Ostend to Cart Gap Coastal Strategy Study

Executive Summary

Report EX 4342
November 2001

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HR Wallingford

Address and Registered Office: HR Wallingford Ltd. **Howbery Park, Wallingford, OXON OX10 8BA**
Tel: +44 (0) 1491 835381 Fax: +44 (0) 1491 832233

Contract - Consultancy

This report describes work commissioned by North Norfolk District Council whose representative was Mr Peter Frew. The HR Wallingford job number was CBR 2955. The work was carried out by members of the Coastal and Engineering Groups and the HR Wallingford project manager was Dr Alan Brampton.

Prepared by .....

(name)

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(Title)

Approved by .....

(name)

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(Title)

Authorised by .....

(name)

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Summary

Ostend to Cart Gap Coastal Strategy Study

Executive Summary

(Main Strategy Study)Report EX 4342
November 2001

The Ostend to Cart Gap Coastal Defence Strategy Study provides a framework for the sustainable management of the coastal defences between Ostend and Cart Gap, including Happisburgh. The Strategy identifies opportunities and constraints for coastal management over the next 50 years, as well as a more detailed Coastal Defence Implementation Plan for the next 5 years.

This Executive Report provides a summary of the key issues presented within the main Strategy Report (Report EX 4342, October 2001). This includes a review of the key physical processes and their interaction with existing defences, consideration of the historical development of the coastline, identification and evaluation of a range of potential coastal defence management options and selection of the preferred management approach based on engineering, environmental and economic reasoning.

The coastline within this study area has always suffered from erosion. However, with the progressive deterioration of coastal defences that were constructed in the late 1950's, there has been rapid erosion of the cliff line in some areas leading to the loss of some property, and considerable concern among the local community. Analysis of the erosion hazard suggests that under a 'do nothing' approach, assets valued at between £1.1M and £1.5M would be lost over the next 50 years. These losses have been predicted using a best judgement approach to predict realistic losses, rather than a maximum / minimum approach. Should sea level rise accelerates to 6mm/yr, as latest guidance suggests, the predicted losses would be conservative estimates.

Within the study area a number of key issues and constraints have been identified. These have been taken into consideration in developing the management strategy and include:

- Longshore Drift
  The very high rate of longshore drift means that a disturbance to beach sediment supply and movement can have significant effects on coastal erosion. Any management scheme therefore needs to consider potential impacts along the whole coastline
  .
- Rate and Location of Erosion
  The rate and location of erosion is influenced by the deterioration and failure of the existing timber revetment. The location of revetment failure will influence the rate and location of coastal erosion.

- Losses to the Community
  The rapid and severe erosion during the last 5-10 years has resulted in the loss of a number of properties and continues to threaten more, placing a severe strain on the local community.

- Value of assets
  Assets at risk range from farmland, to recreational facilities, residential housing and a RNLI lifeboat station. However, in relation to the cost of large-scale coastal defence works, the value of assets at risk is low. Any solution meeting economic criteria will therefore need to be innovative and of modest cost.

A Management Strategy has been developed that can be implemented progressively through three phases of work. Given the extreme rates of erosion within the study area and the difficulty of predicting development of these conditions into the future, a flexible approach to implementation of these works has been proposed. Subsequent to the initial Phase I work, Phases II and III need only be implemented if the standard of defence offered by Phase I proves insufficient for stable long-term protection.

The strategy focuses defence measures around the Beach Road area at Happisburgh. Erosion in this area poses the greatest threat to assets; hence defences constructed in this area offer the best return on money invested.

Stage I of the strategy costs approximately £500K to implement and comprises:
- Construction of a rock groyne at the south-eastern end of Beach Road
- Construction of a geotextile based groyne just north-west of the beach access ramp
- Construction of a geotextile based groyne on the upper beach midway along the Beach Road frontage

Stage II of the strategy costs approximately £60K to implement and comprises:
- Refurbishment of the timber groyne midway along the Beach Road frontage

Stage III of the strategy costs approximately £145K to implement and comprises:
- Construction of a rock sill between the rock groyne (Stage I) and the midway groyne (Stage II)

Key tasks, in addition to the construction works themselves, include monitoring of coastal erosion and the condition of the existing timber revetment. Where the timber revetment is failing, removal remains an option that is in the interests of public safety and will limit damage to the remaining defences. However, the implications of such removal on coastal erosion will need to be considered carefully prior to any action.

Implementation of the proposed defence works is dependent upon assessment for grant aid by the Department for Environment, Food and Rural Affairs (DEFRA). Economic analysis of the proposed management strategy shows a benefit cost ratio of between 2.8 and 1.5, depending upon the extent of work required (i.e. just Phase I, or Phases I to III). Analysis through the DEFRA priority scoring system

produces a priority score for the proposed works of between 22 and 24 points, thus exceeding the current threshold for scheme approval.

It should be recognised that should the scheme be approved for funding, it will then be necessary to undertake a more detailed scheme appraisal and design prior to any construction works.

Contents

1. INTRODUCTION

This Executive Summary Report presents an overview, conclusions and recommendations for the Ostend to Cart Gap Coastal Strategy Study. Full details of this study may be found in the study report – *Ostend to Cart Gap Coastal Strategy Study, Report EX 4342, September 2001.*

The study frontage is some 4km long and located on the North Norfolk coast between Ostend in the north-west to Cart Gap in the south-east (Figure 1). This corresponds to the Shoreline Management Plan Management Units SEA 1 and SEA 2.

