPB and Lincolnshire Trust for Nature Conservation believe that the Lincolnshire coast and associated areas of conservation importance (saltmarsh, dune systems, etc.) may be sustained by sediment eroded from the Holderness coast to the north. Scientific evidence is inconclusive at present. However, if this is the case, the coastal defence strategies adopted along the Holderness coast will have important implications to the sustainability of Lincolnshire coastal habitats. Therefore, there

is a need for liaison between both SMP steering groups.

A second area of concern with respect to sediment supply is the monitoring of any impacts of beach nourishment along the Lincolnshire Coast on the Gibraltar Point SSSI, NNR, SPA and Ramsar, particularly with regard to the introduction of alien beach material (i.e. of different grading etc).

6.2.4 Coastal Defences

Information on the type, standard and life of the defences along the Lincolnshire coast is generally adequate. The only exceptions are the lengths to the north of Mablethorpe (Management Units 1 and 2) where the standard and life of the defences is not known.

6.3 RECOMMENDATIONS FOR FUTURE MONITORING

6.3.1 Coastal Processes

The combination of existing surveys (Section 6.3.4) with those proposed (Section 6.3.3) and additional monitoring identified in Section 6.4 will provide adequate data to monitor the coastal processes in the future.

6.3.2 Land Use, Human and Built Environment

A monitoring framework should be produced which meets the requirements of further studies outlined in Section 6.2.2. These are as follows:

- continue/extended monitoring of coastal processes (See Section 6.3.4), particularly sediment deposition, to determine if accretion will maintain the standard of flood defence in Management Units 1, 2, 10 and 11. In addition, the potential sediment transport pathways into the Wash (and Wainfleet Haven) should be examined.

  It is envisaged that this work would be established prior to the first review of the SMP and continue through the life of the SMP.

- walkover surveys and site analysis (with geophysical surveys where necessary) to determine the extent of potentially archaeologically interesting layers (particularly Management Units 3 to 9).

  It is envisaged that this work would be conducted prior to the first review of the SMP.

6.3.3 Natural Environment

A monitoring framework should be produced which fills some of the information gaps described in Section 6.2.3. These monitoring requirements are as follows:

- integration of SMP monitoring requirements with those of the Agency Coastal Wildlife Database, particularly with reference to detecting habitat change as a result of flood defence options or changing coastal processes. Particular reference should be paid to the effect of the management options on:

  - intertidal habitats (saltmarsh, mudflats and sandbanks)
  - subtidal habitats (with reference to changing substrate)
  - terrestrial coastal habitats (sand dunes) dependent on coastal processes
  - species populations (birds, seals, invertebrates).

  It is envisaged that this work would be established prior to the first review of the SMP and continue through the life of the SMP.

- monitoring of sediment deposition (volume, sediment grading, chemical attributes) to establish whether coastal processes will allow sites of nature conservation importance to be sustained or re-established in relation to CNC or CNA.

- monitoring of fisheries undertaken by MAFF, the Sea Fisheries Committee and the Environment Agency for the Lincolnshire project should be integrated into the SMP. Particular reference should be paid to the impact of dredging and beach nourishment operations on the fishing and spawning grounds of the area.

  It is envisaged that these initiatives would be completed prior to the first review of the SMP.

6.3.4 Coastal Defences

Extensive monitoring is already undertaken along the Lincolnshire coast, this includes:

- twice yearly beach profile surveys at 1km intervals (in January and July/August)
- bathymetric surveys at 4 yearly intervals (taken in July/August)
- annual aerial surveys taken during low water
- shoreline inspections of the beach and structures.

This level of monitoring should continue.

In addition, a land and aerial survey of the dunes to the south of Skegness was undertaken in 1996 to assess the standard of the natural defences. In the future it is recommended that the annual aerial photography coverage (listed above) is extended landwards to include the defence line between Skegness and Gibraltar Point. These photographs should then be analysed (using photogrammetric techniques) to confirm that the dunes continue to provide an adequate standard of defence. It is envisaged that this analysis would be undertaken at 5 yearly intervals.

The Agency has also instigated surveys to monitor the performance of the beach nourishment scheme. The additional surveys include:

- four bathymetric surveys over the period November 1995 to April 1996 carried out between Winthorpe Avenue, Skegness and the northern extent of the nourishment
- two bathymetric surveys (one in November 1995 and one in April 1996) carried out between Winthorpe Avenue, Skegness and Gibraltar Point
- one bathymetric survey in April 1996 carried out between the northern extent of the nourishment and Mablethorpe
- oblique colour aerial photography at monthly intervals between Mablethorpe and Skegness.

It is recommended that this additional level of monitoring is continued during the construction of the beach nourishment scheme. Following the completion of the scheme, a thorough review of the monitoring programme should be undertaken.

6.4 RECOMMENDATIONS FOR FUTURE RESEARCH

6.4.1 Coastal Processes

- **Sources of Sediment**

  It is recommended that research is undertaken to fully explain why the coastline to the north of Mablethorpe is accreting. In particular to determine:

  - the relevance of the offshore banks as a source of sediment for the Lincolnshire beaches
  - whether the Holderness coastline is a source of sediment for the Lincolnshire beaches

  It is envisaged that this could be long term strategic research building upon the work completed by Robinson (1968), Maclaren (Halcrow, 1990) and the Institute of Estuarine and Coastal Studies (IECS, 1992). It should also take account of the current Land and Ocean Interface Study (LOIS) of the Holderness coast and Humber Estuary.

  It is considered that numerical techniques are insufficiently advanced to greatly assist with this research, it is therefore likely that extensive field measurements would be required.

  It is recommended that work is undertaken in collaboration with the researchers listed above.

It is envisaged that this work would still be in progress at the first review of the SMP.

- **Longshore Transport Rates**

  It is recommended that a short study is undertaken to determine the net longshore transport rates along the shoreline to the north of Mablethorpe and south of Skegness. This work could be undertaken using numerical techniques and wave data derived for the strategy study for the Mablethorpe to Skegness Sea Defences (NRA, 1991).

  The study should also include work to establish the extent to which sediment is moving from the Lincolnshire coast and into the Wash. It is envisaged that this would require field measurements of tidal currents off Gibraltar Point. Wave data would be taken from the strategic study for the Mablethorpe to Skegness Sea Defences (NRA, 1991). This information would then be used in a numerical model to determine the potential for sediment movement around Gibraltar Point.

  This work should be undertaken before the first review of the SMP.

- **Beach and Seabed Sediments**

  A sampling exercise should be undertaken to the north of Mablethorpe to establish the grading of the beach material. It is envisaged that samples would be taken at 1km intervals along the beach and at three points down the beach (at the MHWS, MSL and MLWS marks). The exercise should be undertaken before the first review of the SMP.

  To the south of Skegness, it is assumed that beach sampling would be undertaken as part of the monitoring associated with the Mablethorpe to Skegness beach nourishment scheme (See Section 6.3.3).

  A comprehensive seabed survey to establish the nature of the sediments to the south of Skegness is not necessary at this stage. However, this should be reconsidered during the first review of the SMP.

- **Shoreline Evolution**

  The beach profile data together with the bathymetric surveys collected by the NRA/Agency and others since the 1970's should be analysed so that the existing shoreline evolution information can be updated. This work should be undertaken before the first review of the SMP.

6.4.2 Human and Built Environment

- **Flood Defences**

The studies into coastal processes (Section 6.4.1) together with the work recommended in Section 6.4.4, will determine whether an adequate standard of defence can be maintained along those lengths of coast where do nothing is thought appropriate.

- **Archaeology**

It is recommended that further archaeological studies (walkover surveys and site investigation) of Management Units 3-9 and the northern part of Unit 10 take place to record fully the potential archaeological exposures within these management units. These studies should be used to assess the effectiveness of the Mablethorpe to Skegness Beach Nourishment Scheme in protecting areas of archaeological interest. The studies should also be in line with the recommendations of the County Archaeologist and the Lindsey Coastal Survey (1989-90).

It is recommended that this study is completed prior to the first review of the SMP to ensure informed management decisions.

6.4.3 Natural Environment

- **Wildlife**

The extensive coastal wildlife monitoring work of the Agency (ie. the Coastal Wildlife Database) and other bodies (eg. English Nature and the Lincolnshire Trust for Nature Conservation) should be integrated with the SMP to assess the strategic coastal defence options to ensure that they are meeting the management objectives of the SMP.

It is envisaged that the wildlife monitoring work is integrated prior to the first review of the SMP.

- **Conservation, Coastal Processes and the application of CNC and CNA**

Research should be conducted into the sustainability of conservation sites by coastal processes in order to allow classification of features as either CNC or CNA (See Section 6.2.3). This study should address the following key areas:

- the significance of the Holderness Coast as a sediment source for the Lincolnshire coast (see Section 6.2.1)
- the impact of coastal processes on the North Lincolnshire Coast SSSI, Humber Estuary SPA and Ramsar and Saltfleetby-Theddlethorpe Dunes SSSI and NNR (see Section 6.2.3)
- the ability of management methods to replace habitats lost or damaged by flood defence works (ie. will coastal processes sustain the re-establishment of habitats at the locations where they were removed or at other sites along the coast without causing damage to additional sites)

- the impact of the management unit strategies on the sediment supply to both Gibraltar Point and the Wash SSSI, SPA, candidate SAC, NNR and Ramsar
- whether the accreting trend of the coastline will outstrip sea level change or could "coastal squeeze" of habitats between the man-made sea defences and rising sea levels occur.

It is recommended that these studies are completed prior to the first review of the SMP.

- **Agency's Environmental Assessment Procedures**

It is recommended that all specific coastal defence schemes should be reviewed under the Agency's Environmental Assessment Procedures prior to implementation. This should involve either environmental appraisal, where environmental impacts are thought to be negligible, or formal Environmental Assessment for projects envisaged as having significant impacts. Future Environmental Assessment procedures should take account of the information already produced for the Lincolnshire beach nourishment scheme between Mablethorpe and Skegness (PDE, 1992). However, for works outside of this area, particularly in Management Units 1, 2 10 and 11, further work may be necessary given the statutory importance of the area (SSSI, SPA, NNR, candidate SAC and Ramsar) and the relative lack of existing information concerning how coastal processes sustain these conservation sites and habitats (Sections 6.2.3 and 6.4.3).

Environmental Assessment requirements for works carried out by the Agency are derived from legal obligations set out under:

- The Environment Act (1995)
- S1 1217 Land Drainage Improvement Works (Assessment of Environmental Effects) Regulations 1988.
- S1 1199 Town and County Planning (Assessment of Environmental Effects) Regulations 1988.

It is recommended that these Environmental Assessment procedures should be followed as appropriate throughout the life of the SMP as coastal defence options are designed and implemented.

- **Fisheries**

The environmental impact of proposed coastal defence works on the area's fishing interests should be assessed and management or mitigation measures recommended.

6.4.4 Coastal Defences

It is recommended that the standard and life of the defences to the north of Mablethorpe are established.

It is envisaged that this would involve the following fieldwork:

- a detailed inspection to determine the condition of the defences
- a survey of the defences to determine typical cross-sections and crest levels
- beach profiles, as necessary to supplement the monitoring already undertaken by the Agency.

Information from the fieldwork and, where necessary, wave data from the strategy study for the Mablethorpe to Skegness Sea Defences (NRA, 1991) would be used to establish the standard of the defences.

The results of the inspection would be used to determine the life of the defences.

This work should be undertaken before the first review of the SMP.

Recent research by the Proudman Oceanographic Laboratory (POL, 1995) has provided new extreme water level predictions for the east coast of England. It is recommended that this research is carefully reviewed to establish whether it has any consequences for the Lincolnshire SMP.

This work should be undertaken by December 1997.

SECTION 7

RECOMMENDATIONS FOR FUTURE REVIEW OF THE SMP

7.1 RECOMMENDATIONS FOR FUTURE REVIEW

7.1.1 Overview

Given the time required to prepare an SMP, the speed of change of the relevant issues, and the norm for other similar or related initiatives (eg. strategies), it is recommended that the SMP is reviewed and updated on a 5 yearly cycle.

There are three phases to consider in the process leading to the up-dating and re-issue of the SMP in 5 years time. These phases are:

(i) **Now** - that is, the time of production of the final Lincolnshire Shoreline Management Plan in 1996.

(ii) **Interim Period** - the period between production of the present SMP and the start of preparation of the next issue of the SMP.