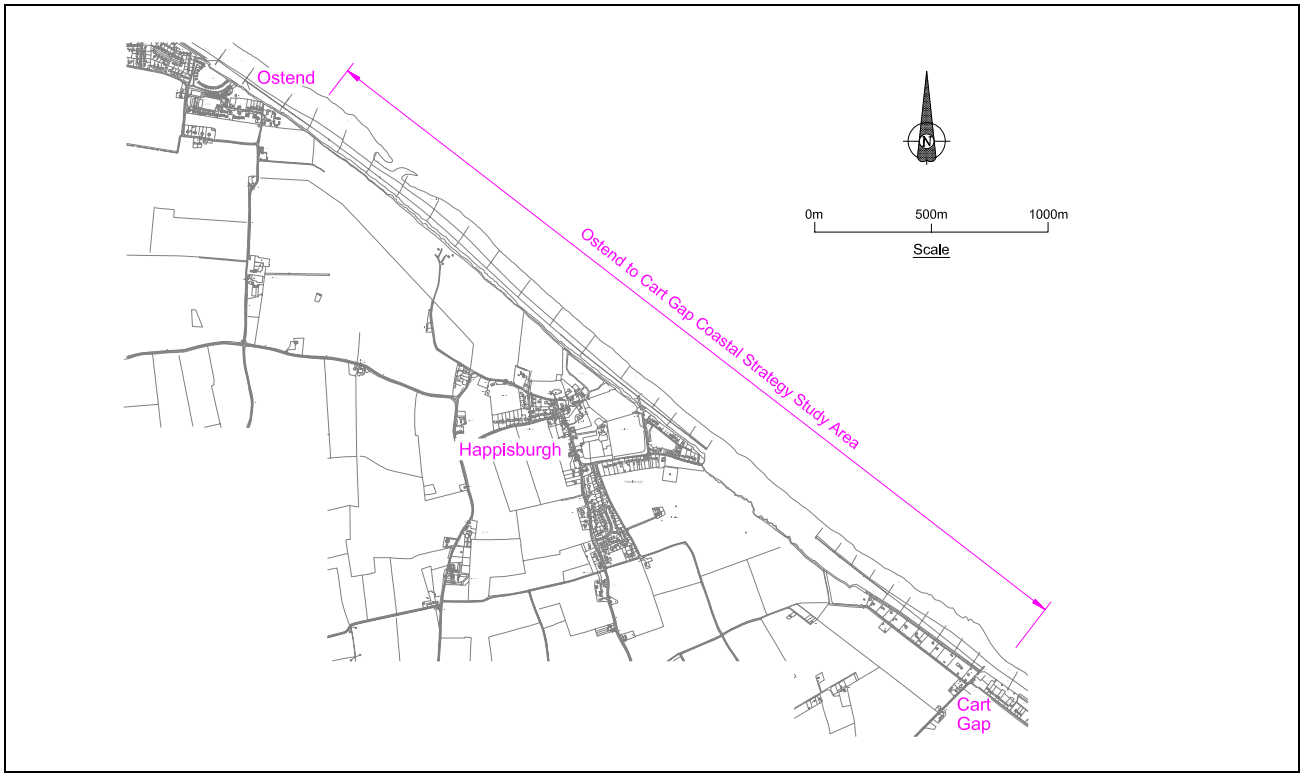

Figure 1 Extent of study area

This stretch of coastline is renowned for problems associated with coastal erosion. The cliffs along this part of the coast have been subject to erosion at least since sea levels in the North Sea rose to approximately present-day levels, a few thousand years ago. Their geological composition, mainly of clay and sand, means that they are prone to frequent landslides, and have little resistance to marine erosion. The construction and maintenance of coastal defences, mainly timber groynes and revetments, has slowed recession of the cliff top during the past few decades. However, deterioration of these timber structures, and removal in some areas, has allowed an increased rate of erosion during the past 5 years which has led to considerable loss of land to the south-east of Happisburgh and some properties along Beach Road at Happisburgh.

2. THE STRATEGIC APPROACH

In 1993 the Ministry of Agricultural Fisheries and Food (MAFF) and the Welsh Office published their "Strategy for Flood and Coastal Defence in England and Wales". This publication identified the need to manage the shoreline from the perspective of coastal processes rather than in accordance with the administrative boundaries of the coastal operating authorities.

To assist this process, MAFF provided guidance that outlines the approach to developing management strategies that is consistent with their stated Policy objective of reducing risks to people and the developed and natural environment from flooding and coastal erosion. To enable management decisions to be taken within such a strategic framework, a hierarchy of 'Plans' and 'Appraisals' has evolved that consider the shoreline in progressively greater detail. This hierarchy comprises Shoreline Management Plans (SMP's), followed by Strategy Plans, followed by Scheme Appraisal (Figure 2). Each of these approaches becomes progressively more detailed and site specific, leading ultimately to the implementation of an appropriate management scheme for a stretch of coastline.

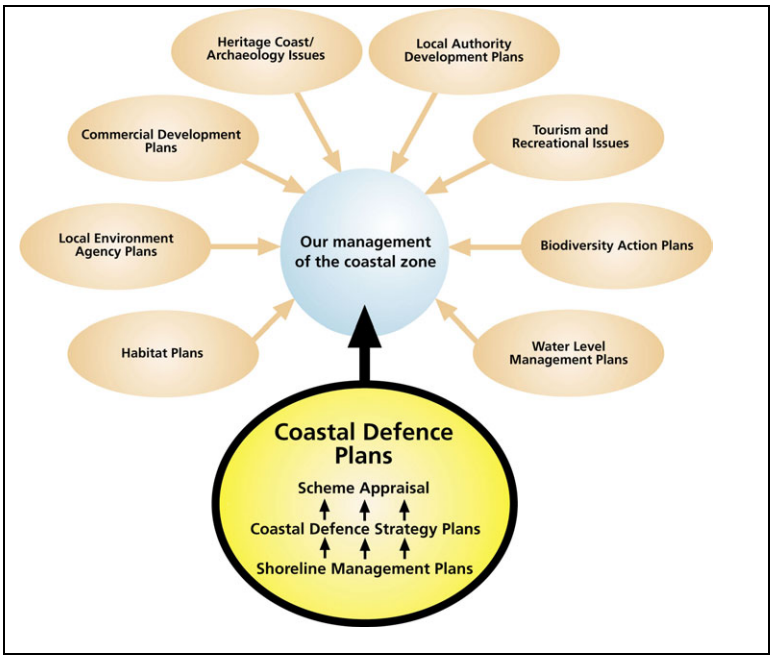

Figure 2 Hierarchy of coastal management plans and appraisals

The 'Ostend to Cart Gap Coastal Defence Strategy Study' follows on from the earlier Shoreline Management Plan (1996), and provides recommendations for a management strategy, that includes the outline design of defences. Following possible acceptance of these recommendations by DEFRA, and approval for grant aided funding, a more detailed scheme appraisal / scheme design would be undertaken prior to any construction.

3. ANALYSIS OF THE STUDY AREA

In order to develop a management strategy that takes into consideration the physical coastal processes, environmental issues and concerns of local industry and residents alike, it is first necessary to consult with all relevant organisations and to analyse the coastal processes (wind, waves, tides etc.). Consultation is undertaken through questionnaire and direct consultation with organisations, whilst the latter is undertaken through a combination of site visits, desk studies and computer simulation.

3.1 The consultation process

A total of 29 different organisations or representatives were contacted during the consultation process. Consultees included the Coastal Concern Residents Group, Happisburgh and Walcott Parish Council, North Norfolk District Council, Utility Companies, the Environment Agency, English Nature, the Countryside Commission, RNLI etc. In addition to this initial consultation, a public meeting was held at Happisburgh Village Hall on the evening of Friday 18th May 2001. This was attended by 80-100 people, demonstrating strong local interest in development of the strategy, and provided further opportunity to explain the study process and to receive direct feedback.

The aim of the consultation process was two-fold; firstly to inform all parties with an interest in the area of the opportunity to participate in development of the future strategy, and secondly to receive direct feedback on issues of concern that should be taken into consideration when developing the final strategy.

3.2 Environmental value

A review of environmental interests in the study area included an assessment of any environmental designations, the geology, flora and fauna, historic environment and recreation.

Environmental Designations

There is a Site of Special Scientific Interest (SSSI) running north-west from the beach access ramp at Happisburgh to just north-west of the Happisburgh Caravan Park. This designation (Happisburgh Cliffs) is based upon interest in the glacial deposits exposed within the eroding cliff face. Key concerns here are to ensure that the cliffs are allowed to continue eroding naturally wherever possible.

Geology

The geology of this area comprises largely of glacial drift deposits comprising heterogeneous clays, silts, sands and gravels. This mixture of deposits reacts differently to the effects of waves, tides, rainfall and weather. The clay deposits are generally more resistant to erosion by the sea, and often remain as an outcrop, jutting seaward from the cliffs while sandy deposits on either side retreat more rapidly. The net result is a typically ragged cliff line, with numerous small bays and headlands. While the erosion of the clay provides no useful beach material, the sandy deposits in the Happisburgh cliffs do provide a significant amount of beach material, adding to the "sediment budget" for the coastline both locally and further along the coast to the east and south.