(iii) **Preparation of Revised SMP** - the period for reviewing, revising and producing the Revised SMP. This period is similar to that required for preparation of the present SMP.

The overall process should be considered in 13 separate activities which are shown in Table 7.1 under the respective phases.

Within this process, the SMP should be closely co-ordinated with other coastal initiatives, particularly adjacent SMPs.

TABLE 7.1

REVIEW PROCESS

Phase	Activity	
Now	**1**	**SMP: (1996)**
Interim Period	**2**	**Feedback**
	3	Monitoring
	4	Research
Preparation of New SMP	**5**	**SMP Revision: Ist Notice**
	6	Collate Findings
	7	Update Land Use and Planning Issues
	8	Review SMP
	9	**SMP Revision: 2nd Notice**
	10	Revise SMP
	11	**Draft SMP (2001)**
	12	Finalise SMP
	13	SMP (2001)

Note: Bold text denotes document preparation.

Figure 7.1 shows the inter-relation between these thirteen activities which are described in the next section.

7.1.2 Activities

This section outlines the form and scope of each activity.

Activity 1: SMP (1996)

The starting point in the SMP process is the production of the first edition of the Shoreline Management Plan in the spring of 1996.

Activity 2: Feedback

On its production in 1996 the final SMP will be available to all those with interests in its application. Whilst there is no formal consultation period immediately following its production, the consultees are at liberty to forward comments on the SMP at any time.

A system should be put in place for dealing with feedback in a systematic and consistent manner. This should include:

- allocating an individual to be responsible for administering feedback procedures
- setting up a database containing consultees' details, response date(s), comments and follow-up actions
- adding to the database as feedback is received
- responding to communications.

Activity 3: Monitoring

The Lincolnshire coast is already subject to a major monitoring campaign by the Agency. Some further measures are, however, recommended in Section 6.3. It is anticipated that this new work will be incorporated into the regular monitoring campaign during 1996 and will continue thereafter. The results of this work will serve two purposes: firstly, to provide direct information to the SMP; and secondly, to provide input parameters to future research.

Activity 4: Research

Section 6.4 recommends the future research that would be undertaken to improve understanding in various aspects of the SMP. It is important that this work is administered as discrete tasks and completed in advance of the start of preparation of the new SMP.

Activity 5: SMP Revision - 1st Notice

Soon after the start of preparation of the new SMP, the 1st Notice should be issued to consultees. This notice is analogous to the Scoping Document issued in preparation of the present SMP. It will inform consultees of the SMP revision process and invite them to forward information and to advise any concerns they might have. It should include a summary of the results of monitoring and research.

Activity 6: Collate Findings

This item relates essentially to a collation of the findings of the monitoring and research undertaken during the "interim period". To that end, it will present the findings focused in terms of the SMP in the subject areas of coastal processes, the human and built environment, and the natural environment.

Activity 7: Update Land Use and Planning Issues

Whereas other elements of the SMP will be enhanced as a result of monitoring and research (i.e. coastal processes, human and built environment and the natural environment), it will still be necessary to update details of land use and planning issues. In order to obtain the most up-to-date information it is recommended that this task is reserved until the time of preparing the new SMP.

The land use data presented in the 1996 SMP was derived from satellite imagery. This data could be updated by obtaining satellite images of the coast and processing the data to identify changes in land use categories. This would have the advantage (over conventional "ground - work") that the data would be coherent, consistent and entirely compatible with that contained in this present SMP.

Local authorities would have to be consulted to obtain revisions and added notes to structure plans and local plans.

Activity 8: Review SMP

Having obtained responses to the SMP Revision - 1st Notice, collated findings of monitoring and research, and updated land use and planning issues, it will be possible to review the current SMP and its continuing suitability.

Activity 9: SMP Revision - 2nd Notice

The process of review will culminate in the preparation of the SMP Revision - 2nd Notice. This would not be a draft SMP and would not be analogous to the Stage 1 SMP, but would take the form of a critique of the current SMP. It would advise of areas in which the SMP is to be revised and highlight any likely impacts on the SMP conclusions.

The document would be issued for consultation.

Activity 10: Revise SMP

Following receipt of responses on the 2nd Notice, the SMP would be revised. This work would entail modification to the SMP maps and a revision of the text.

Activity 11: Draft SMP (2001)

Revision of the SMP will culminate in production of the Draft Shoreline Management Plan (2001) for the Lincolnshire coast. It is anticipated that this document will follow the same basic format as the present SMP, i.e.

- Core Report
- Atlas
- Supporting Document

As with the present edition, the SMP would be issued for formal consultation.

Activity 12: Finalise SMP

Following a period of formal consultation the Draft SMP would be revised, taking on board the outcome of the consultation.

Activity 13: SMP (2001)

The final activity is the production of the final Shoreline Management Plan (2001) for the Lincolnshire coast, issued five years after the issue of the present edition.

7.2 PROGRAMME

Figure 7.2 shows a programme for the future review of the SMP. Key factors to note in the scheduling of this programme are as follows:

- monitoring should be initiated as soon as possible following issue of the present SMP, or as indicated in Section 6.3

- it is desirable to delay research to take advantage of the results of monitoring, however, it should be completed in advance of preparation of the new SMP. The programme assumes (provisionally) that this work is carried out between new year 1998 and mid 1999.

- an overall programme time of 15 months is allowed of preparation of the revised SMP (Activities 5 to 13); this compares with 18 months for production of the present SMP.

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GLOSSARY

Astronomical Tide	The tide levels and flows which would result from gravitational effects eg. of the Earth, Sun and Moon, without any meteorological influences.
Atlas	This document provides a summary of data collected during the preparation of the Lincolnshire Shoreline Management Plan
Beach Nourishment	The importation of material to supplement the existing beach (also known as beach recharge/replenishment/feeding).
Bedload Current Residual	The difference in the capacity of the flood and ebb tidal flows to transport material along the seabed.
Chart Datum	The level to which both tide levels and water depths are reduced on marine charts. On UK charts, this level approximates to the predicted lowest astronomical tide level (LAT).
Core Report	This document sets out the strategy for the Lincolnshire coast. It includes details of the appraisal process leading to the selection of they preferred options. It also contains recommendations for future monitoring, research and updating.
Detached Breakwaters	Coastal structures lying parallel to, but not connected to the shore. They are generally constructed from imported rock or concrete units placed on the sea bed.
Drift Divide	A point where the orientation of the coast changes abruptly and beach material is moving away from the point.
Ebb	Period when tide is falling. Often taken to mean the ebb current which occurs during this period.
Fauna	Animals
Flood	Period when tide is rising. Often taken to mean the flood current which occurs during this period.
Flora	Plants
Geomorphology	The study of landforms and landforming processes.
Groynes	Coastal structures lying at right angles to, and connected to the shore. They may be constructed from timber, concrete, steel sheet piles or rock.

Hard Defences	Defences that tend to confront and resist the natural coastal processes, eg. seawalls.
Hinterland Boundary	The landward boundary of the Lincolnshire Shoreline Plan.
Local Plan	A document which sets out the policies at a district level.
Longshore Transport	Movement of beach sediments approximately parallel to the shoreline. Also known as longshore drift.
Management Objectives	Objectives for the management of the shoreline. These objectives form the basis for the appraisal and development of the strategic coastal options.
Management Unit	A length of shoreline with coherent characteristics in terms of both natural coastal processes and land use.
Neap Tide	Tides of small range which occur twice a month (when the moon is in quadrature).
Offshore Boundary	The seaward boundary of the Lincolnshire Shoreline Management Plan.
Planning Policy Guidance	Notes prepared by the Government to provide guidance to local authorities and others on policies and the operation of a planning system.
Ramsar Site	Protected wetland site under the Ramsar convention on wetlands of international importance especially as waterfowl habitat.
Revetment	A sloping surface of stone, concrete or other material used to protect an embankment, natural coast or shoreline against erosion.
Residual Life	The number of years the defence is estimated to last before its integrity is compromised as a result of progressive deterioration.
Sea Walls	Solid coastal structure built parallel to the shoreline.
Scoping Document	The document issued to interest parties at the start of the first stage in the production of the Lincolnshire Shoreline Management Plan.
Sediment Cell	A length of coastline which is relatively self-contained as far as the movement of sand or shingle is concerned.
Sediment Sink	A point on the coast where material is moving towards the point and beaches are tending to build up.
Shoreline	The interface between the land and the sea.

Shoreline Management Plan	A document which sets out a strategy for coastal defences for a specified length of coast.
Significant Wave Height	The average of the highest one third of the waves
Soft Defences	Defences designed to work with rather than against the natural coastal processes. They tend to absorb rather than reflect wave energy and be dynamic rather than static eg. beach nourishment.
Spring Tide	Tides of large range which occur twice a month (when the moon is new or full).
Standard of Defence	The return period of the storm event that the defences are able to provide protection against.
Strategic Coastal Defence Option	Generic term for any coastal management strategy eg. do nothing, advance, retreat or hold the existing coastal defence line.
Structure Plan	A document providing strategic policies and the statutory planning framework for the county.
Supporting Document	This document provides background to the information contained in the Atlas.
Surge	Change in water level as a result of meterological conditions (wind, high or low atmospheric pressure).
Tidal Range	The vertical difference between high and low water.
Tidal Current Residual	The difference between the flood and ebb tidal flows.

ABBREVIATIONS

AAD	Average Annual Damage
AD	Annual Damage
Agency	Environment Agency (Anglian Region)
CCA	Coastal Conservation Areas
CNA	Constant Natural Asset
CNC	Critical Natural Capital
DOE	Department of the Environment
DTI	Department of Trade and Industry
ELDC	East Lindsey District Council
ESFJC	Eastern Sea Fisheries Joint Committee
EN	English Nature
GCRS	Geological Conservation Review Site
HE	House Equivalent
IDB	Internal Drainage Board
IPCC	Intergovernmental Panel on Climate Change
LCC	Lincolnshire County Council
LCP	Lincolnshire Coastal Partnership
LTNC	Lincolnshire Trust for Nature Conservation
MAFF	Ministry of Agriculture, Fisheries and Food
MOD	Ministry of Defence
NCC	Nature Conservancy Council
NNR	National Nature Reserve
NRA	National Rivers Authority (Anglian Region)
OD	Ordnance Datum
PAGN	Project Appraisal Guidance Notes
PPG	Planning Policy Guidance
pSAC	possible Special Area of Conservation
PV	Present Value
RIGS	Regionally Important Geological Site
RNLI	Royal National Lifeboat Institution
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SMP	Shoreline Management Plan
SMR	Sites and Monuments Register
SNCI	Site of Nature Conservation Importance
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
STW	Sewage Treatment Works

TABLE I.1

MANAGEMENT UNIT 1: DONNA NOOK TO SALTFLEET

STRATEGIC OPTION	GENERAL MANAGEMENT OBJECTIVES			SPECIFIC MANAGEMENT OBJECTIVES										
					Land use and the Human and Built Environment							Natural Environment		
	Sustainable	Compatible with preferred options for adjacent Management Units*	Compatible with processes at work within cell	Coastal Defence	Planning	Agriculture	Fisheries	Tourism & Recreation	Archaeology	Military Use	Offshore Activity	Biological & Geological	Landscape	Water Quality
Do Nothing	x	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Retreat	✓	✓	x	✓	x	x	✓	✓	✓	✓	✓	✓	✓	✓
Hold the Line	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Advance	✓	✓	✓	✓	x	✓	✓	x	✓	x	✓	x	x	✓

Viable Option: Hold the line

Notes

- ✓ Complies with management objective
- x Conflicts with management objective
- * Assumes preferred options are those identified in Section 5.0.

TABLE I.2

MANAGEMENT UNIT 2: SALTFLEET TO MABLETHORPE

STRATEGIC OPTION	GENERAL MANAGEMENT OBJECTIVES			SPECIFIC MANAGEMENT OBJECTIVES										
					Land use and the Human and Built Environment							Natural Environment		
	Sustainable	Compatible with preferred options for adjacent Management Units*	Compatible with processes at work within cell	Coastal Defence	Planning	Agriculture	Fisheries	Tourism & Recreation	Archaeology	Military Use	Offshore Activity	Biological & Geological	Landscape	Water Quality
Do Nothing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Retreat	✓	✓	x	✓	x	x	✓	✓	✓	✓	✓	✓	✓	✓
Hold the Line	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Advance	✓	✓	✓	✓	x	✓	✓	x	✓	x	✓	x	x	✓

Viable Options: Do Nothing and Hold the line

Notes

- ✓ Complies with management objective
- x Conflicts with management objective
- * Assumes preferred options are those identified in Section 5.0.