Flora & Fauna

Since the cliffs are experiencing nearly continuous erosion, and thus restricting the vegetation and animal communities on the cliff faces, the variety and interest in flora and fauna for this area is not as great as in other regions of Norfolk. Sand Martins do nest just below the top of the cliff face in sandy areas and where vegetation does gain a temporary foothold, it is most prolific in area where the water seeps through the cliff face.

Historic Environment

The historic environment may be defined as comprising all traces of past human activity and including archaeological remains (on land and the seabed), historic buildings, parks and gardens and historic landscapes. Neither English Heritage nor the Archaeological Unit of Norfolk County Council

(Gressenhall) identified any buildings or archaeological features of interest within a reasonable distance from the cliff edge. The only historical interest close to the cliff edge identified are the derelict gun emplacements on the cliff top about halfway between Happisburgh and Ocean Village, which were built during the last century.

Recreation

The coastline between Ostend and Cart Gap is popular with holidaymakers, despite the fact that safe public access to the beach from the cliffs is only possible at three locations. Apart from a café in Happisburgh, there are few other retail facilities for holidaymakers. Despite, or perhaps because of, the lack of a commercial character to this seaside area, there are many places for holidaymakers to stay in the immediate vicinity, including caravan sites at both Ostend and Happisburgh. Many of the properties nearest to the edge of the cliffs were built as temporary summer accommodation, originally little more than wooden beach huts. However, many of these properties have been improved over the years, or have even been completely rebuilt and are now occupied throughout the year, either by their owners or let to holidaymakers. These properties are concentrated at Ostend, at Happisburgh (Beach Road) and at Cart Gap (Eccles-on-Sea).

3.3 Hydrodynamic loading

Hydrodynamic loading refers to the waves, tidal currents and changes in tidal level at a site. It is important to analyse and understand these since they directly affect and change the shoreline. By understanding these processes, computer models may be used to simulate how these conditions may vary in the future if different types of defence were constructed at different locations. For this strategy study a number of models were used to predict the different loading conditions and ultimately to predict behaviour of the cliff line into the future. Figure 3 below is indicative of the type of data collected and analysed for the study and shows fetch lengths for the prediction of waves at Happisburgh and the distribution of waves (height, number, direction) generated from observed data.

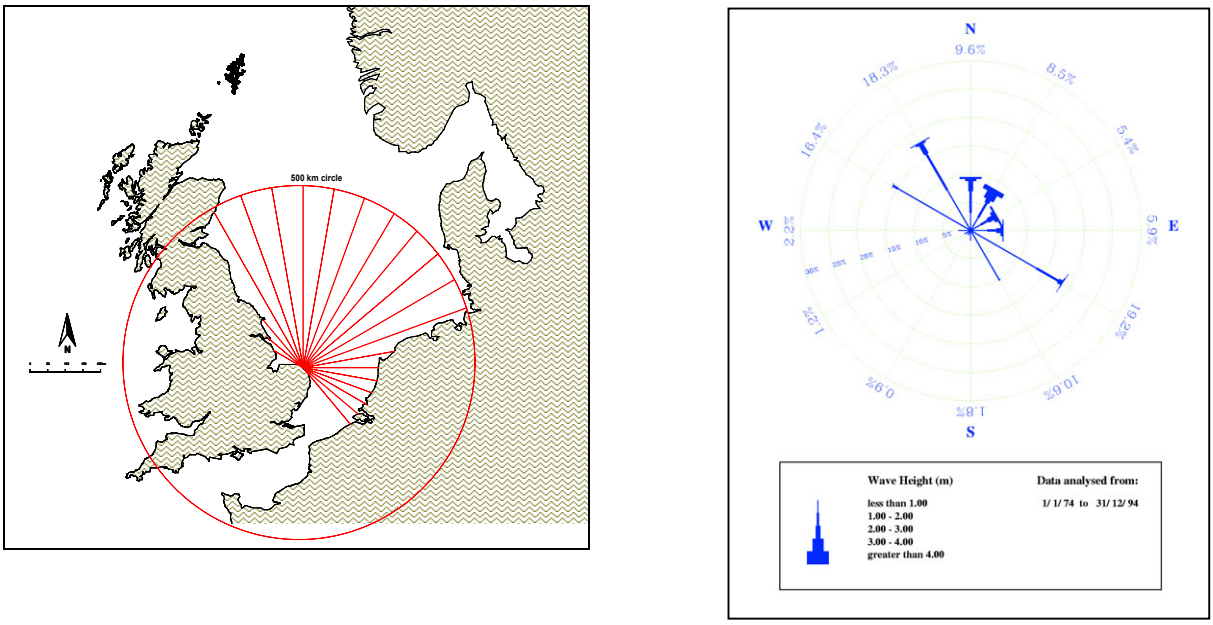

Figure 3 Waves prediction at Happisburgh

3.4 Littoral processes and shoreline evolution

Studying the interaction of the cliffs, beaches and seabed with the environmental loading allows an understanding of the beach processes and subsequent prediction of the cliff recession in response to natural forces and to the installation of coastal defence schemes. The following simplified flowchart shows the main processes and their interrelationship:

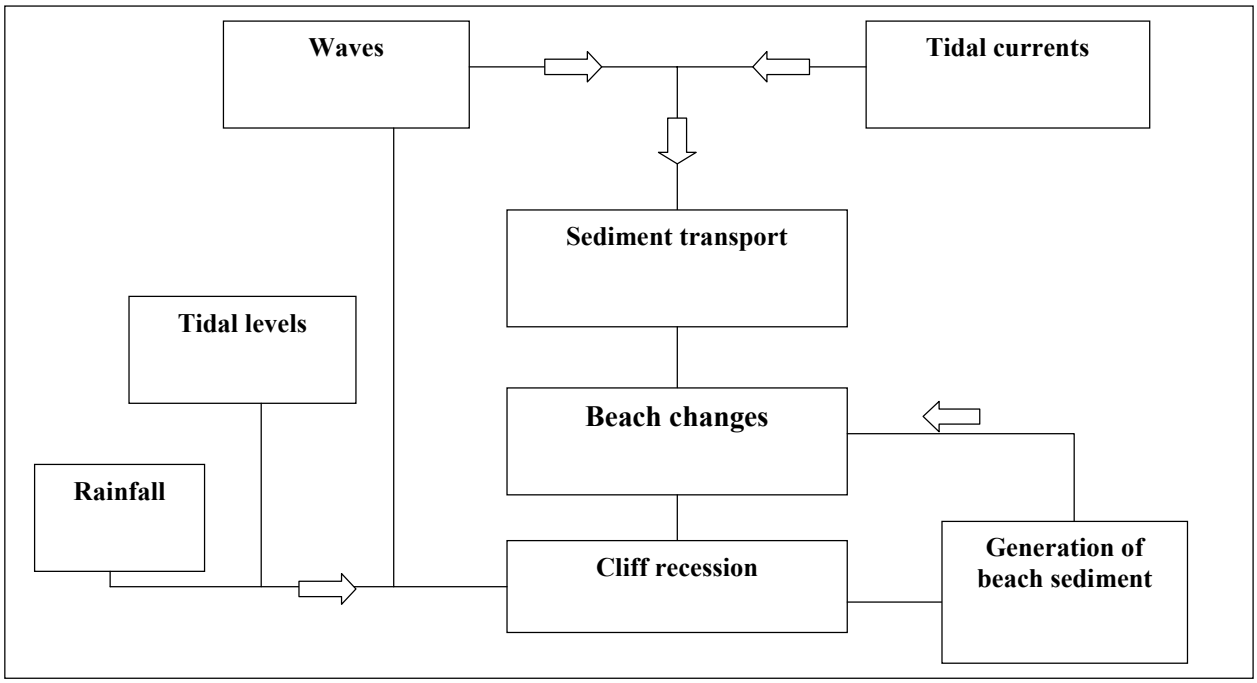

Figure 4 Simplified flowchart of littoral processes

This stretch of coast has been subject to erosion and retreat since the end of the last Ice Age when the North Sea basin filled (again) with water. The main processes causing the coastal changes can be summarised as follows:

- Variations along the coast in the rate of beach sediment transport (longshore drift);
- Erosion of the nearshore seabed, which is of similar soft rock to the cliffs;
- Landwards migration of the beach profile in response to sea level rise;
- Loss of sand from the beaches to the nearshore seabed;
- Wave attack on the cliff face at and above the high water mark;
- Cliff weathering and erosion, e.g. by winds, rainfall, freeze-thaw etc; and
- Land-sliding of the cliff faces caused by saturation by groundwater flows.

Prior to the construction of coastal defences in the study area, the rates of cliff recession due to all these causes appears to have been at a rate of approximately 0.5m/ year, although there were variations in this rate along the coast and in response to varying weather conditions. Following the construction of coastal defences, these natural processes were altered, leading to a reduction in cliff recession rates in some areas (typically where there was greatest human development of the cliff-top land) but at the expense of increased recession on undefended sections. This effect of increased recession occurred on the eastern or southern side of any coastal defences. The reasons for this are as follows. First, the coastal defences reduced the erosion of the cliffs behind them, thus reducing the supply of sediment to the beaches locally. Second, and more important, the defences, particularly groynes, tended to trap beach sand travelling along the coast from the west and north. Both these effects reduced the amount of sand arriving on the beaches in front of the cliffs immediately east and south of the defences, a phenomenon known as “drift starvation”. Because the drift rate on the unprotected coast was now not supplied by (enough) sand arriving from the defended frontage, the beaches, and shortly afterwards the cliffs, eroded to make up the deficit in the sediment budget.

There was, however, an opposite effect on beaches to the west and north of defended frontages, where beach material tended to accumulate since it could only travel past the groynes and seawalls more slowly. For this reason, it seems unlikely that the present problems of rapid erosion south-east of Happisburgh are being made worse by the offshore breakwaters installed by the Environment Agency near Sea Palling, further to the south-east. If anything, these defences should have a slightly beneficial effect on the problems of cliff recession further to the north-west. Other causes of beach loss have also been mentioned in connection with the recent increased rate of recession near Happisburgh. Of these the most frequent concern is the effect of offshore dredging for aggregates. The nearest area of seabed where any such dredging has taken place in recent years is offshore from Caistor, about 40km distant to the ESE. This dredging is too far away and in water too deep to affect waves, tidal currents or sediment transport processes in the Happisburgh area.

The process that is most influential in causing cliff recession (over and above the expected "natural" rate of about 0.5m/ year) is the variation in longshore drift rates along the study frontage. An assessment of longshore drift rates shows that the drift rate along this coastline is very large. As a consequence, the installation of coastal defences such as groynes, even if they are only partly effective at altering the "natural" drift rates, will provoke rapid changes in the beach plan shape. More relevantly from the viewpoint of recent erosion of the coast south-east of Happisburgh, any change in such defences along this coastline will similarly provoke rapid changes in the beaches and hence the cliffs behind them.

3.5 Past shoreline change and influence on coastal defences

Prior to 1958 this shoreline was undefended. Timber defences were then constructed, comprising a revetment parallel to the shore and a number of timber groynes. The revetment had a design life of 40 years, which is consistent with the progressive failure of these defences that can be seen today. Since construction in 1958, considerable repair and reinforcement work has been required to maintain the system. It is now appreciated that the original design was under-designed for the exposed conditions of the frontage. In 1968, additional groynes were constructed and gabion defences placed along the toe of the cliff in front of Beach Road. These gabions were later replaced by concrete blocks, which are still in position today.

At the south-eastern end of the study area (Cart Gap), NNDC built a concrete sea wall in 1986. This hard defence now acts not only to protect the Bush Estate but also protects against the outflanking of the Environment Agency flood defences to the east. In 1993, the sea wall at Cart Gap was outflanked and it was extended inland to prevent further outflanking. The importance of maintaining these defences to avoid outflanking of Environment Agency flood defences to the south-east continues to be an important consideration.

In 1991, a breach in the defences occurred and two groynes were removed from the defence system (for safety reasons). For many years up to this point, extensive maintenance and repair works had been undertaken but with apparent limited long-term effect and at a disproportionate cost. In 1991 it was decided that this approach was not sustainable and the decision was taken to limit works to ensuring that the remaining structures posed no threat to public safety. In the years since 1991, the timber defences have continued to fail and by 1995 a breach width of 300m had developed south-east of Happisburgh, with a further 400m of revetment in poor condition. The coastline to the south-east of Happisburgh village suffered rapid erosion. Rates predicted in the 1995 study ranged between 4.0 and 8.3 m/yr. By January 2001, the breach in defences had grown to approximately 500-600m with large lengths of the revetment to the north-west of Happisburgh also being assessed as having no residual life – i.e. these defences could fail at any time.

In order to predict future potential erosion, a detailed analysis of the cliff erosion rate and behaviour since 1994 was undertaken (see Figure 5). In conjunction with knowledge of the coastal processes, this allowed an estimate of future conditions to be made, assuming that no action was taken to prevent erosion. This 'base' condition is known as the 'do nothing' scenario and is used for comparing the effect and cost of different potential defence schemes.