TABLE I.3

MANAGEMENT UNIT 3: MABLETHORPE TO SANDILANDS

STRATEGIC OPTION	GENERAL MANAGEMENT OBJECTIVES			SPECIFIC MANAGEMENT OBJECTIVES										
					Land use and the Human and Built Environment							Natural Environment		
	Sustainable	Compatible with preferred options for adjacent Management Units*	Compatible with processes at work within cell	Coastal Defence	Planning	Agriculture	Fisheries	Tourism & Recreation	Archaeology	Military Use	Offshore Activity	Biological & Geological	Landscape	Water Quality
Do Nothing	x	x	✓	x	x	x	x	x	x	N/A	✓	x	x	x
Retreat	✓	x	✓	x	x	x	✓	x	x	N/A	✓	✓	✓	✓
Hold the Line	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓
Advance	x	x	x	✓	✓	✓	✓	✓	✓	N/A	✓	x	✓	✓

Viable Option: Hold the line

Notes

✓	Complies with management objective
x	Conflicts with management objective
N/A	Not applicable as there are no military interests within the unit.
*	Assumes preferred options are those identified in Section 5.0.

TABLE I.4

MANAGEMENT UNIT 4: SANDILANDS TO ANDERBY CREEK

STRATEGIC OPTION	GENERAL MANAGEMENT OBJECTIVES			SPECIFIC MANAGEMENT OBJECTIVES										
					Land use and the Human and Built Environment							Natural Environment		
	Sustainable	Compatible with preferred options for adjacent Management Units*	Compatible with processes at work within cell	Coastal Defence	Planning	Agriculture	Fisheries	Tourism & Recreation	Archaeology	Military Use	Offshore Activity	Biological & Geological	Landscape	Water Quality
Do Nothing	x	x	✓	x	x	x	x	x	x	N/A	✓	✓	✓	✓
Retreat	✓	x	✓	✓	x	x	✓	x	x	N/A	✓	✓	✓	✓
Hold the Line	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓
Advance	x	x	x	✓	✓	✓	✓	✓	x	N/A	✓	x	x	✓

Viable Option: Hold the line

Notes

- ✓ Complies with management objective
- x Conflicts with management objective
- N/A Not applicable as there are no military interests within the unit.
- * Assumes preferred options are those identified in Section 5.0.

TABLE I.5

MANAGEMENT UNIT 5: ANDERBY CREEK

STRATEGIC OPTION	GENERAL MANAGEMENT OBJECTIVES			SPECIFIC MANAGEMENT OBJECTIVES										
					Land use and the Human and Built Environment							Natural Environment		
	Sustainable	Compatible with preferred options for adjacent Management Units*	Compatible with processes at work within cell	Coastal Defence	Planning	Agriculture	Fisheries	Tourism & Recreation	Archaeology	Military Use	Offshore Activity	Biological & Geological	Landscape	Water Quality
Do Nothing	x	x	✓	x	x	x	x	x	x	N/A	✓	x	x	x
Retreat	✓	x	✓	x	x	x	✓	x	x	N/A	✓	x	x	✓
Hold the Line	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓
Advance	x	x	x	✓	✓	✓	✓	✓	x	N/A	✓	x	x	✓

Viable Option: Hold the line

Notes

- ✓ Complies with management objective
- x Conflicts with management objective
- N/A Not applicable as there are no military interests within the unit.
- * Assumes preferred options are those identified in Section 5.0.

TABLE I.6

MANAGEMENT UNIT 6: ANDERBY CREEK TO CHAPEL ST LEONARDS

STRATEGIC OPTION	GENERAL MANAGEMENT OBJECTIVES			SPECIFIC MANAGEMENT OBJECTIVES										
					Land use and the Human and Built Environment							Natural Environment		
	Sustainable	Compatible with preferred options for adjacent Management Units*	Compatible with processes at work within cell	Coastal Defence	Planning	Agriculture	Fisheries	Tourism & Recreation	Archaeology	Military Use	Offshore Activity	Biological & Geological	Landscape	Water Quality
Do Nothing	x	x	✓	x	x	x	x	x	x	N/A	✓	x	x	x
Retreat	✓	x	✓	✓	x	x	✓	x	x	N/A	✓	x	x	✓
Hold the Line	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓
Advance	x	x	x	✓	✓	✓	✓	✓	x	N/A	✓	x	x	✓

Viable Option: Hold the line

Notes

- ✓ Complies with management objective
- x Conflicts with management objective
- N/A Not applicable as there are no military interests within the unit.
- * Assumes preferred options are those identified in Section 5.0.

TABLE I.7

MANAGEMENT UNIT 7: CHAPEL ST LEONARDS

STRATEGIC OPTION	GENERAL MANAGEMENT OBJECTIVES			SPECIFIC MANAGEMENT OBJECTIVES										
					Land use and the Human and Built Environment							Natural Environment		
	Sustainable	Compatible with preferred options for adjacent Management Units*	Compatible with processes at work within cell	Coastal Defence	Planning	Agriculture	Fisheries	Tourism & Recreation	Archaeology	Military Use	Offshore Activity	Biological & Geological	Landscape	Water Quality
Do Nothing	x	x	✓	x	x	x	x	x	x	N/A	✓	x	x	x
Retreat	✓	x	✓	x	x	x	✓	x	x	N/A	✓	x	x	x
Hold the Line	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓
Advance	x	x	x	✓	✓	✓	✓	✓	x	N/A	✓	x	x	✓

Viable Option: Hold the line

Notes

✓ Complies with management objective
x Conflicts with management objective
N/A Not applicable, as there are no military interests within the unit.
* Assumes preferred options are those identified in Section 5.0.

TABLE I.8

MANAGEMENT UNIT 8: CHAPEL ST LEONARDS TO INGOLDMELLS

STRATEGIC OPTION	GENERAL MANAGEMENT OBJECTIVES			SPECIFIC MANAGEMENT OBJECTIVES										
					Land use and the Human and Built Environment							Natural Environment		
	Sustainable	Compatible with preferred options for adjacent Management Units*	Compatible with processes at work within cell	Coastal Defence	Planning	Agriculture	Fisheries	Tourism & Recreation	Archaeology	Military Use	Offshore Activity	Biological & Geological	Landscape	Water Quality
Do Nothing	x	x	✓	x	x	x	✓	x	x	N/A	✓	x	x	x
Retreat	✓	x	✓	✓	x	x	✓	x	x	N/A	✓	✓	✓	✓
Hold the Line	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓
Advance	x	x	x	✓	✓	✓	✓	✓	x	N/A	✓	x	x	✓

Viable Option: Hold the line

Notes

- ✓ Complies with management objective
- x Conflicts with management objective
- N/A Not applicable as there are no military interests within the unit.
- * Assumes preferred options are those identified in Section 5.0.

TABLE I.9

MANAGEMENT UNIT 9: INGOLDMELLS TO SKEGNESS

STRATEGIC OPTION	GENERAL MANAGEMENT OBJECTIVES			SPECIFIC MANAGEMENT OBJECTIVES										
					Land use and the Human and Built Environment							Natural Environment		
	Sustainable	Compatible with preferred options for adjacent Management Units*	Compatible with processes at work within cell	Coastal Defence	Planning	Agriculture	Fisheries	Tourism & Recreation	Archaeology	Military Use	Offshore Activity	Biological & Geological	Landscape	Water Quality
Do Nothing	x	x	✓	x	x	x	x	x	x	N/A	✓	x	x	x
Retreat	✓	x	✓	x	x	x	✓	x	x	N/A	✓	✓	✓	✓
Hold the Line	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓
Advance	x	x	x	✓	✓	✓	✓	✓	x	N/A	✓	x	x	✓

Viable Option: Hold the line

Notes

- ✓ Complies with management objective
- x Conflicts with management objective
- N/A Not applicable as there are no military interests within the unit.
- * Assumes preferred options are those identified in Section 5.0

TABLE I.10

MANAGEMENT UNIT 10: SKEGNESS TO SEACROFT

STRATEGIC OPTION	GENERAL MANAGEMENT OBJECTIVES			SPECIFIC MANAGEMENT OBJECTIVES										
					Land use and the Human and Built Environment							Natural Environment		
	Sustainable	Compatible with preferred options for adjacent Management Units*	Compatible with processes at work within cell	Coastal Defence	Planning	Agriculture	Fisheries	Tourism & Recreation	Archaeology	Military Use	Offshore Activity	Biological & Geological	Landscape	Water Quality
Do Nothing	x	x	✓	x	x	x	x	x	x	N/A	✓	x	x	✓
Retreat	✓	✓	x	x	✓	x	✓	✓	✓	N/A	✓	x	x	✓
Hold the Line	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓
Advance	✓	✓	✓	✓	x	✓	✓	x	✓	N/A	✓	x	x	✓

Viable Options: Hold the line

Notes

- ✓ Complies with management objective
- x Conflicts with management objective
- N/A Not applicable as there are no military interests within the unit.
- * Assumes preferred options are those identified in Section 5.0.

TABLE I.11

MANAGEMENT UNIT 11: SEACROFT TO GIBRALTAR POINT

STRATEGIC OPTION	GENERAL MANAGEMENT OBJECTIVES			SPECIFIC MANAGEMENT OBJECTIVES										
					Land use and the Human and Built Environment							Natural Environment		
	Sustainable	Compatible with preferred options for adjacent Management Units*	Compatible with processes at work within cell	Coastal Defence	Planning	Agriculture	Fisheries	Tourism & Recreation	Archaeology	Military Use	Offshore Activity	Biological & Geological	Landscape	Water Quality
Do Nothing	x	✓	✓	x	x	x	✓	✓	✓	N/A	✓	✓	✓	✓
Retreat	✓	✓	x	✓	✓	x	✓	✓	✓	N/A	✓	x	x	✓
Hold the Line	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓
Advance	✓	✓	✓	✓	x	✓	✓	x	✓	N/A	✓	x	x	✓

Viable Options: Hold the line

Notes

✓	Complies with management objective
x	Conflicts with management objective
N/A	Not applicable as there are no military interests within the unit.
*	Assumes preferred options are those identified in Section 5.0

APPENDIX II
DETAILS OF ECONOMIC ASSESSMENT

APPENDIX II

DETAILS OF ECONOMIC ASSESSMENT

II.1. INTRODUCTION

The guidance notes published by MAFF (MAFF, 1995) for the preparation of SMPs require an appraisal of the benefits and costs of the strategic options to be undertaken to confirm viability. The guidance indicates that exhaustive economic justification is not required at this stage as a more detailed examination of all benefits and costs will be carried out later during the preparation of scheme strategy studies.

This appendix sets out the approach adopted for the assessment of costs and benefits for the SMP and summarises the data used and results obtained. It has been undertaken in accordance with the principles described in MAFF's Project Appraisal Guidance Notes (PAGN) (MAFF,1993).

In undertaking the appraisal the following basic steps were completed:

- evaluation of the capital and maintenance costs for each strategic option (except do nothing which involves no expenditure)
- evaluation of potential damage costs if no project is undertaken
- evaluation of potential damage costs for each strategic option
- calculation of the benefits of carrying out individual strategic options in relation to the without project option.

The following sections of the appendix discuss these steps. The results of the economic assessment are presented in Section 4.

The base date for the calculations is 1996.

II.2. COSTS

II.2.1 Management Unit 1

The existing defences in Management Unit 1 comprise of an 8050m long clay embankment.

The cost of holding the line within this management unit is based on upgrading the embankment to a 200 year standard plus maintenance over a 50 year period. Design and supervision costs have been included.

Using the information available on the standard and life of the existing embankment, the following assumptions have been made to determine costs for the hold the line option:

- Capital Works:- 50% of the embankment requires raising by 1m to provide a 200 year standard. The remainder of the embankment provides this standard of protection

- Maintenance Works: every 20 years the embankment is raised by 0.5m to account for settlement, erosion losses and sea level rise.

Capital, maintenance, design and supervision costs are shown in Table II.1. Capital and maintenance costs include a 15% allowance for preliminary items and a 10% contingency sum. Design and supervision costs are assumed to be 5% of the cost of the works.