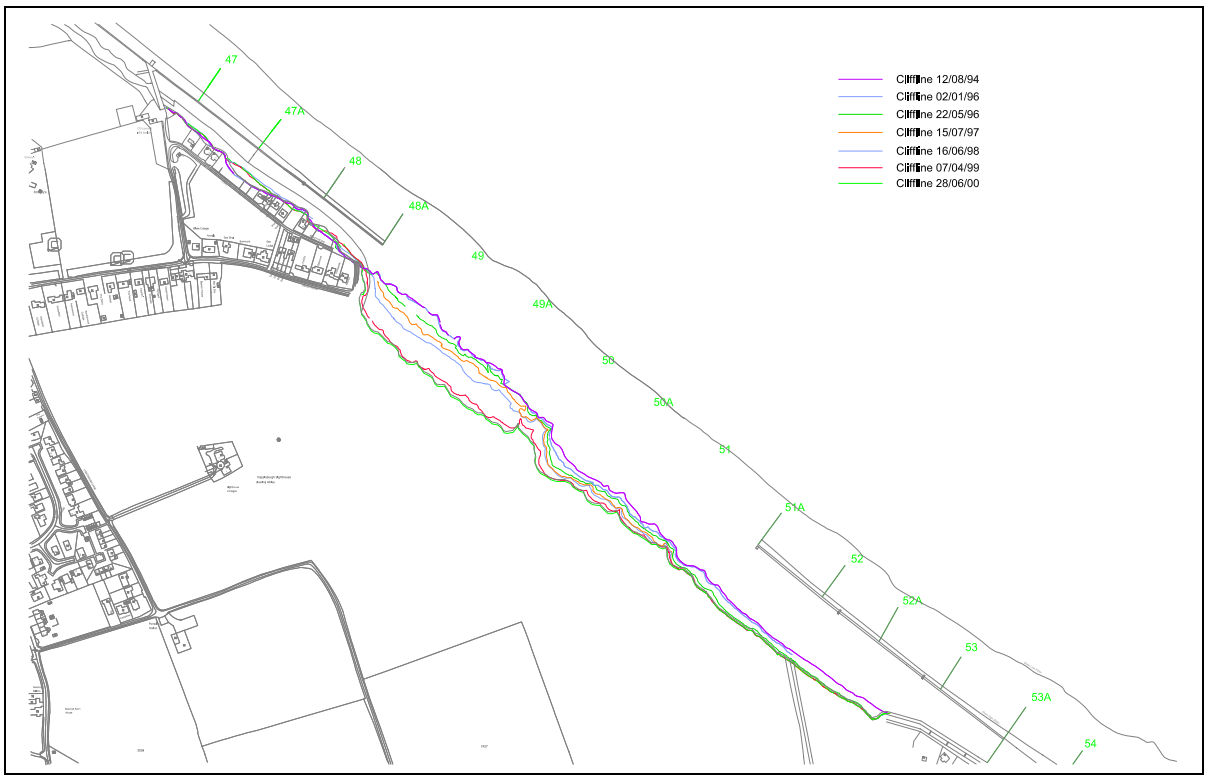

Figure 5 Coastal erosion rate south-east of Happisburgh

4. THE 'DO NOTHING' SCENARIO

By predicting the processes that would occur if no action were taken to maintain or further protect the coastline, and combining this prediction with an estimate of the value and timing of assets (houses, property, business etc.) that may be lost during this process, a monetary value may be calculated for the 'Do Nothing' scenario. The cost of possible defence measures may then be compared against this value to demonstrate that the cost of the proposed works is justified by the value of assets protected.

As part of this assessment, it was therefore necessary to predict the residual life of the existing defences, the likely rate and location of coastal erosion, and the value of assets that may be lost. The residual life of the defences was determined through inspection. The rate of erosion was predicted using numerical models and expert judgement drawing on the information developed about the coastal processes, largely based on recent experience. The valuation of assets was undertaken using a combination of past property valuation data, specific valuations, current property sale prices and financial market indices. The value of assets included recognition of both tangible and intangible assets – for example, the value of the RNLI service at Happisburgh.

There is considerable uncertainty surrounding many stages of the estimation process for predicting the 'Do Nothing' outcome. Given this uncertainty, it was considered appropriate to consider two potential consequences of the 'Do Nothing' option, resulting in two different erosion scenarios. The impacts of each outcome were then weighted and combined to obtain a single representative figure for the losses incurred.

<u>Do Nothing Scenario 1 - Lower Loss Scenario</u>
Under this scenario:

- Cliff recession and loss of properties in Happisburgh (Beach Road area) continues with erosion to the south-east of the village cutting in a north and westerly direction. Within 5 years it is predicted that all properties along the Happisburgh Beach Road frontage will be lost to erosion, with the cliff edge receding by some 30m from its current line. Additional (brick built) properties will be lost in later years as the erosion continues to affect land within the triangular area enclosed by Beach Road.

- Erosion of the cliffs to the north-west of Happisburgh develops as the timber revetment defences begin to fail. The majority of this land is open farmland, although Happisburgh Caravan Park will be affected.

- Erosion of farmland at Ostend, just south-east of Coastline Village, increases as defences along this stretch fail and defences in front of the housing are maintained. Erosion is greatest in farmland just to the south-east of Coastline Village, with the cliff line receding by up to 200m in this location. Material eroded from the cliffs here will be carried south-east and will help to reduce erosion in the area of Happisburgh.

- Erosion of the cliffline just north-west of the seawall near Cart Gap is limited. The main force of erosion is expected to be focussed further to the north-west with sediment being carried towards Cart Gap.

In very broad terms, it is anticipated that (under this scenario) property in the village of Happisburgh further back than, say, 100m from the current cliffline will not be affected by erosion within the 50 year prediction period.

<u>Do Nothing Scenario 2 - Higher Loss Scenario</u>
Under this scenario:

- Erosion and loss of properties in Happisburgh (Beach Road area) continues with erosion to the south-east of the village cutting in a north and westerly direction. Within 5 years it is predicted that all properties along the Happisburgh Beach Road frontage will be lost to erosion, as well as some of the

brick built properties along the rear section of Beach Road. It is predicted that the cliffline will recede by some 75m from its current line within this 5-year period.

- As defences fail along the frontage as far as the north-western edge of Happisburgh Caravan Park, erosion will be focussed in this area with a rapid cutback of the cliffline by 110m between years 5 and 10. This erosion would remove the Caravan Park and the lifeboat station as well as threatening property in the area of Hill House. As erosion continues, the church will be lost after approximately 20 years.

- Significant erosion of farmland between Happisburgh and Ostend is not predicted under this scenario since it has been assumed that defences remain intact along this frontage.

- Erosion of the cliffline just north-west of the seawall near Cart Gap is limited. The main force of erosion is expected to be focussed further to the north-west with sediment being carried towards Cart Gap.

In very broad terms, it is anticipated that (under this scenario) property in the village of Happisburgh along Beach Road may be affected as far back as the road junction adjacent to Blake Cottage and that property around Hill House, including the Manor House, Hill House, The Rectory and the Church may be affected. It should be reiterated that there is considerable uncertainty surrounding the prediction of erosion along this frontage. The interaction of natural processes with the progressive failure of defences and variable ground / soil conditions means that the progression of erosion could be different to the predictions in some areas and subsequently affect the overall development pattern.

The two scenarios above are presented as realistic 'Do Nothing' scenarios. Two scenarios are presented rather than one, to try and allow for the uncertainty surrounding prediction of the consequences of the 'Do Nothing' option. The two scenarios may be taken as representing lower and higher loss scenarios. These are not maximum and minimum predictions but rather a realistic attempt to represent what might occur. If extreme conditions are taken for modelling erosion, then predictions of much greater erosion may be developed. However, the probability associated with such an occurrence must also be considered to be much smaller.

The (net present) value of assets at risk under each of these scenarios has been estimated to be approximately £0.7M under the lower loss, Scenario 1, and £2.3M under the higher loss, Scenario 2.

In order to present a single estimate of 'Do Nothing' assets at risk, the valuations associated with each of the two scenarios may be combined. Values may be combined equally (i.e. 50:50 ratio) or may be weighted in favour of the more likely scenario. There is an argument in favour of weighting the values 50:50 given the uncertainty in prediction and difficulty in defining an exact weighting. Judgement based upon the analyses to date suggests that a weighting of 50:50 or perhaps 60:40 in favour of the lower loss scenario is most appropriate.

Combined NPV of Assets at Risk for the Do Nothing Scenario:

50:50 ratio = £1.5M
60:40 ratio = £1.3M
70:30 ratio = £1.1M

These figures were then used in comparison against the cost of potential works when considering possible management strategies for the study area.

5. OPTION IDENTIFICATION, EVALUATION AND SELECTION

Flood and coastal defences designed to reduce flood or erosion risk must be technically sound, economically viable and environmentally acceptable.

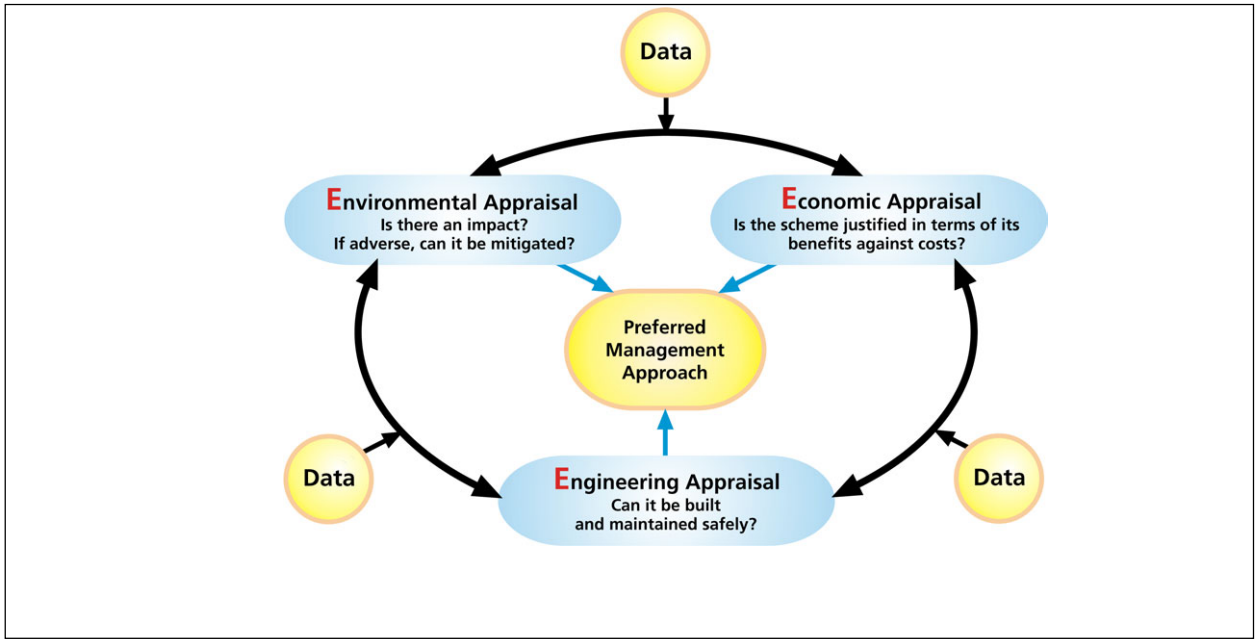

Figure 6 Option identification philosophy

These three objectives may be considered for each idea or solution proposed for inclusion within the management strategy and ultimately, each option prioritised against these conditions, leading to a preferred option or options. The process undertaken for the development of defence solutions for this strategy study is shown in Figure 7 below.

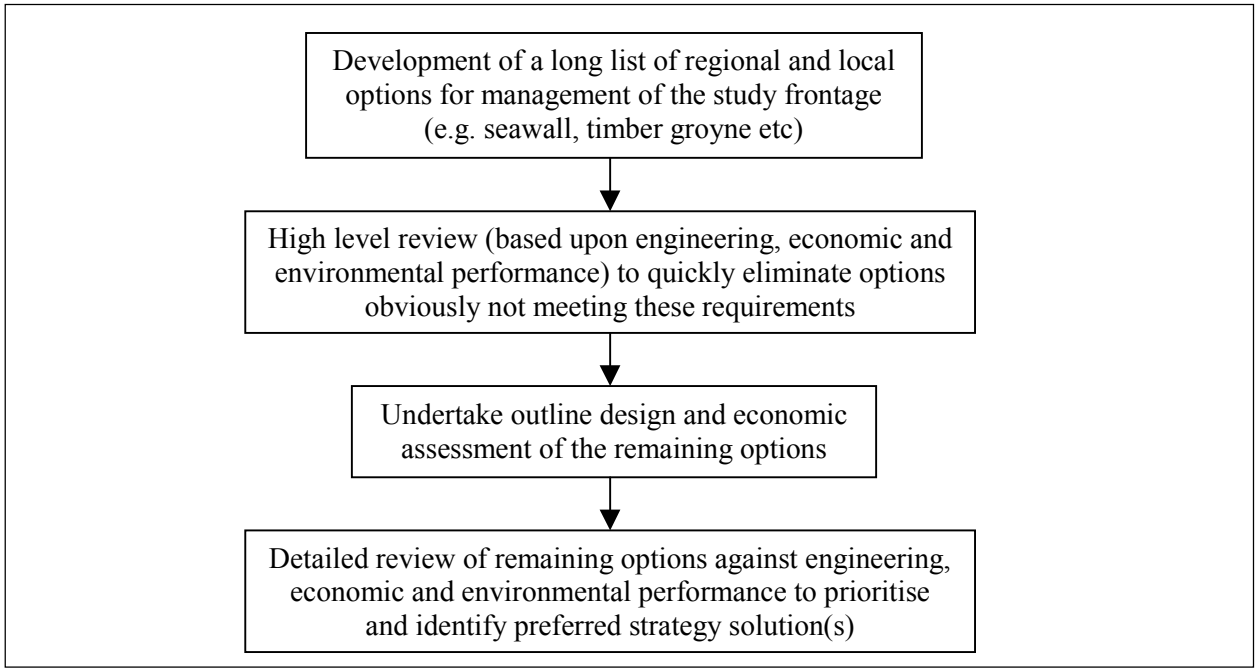

Figure 7 Defence option prioritisation process

From an initial list of 35 defence options, a total of 11 were identified for more detailed assessment. The remaining 24 were rejected during the broad level review. Of the 11 that were selected for more detailed assessment, the cost of the individual works ranged from £0.3M to £1.1M. However, many of the defence options considered offered only a specific type or location of defence that on its own would not offer a suitable defence strategy, but when combined with one or more of the other defence options could provide an acceptable solution. Combinations of defence options were then considered in developing the final management strategy.

6. THE MANAGEMENT STRATEGY

A strategy has been developed that is supported by the analysis and findings of the entire strategy study. Four key issues identified during the study and key to the solution are:

- Coastal erosion is the main problem faced for management of the study coastline
  Any long-term solution needs to consider the threat to assets posed by erosion and the implications for other reaches of coastline if defences are constructed

- The rate of longshore drift is very high in this area
  Any defence measure should consider how sediment will move along the coastline. Changing the source / supply of sediment could significantly affect some areas. High longshore drift makes the site suitable for use of groynes as a means of increasing the beach level and protecting the shoreline.