TABLE II.1

HOLD THE LINE COSTS (MANAGEMENT UNIT 1)

ITEM	QUANTITY	UNIT	RATE (£)	COST (£)
Capital costs:				
Preliminary Items	-	Sum	-	100,000
Bank Raising	4025	lin m	165	664,000
Contingency	-	Sum	-	76,000
TOTAL				840,000
Maintenance costs: (every 20 years)				
Preliminary Items	-	Sum	-	133,000
Bank Raising	8050	lin m	110	886,000
Contingency	-	Sum	-	102,000
TOTAL				1,121,000
Design & Supervision costs:				
Capital Works	-	Sum	-	42,000
Maintenance Works	-	Sum	-	56,000

The present value of the costs are shown in Table II.2.

TABLE II.2

PV COSTS FOR HOLD THE LINE (MANAGEMENT UNIT 1)

COSTS (£) YEAR PV FACTOR	0 1	19 0.331	39 0.103	TOTAL
Design and Supervision	42,000	56,000	56,000	
Capital	840,000	-	-	
Maintenance	-	1,121,000	1,121,000	
Total	882,000	1,177,000	1,177,000	3,236,000
Present Value	882,000	390,000	121,000	1,393,000

II.2.2 Management Units 3 to 9

The existing defences in Management Units 3 to 9 comprise concrete seawalls, some with rock armour or concrete units as toe protection and revetments.

The costs of holding the line within these management units is based on the Agency's beach nourishment scheme which will provide a 200 year standard of defence. It is assumed that expenditure on the beach nourishment scheme in 1994 and 1995 is a "sunk" cost. Costs have therefore been assessed taking the following into account:

- Capital Works
  - nourishment of the beaches from north of Ingoldmells to Mablethorpe between 1996 and 1998
  - necessary upgrading of seawalls from Skegness to Mablethorpe between 1996 to 1998
  - Capital works at Lagoon Walk in 1997
- Maintenance Works
  - periodic renourishment of the beaches to counter longshore movement and losses
  - maintenance of the existing seawalls
- Design and Supervision

- Monitoring
  - fisheries liaison for dredging operations
  - beach and offshore monitoring programme
  - onshore and offshore environmental monitoring programme

The cost of the beach nourishment scheme has been based on the economic appraisal completed by PD (1995) and rates provided by the Agency from their current contract. Rates used include for preliminary items; a contingency allowance of 10% has been included for all capital and maintenance works.

Capital, maintenance, design and supervision, and monitoring costs for the hold the line option are shown in Table II.3. The table also indicates the present value of the costs.

TABLE II.3

HOLD THE LINE COSTS (MANAGEMENT UNITS 3 TO 9)

YEARS	0	1	2	3	4	5-9	10-19	20-29	30-39	40-49	TOTAL
Design & Supervision	292219	309318	185759	400	400	137871	322325	931176	340364	313632	2943179
Monitoring						909773	1819443	1819444	1819443	1819443	8187546
Capital Works:											
Nourishment	10883242	11406288	9835356					7355852			47880738
Seawalls	1400000	1700000	197000								2097001
Contingency	1228324	1310629	1003236					735585			4997774
Maintenance Works:											
Renourishment						6594406	15449768	13233529	16325278	15027871	66630852
Seawalls	6000	6000	8000	8000	8000	346742	693482	693482	693482	693482	3158670
Contingency	600	600	800	800	800	694115	1614325	1392701	1701876	1572135	6978952
Total	13810385	14732835	11230151	9200	9200	8682907	19899343	26161769	20880443	19426563	134842796
Present Value	13810385	13898901	9994794	7725	7288	5542604	9497874	7219340	3253225	1697739	64929874

Note: Costs in £

II.2.3 Management Units 10 and 11

The existing defences in Management Units 10 and 11 comprise 4600m of natural dunes and a 400m long clay embankment (Bulldog Bank).

The cost of holding the line within these management units is based on the following:

- Management of the natural dunes - this includes an allowance for the improvement of the dunes to the south of Bulldog Bank where there are a number of minor gaps.

- Maintenance of the embankment - every 20 years the embankment is raised by 0.5m to account for settlement, erosion losses and sea level rise.

- Monitoring - at 5 yearly intervals using aerial photograph and field inspections.

The costs summarised in Table II.4 are based on the following rates/sums:

- cost of improvements to dunes = £30,000
- cost of dune management = £1,300/km/annum
- cost of bank raising = £150/m
- monitoring and inspection of defences = £2,000 /annum

Where appropriate the above rates/sums include a 15% allowance for preliminary items, a 10% continency sum and 5% for design and supervision costs.

TABLE II.4

HOLD THE LINE COSTS (MANAGEMENT UNITS 10 & 11)

ITEM	COST (£)	PV COST
Dunes		
Improvements Management	30,000 (Year 0) 5,980 (annually)	30,000 100,000
Bulldog Bank		
Raising	60,000 (Years 19 and 39	26,000
Both		
Monitoring	2,000 (annually)	33,000
	TOTAL	**£189,000**

II.3 BENEFITS

II.3.1 Introduction

The assessment of damages and benefits for the strategic option of hold the line has been based on the use of House Equivalents (HEs). This concept was developed by the Flood Hazard Research Centre (FHRC) at Middlesex University (Middlesex, 1988) to allow a "broad brush" approach for prioritising flood defence schemes. It is therefore considered appropriate for use within the Lincolnshire Shoreline Management Plan.

An HE is defined as the average cost of damage to the average house when flooded. Using HEs it is possible to convert the different assets within the flood area into a common unit. Although intended as a method of comparing or prioritising schemes, it is possible to quantify damages approximately in monetary terms by assigning a damage value to an HE.

The following steps have been undertaken to enable the hold the line benefits to be assessed using HEs:

- assess land use by category (Volume II - Map 11)
- equate land use to HEs
- assess number of HEs contained within flood area
- assess the "without project" and "hold the line" damages per HE
- determine benefits

These steps are described in Sections II.3.2, II.3.3 and II.3.4.

II.3.2 Assessment of HEs Within Flood Area

HE's have been used to convert the land use classification data collected for the SMP (see Volume II - Map 11 and Volume III - Section 5) into a common unit of measure. The relationship between land use types and HEs developed for the NRA Anglian Region Flood Defence Standards of Service and Asset Management Project (NRA, 1995) has been used for the SMP. The steps involved are as follows:

- Within the hinterland area, the **Land Area** covered by each land use type has been determined using Landsat satellite images.
- For residential and commercial property, **Land Areas** derived from satellite images include roads, open gardens and associated open areas. To allow conversion to HEs it is necessary to introduce a **Plot Ratio** to reduce the area to the actual floor area of the properties. These ratios were derived during the NRA Anglian Region project (NRA, 1995).
- **HE Factors** are then used to convert the various land use types into HEs. These factors were originally derived by FHRC (1988) and were adopted for the NRA Anglian Region work.
- The HE value land use type for each is then:

  HE Value = (Land Area x Plot Ratio x HE Factor).

- Finally, the HE values for each land use type are summed to provide the overall HE

value for the hinterland area.

The total number of HEs within the hinterland area is 46,494.

II.3.3 Without Project Damages

Breach Scenario

In assessing the "without project" damages it has been assumed that a breach in the defences at any location along the Lincolnshire coast would (eventually) cause flooding of the entire hinterland area. The scenario adopted for the breach is as follows:

- breach occurs in Year 4 (based on information on the life of the existing defences)
- flooding extends over the entire hinterland area over the next five years i.e. Years 5 to 9.

It has been assumed that the assets within the hinterland would be "written off" as flooding would occur regularly.

Method of Calculating Damages

It is not appropriate to use previously derived values for HEs as these have been based on an assessment of the intermittent damages occurring to assets. To overcome this problem a "written off" value of £60,000 has been adopted for an HE. This value was determined using data held by PD for other projects along the Lincolnshire coastline.

On this basis the total "without project" damages for the SMP are:

46,494 HEs x £60,000 / HE = £2,789,640,000.

The present value of these damages assuming the scenario identified above is given in Table II.4. They amount to £1,861,200,000.

TABLE II.4

PV OF "WITHOUT PROJECT" DAMAGES

DAMAGES (£)						
YEAR	5	6	7	8	9	TOTAL
PV FACTOR	0.747	0.705	0.665	0.627	0.592	
Damages	557,900,000	557,900,000	557,900,000	557,900,000	557,900,000	2,789,500,000
PV Damages	416,800,000	393,300,000	371,000,000	349,800,000	330,300,000	1,861,200,000

The HE factors for the different categories of asset were derived from an analysis of intermittent flood damages rather than written off damages. There is, consequently, an inconsistency in the use of HEs to determine written off damages. Within the context of the SMP,this is not considered a serious inconsistency and, as discussed in Section II.3.5, the without project damages calculated compare reasonably with those calculated by conventional benefits assessment for the Mablethorpe to Skegness Sea Defences.

II.3.4 Combined Strategy Damages

Available methods

Previous studies using HEs have developed two approaches to determine damages. These are:

- the use of average annual damages (AADs) per HE. Calculated as £160/HE (1991 prices)
- the use of average damages (ADs) per flood per HE and applying this to the average annual number of HEs flooded. Calculated as £1135/HE/Flood (1991 prices)

Selection of Method

Both methods consider that damages occur on all flood events and, as such, assume the defences are lost. This is clearly inappropriate for the hold the line option which is to provide a 200 year standard of defence and it is therefore necessary to modify the values for AADs and ADs. Moreover, the use of ADs requires knowledge of the average annual number of HEs flooded. As this information is not readily available it was decided that the use of AADs was the more appropriate approach.

Modification to AAD

The AAD per HE of £160, calculated using updated information presented by Mott MacDonald and Gould Consultants (1991), has been modified as follows:

- the weighted damages have been extrapolated as shown in Figure II.1 to enable the AADs per HE for 200 year standard of defence to be determined.
- AAD for a 200 year standard has been calculated i.e. ½(9339 + 8109) x 0.005 = £44 per HE (see Figure II.1)
- AAD for 200 year standard updated to 1996 giving £52 per HE (RPI factor of 1.18 used)

To check the evaluation of AAD, the normalised damage frequency curve presented in the Flood Defence Management Manual (NRA, 1993) was used to calculate the AAD per HE. Using the average damage for the 10 year event (£990) to "anchor" the normalised curve gave an AAD of £50. This compares well with the £52 calculated above.

Damages

The damages associated with the combined strategy for the Lincolnshire sub-cell, using an AAD of £52 per HE, are given in Table II.5 together with the present value of damages.

TABLE II.5

COMBINED STRATEGY DAMAGES

MANAGEMENT UNIT	NO OF HEs	AAD FOR HE (£)	ANNUAL DAMAGES (£)	PV OF DAMAGES (£)
All	46,494	52	2,417,688	40,375,000

II.3.5 Hold the Line Benefits

Hold the line benefits are summarised in Table II.6.

TABLE II.6

COMBINED STRATEGY BENEFITS

ITEM	COMBINED STRATEGY
Without Project Damages (£)	1,861,200,000
Combined Strategy Damages (£)	40,375,000
Benefits (£)	1,820,825,000

II.3.6 Comparison with Strategy Study for Mablethorpe to Skegness Sea Defences

As part of the Strategy Study for the Mablethorpe to Skegness Sea Defences (NRA, 1991) an appraisal of the beach nourishment option was undertaken. The results of this appraisal and that completed for the SMP are compared in Table II.7.

TABLE II.7

COMPARISON OF ECONOMIC APPRAISALS FOR STRATEGY STUDY AND LINCS SMP

ITEM	STRATEGY STUDY	LINCS SMP
Without Project Damages (£)	944,000,000	1,861,200,000
Combined Strategy/Beach Nourishment Damages (£)	58,000,000	40,375,000

Table II.7 indicates that broadly similar results were obtained in the two appraisals. The without project damages calculated for the SMP exceeded those of the Strategy Study. This was expected as the assessment undertaken for the Strategy Study only considered residential property.

In comparison, the Combined Strategy/Beach Nourishment damages calculated for the Strategy Study exceeded those of the SMP. This would suggest that the AAD per HE used for the SMP was an underestimate of the damages that may occur along the Lincolnshire coast.

Overall it is considered that the use of HEs for economic appraisal provides an acceptable level of accuracy for the purposes of this SMP.