- Prediction of cliff recession in the area is complex and depends upon a combination of coastal processes interacting with existing, but failing timber defences.
  Whilst different scenarios may be considered and predictions of cliff recession rates made through combined desk studies, numerical modelling and expert judgement, it should be recognised that there are many factors that could influence the rate of erosion and considerable uncertainty in the process predictions. This uncertainty should be recognised when considering any "best estimate" predictions.

- The value of assets at risk in the area is relatively low (compared to the cost of major coastal defence works) with the majority of assets focussed around the Beach Road area of Happisburgh.
  The final solution will need to offer a relatively low cost but strong engineering solution to the erosion problem. It is likely that economics will dictate that the solution be local to the area of greatest assets at risk (i.e. Beach Road, Happisburgh).

Of the various defence options considered, the following approaches (in order of preference) were identified as being most appropriate for the study frontage:

1	Option 18 / 28	Geotubes	Limited application to upper beach
2	Option 20	Rock groynes	Southern end of Beach Road
3	Option 21	Timber groynes	Southern and mid Beach Road
4	Option 17	Rock defences – sill with fill.	Beach Road frontage

Based upon this prioritisation, a staged series of works are proposed within an overall management strategy. This strategy is presented schematically in Figure 8 and a general arrangement of the works in Figure 9. The key issues and stages of work summarised below.

6.1 Key issues

Key issues are:

- The economic assessment forces the focus of any defence works to be based around the Beach Road frontage. Works undertaken here will defend the majority of assets but will allow subsequent loss through erosion of farmland along the coast on both sides of Happisburgh village.

- To prevent further erosion at Beach Road it is necessary to stabilise the beach in front of the eroding cliffs. The precise extent to which the proposed measures will work is uncertain so a staged approach to works with monitoring of performance is proposed.

- A fundamental issue for the entire study area is coastal erosion. Monitoring the rate and effects of erosion along the whole frontage is essential, regardless of any defence works installed.

6.2 Preferred management programme

The following points summarise the management programme and should be reviewed in conjunction with Figures 8 and 9.

Stage I of the works is to construct a groyne (preferably of rock) at the south-eastern end of Beach Road, aligning with the existing Groyne 48a and extending back so as to protect the exposed cliff face and protect the whole frontage from south-easterly wave action. Simultaneous construction of two upper beach groynes between the timber revetment and the cliff is also proposed. To minimise costs, these may be formed from Geotubes and their role is to prevent movement of upper beach material and so help to maintain a higher beach level in front of the cliffs. The most northerly of these two groynes is just north-west of the beach access ramp and hence within the SSSI. The function of this groyne will be to limit the movement of sediment under the access ramp and help to stabilise the cliffs for a short distance north-westwards towards the Happisburgh Caravan Park.

In the event that Stage I works are insufficient to prevent continued erosion, Stage II works may be undertaken. If the Stage I groyne is effective, but only over a limited length then a second groyne may be constructed (refurbished / extended) midway between the rock groyne and the beach access ramp (existing Groyne 47a). This will help to maintain an extended beach over the full Beach Road frontage.

In the event that Stage II works are still insufficient to prevent erosion, then Stage III works may be undertaken. Stage III works comprises the construction of a rock sill between the timber revetment and toe of the cliffs. This sill may extend between the rock and midway groyne, or between the midway groyne and beach access ramp, depending upon the performance of the Stage II works. It is anticipated that, if required, this sill would most likely be placed between the rock and midway groynes.

Monitoring of the whole frontage is proposed. Progressive failure of the timber revetment may lead to accelerated erosion in some areas. Under these circumstances, and depending upon the location, it may be better to remove defences elsewhere so as to manage the coastal erosion. By protecting the Beach Road frontage and allowing defences elsewhere to deteriorate, erosion of farmland south-east of both Ostend and Happisburgh will occur.

Erosion of the frontage by the sea wall near Cart Gap is not anticipated to be a problem. However, these defences should be monitored to ensure that erosion does not occur and threaten the defences.

Erosion south-east of Ostend will be severe once the timber revetment fails in this area. The policy within the adjacent management unit is one of hold the line to defend housing built close to the cliff edge. Care will be required to ensure that defences are not outflanked by processes similar to those south-east of Happisburgh.

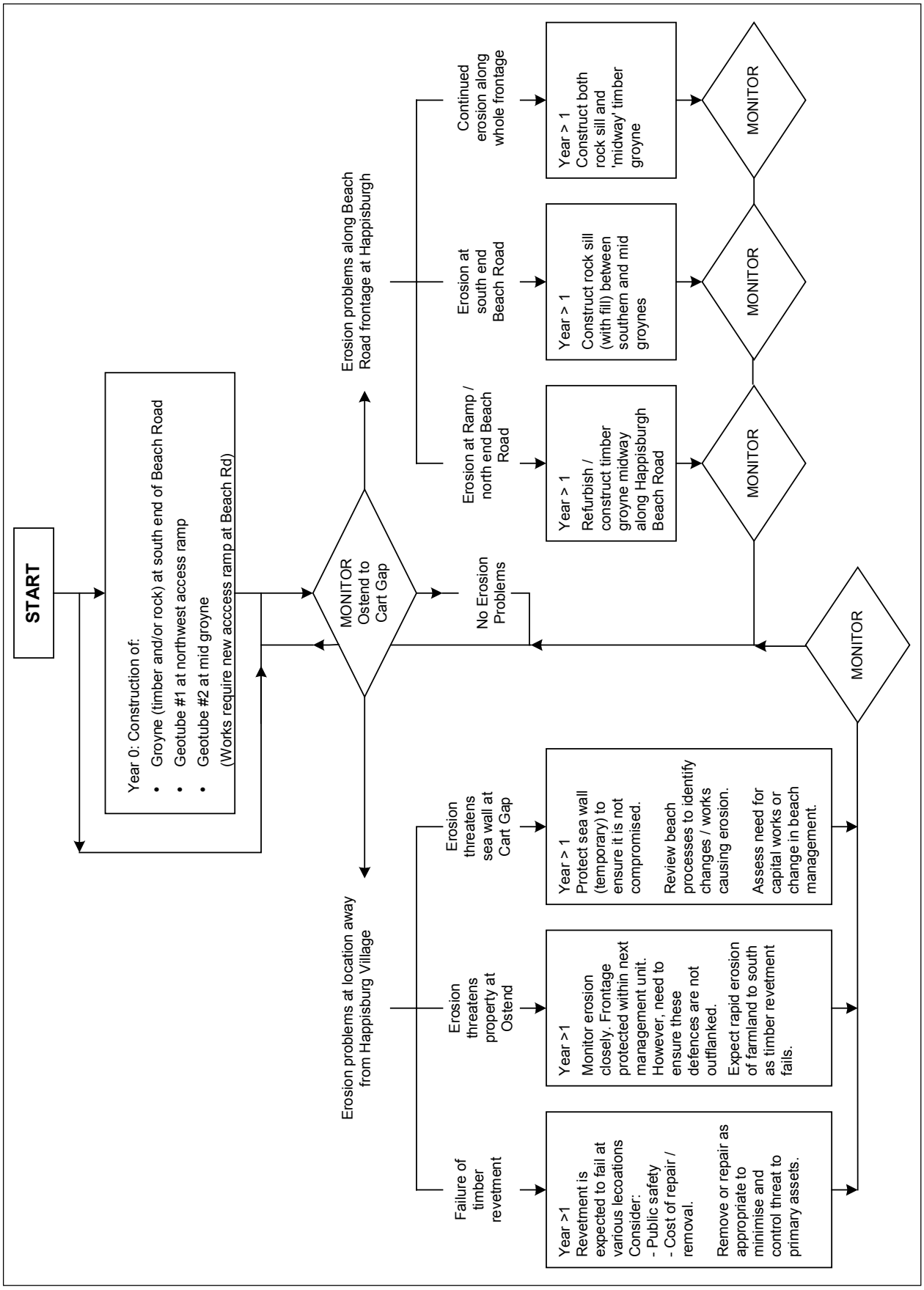

Figure 8 Coastal management strategy

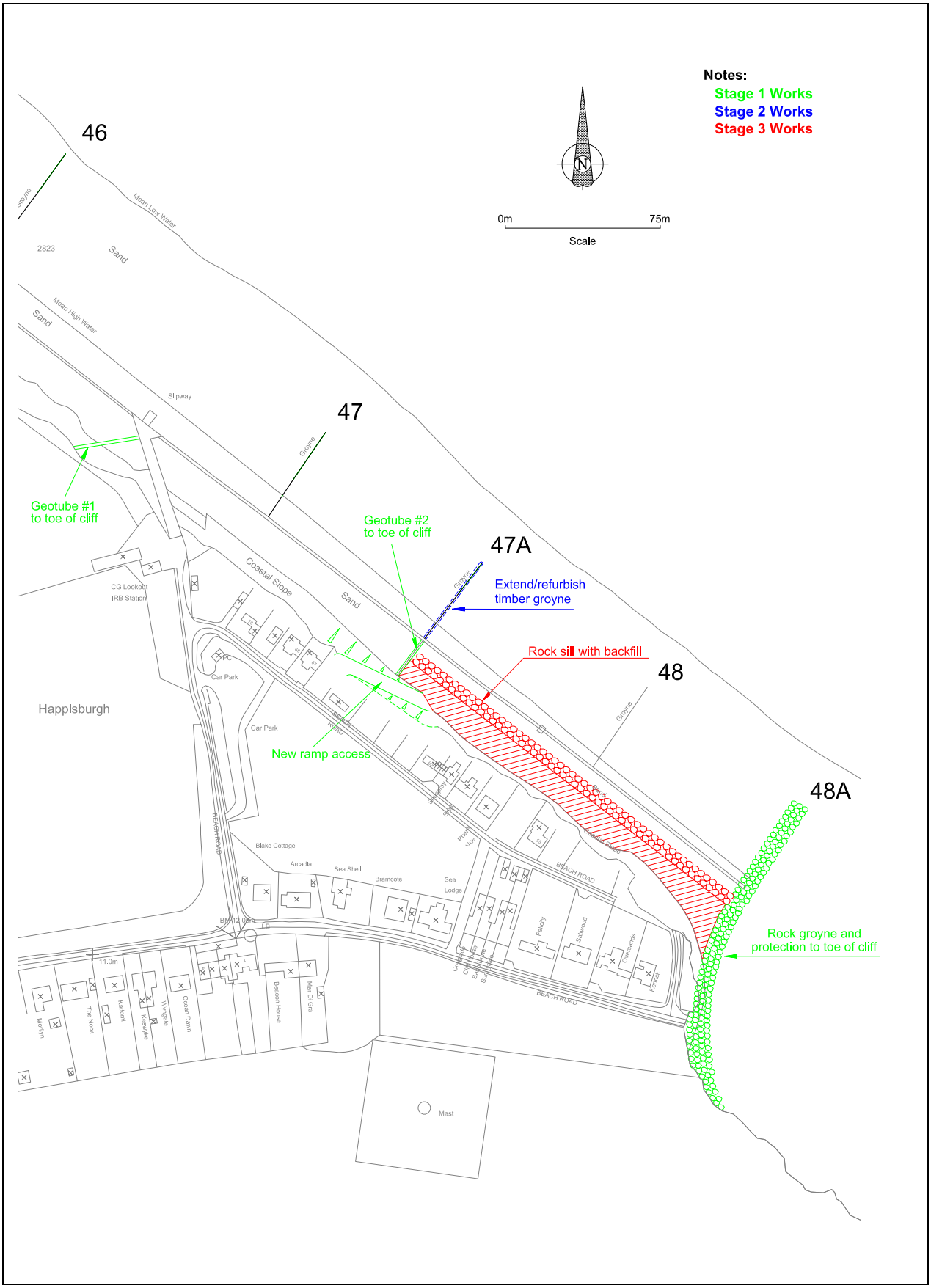

Figure 9 General arrangement of defence works

6.3 Economic viability

The economic viability of the proposed management strategy has been demonstrated through analysis of the benefit cost ratios associated with each stage of the works. The strategy is based on the concept of progressively increasing the extent of defences (to a maximum) to allow an assessment of performance and identification of the need for additional measures. The BC ratio for the works therefore depends upon the extent of protection eventually required, and the timing of such works. In calculating these figures consideration was also given to the value of assets that remain at threat under the proposed management solution (£83K) and the additional cost of monitoring that results through implementation of the management scheme (£25K).

Taking all of these costs into consideration, the NPV of assets protected has been estimated as between £1.1M and £1.4M. Combining these figures with the cost of works, maintenance and monitoring, a benefit cost ratio may be calculated. A range has been given for the ratio below depending upon whether the ratio relates to the 50:50 combined do nothing scenario or the 70:30 combined scenario.

Completion of Stage I	PV Costs = £503k	Works BC Ratio:	2.8 ↔ 2.1
Completion of Stage II	PV Costs = £564k	Cumulative BC Ratio	2.5 ↔1.9
Completion of Stage III	PV Costs = £708k	Cumulative BC Ratio:	2.0 ↔1.5

6.4 DEFRA priority scoring for grant aid

The proposed management strategy has been reviewed according to the priority scoring methodology that MAFF published in 1997. Under this system a score of 8 has been allocated to land use and hazard, 10 to urgency and between 4 and 6 for economic justification.

This results in a combined total DEFRA score of between 22 and 24 points, which exceeds the current threshold for an acceptable coastal defence scheme.

6.5 Strategy revisions and activities to support future coastal management

Typically, the management strategy should be reviewed every 5 years. The overriding issue of concern along this study frontage is the rapid and severe erosion of land that has occurred to the south-east of Happisburgh, which will also occur in other areas along the frontage as the existing timber defences fail. Given that lengths of defence may fail during a single storm, and that significant erosion of land can also occur within a single storm, it is essential that any development of erosion and performance of the strategy is monitored on a regular basis. Key issues for any strategy review and update will therefore include:

- Progress on implementation of the management plan and monitoring programme
- The performance of existing timber defences and impact on local erosion rates
- The effectiveness against erosion of the management strategy staged works
- The need to update the strategy