This report has been prepared under Section 6 of the National Audit Act, 1983 for presentation to the House of Commons in accordance with Section 9 of the Act.

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Comptroller and Auditor General  
National Audit Office  
27 April 1992

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Summary and conclusions

1 Many urban and rural areas along the English coastline depend on coastal defences to protect them from flooding or erosion by the sea or tidal waters. The potentially disastrous effects of the failure of defences were clearly illustrated by the loss of life and widespread flooding and damage caused by the 1953 storms on the East coast of Britain and more recently by the flooding in the Winter of 1989–90.

2 Works to protect the English coastline are divided into two categories:
- sea defences (including tidal defences) to protect against the flooding of low lying areas. These are usually built by the nine English regional offices of the National Rivers Authority; and
- coast protection works to prevent the erosion of land and encroachment by the sea. These are usually carried out by the 89 maritime district councils.

The distinction between the two categories of works is blurred because some defences protect against both flooding and erosion. In this Report the term coastal defence is used to describe both types of work.

3 Prior to 1985 the Department of the Environment were responsible for coast protection and the Ministry of Agriculture, Fisheries and Food were responsible for sea defence. The Ministry assumed responsibility for coast protection in 1985 and now have overall policy responsibility for ensuring the adequacy of coastal defences in England. Operational responsibilities rest with the National Rivers Authority and maritime district councils, to whom the Ministry pay grant towards capital expenditure for the construction and improvement of coastal defences. Grant-aided capital spending on coastal defences in 1990–91 totalled £58 million including £32 million of Ministry grants. The Ministry also fund the Storm Tide Warning Service operated by the Meteorological Office which provides warnings of surge tides. National Rivers Authority regions provide local warnings usually via the police and together with maritime district councils and emergency services are responsible for local action on these warnings.

4 In 1985 the government produced a Green Paper on the 'Financing and Administration of Land Drainage, Flood Prevention and Coast Protection in England and Wales'. The Green Paper favoured an end to the statutory distinction between sea defence and coast protection, and put forward options for the financing of coastal defence. Action on these matters was deferred with the introduction of the Water Act 1989, which created the National Rivers Authority to take over various functions of the water authorities including sea defence.

5 The National Audit Office examined the work of the Ministry and the National Rivers Authority in relation to coastal defences in England, including:
COASTAL DEFENCES IN ENGLAND

- the performance of coastal defences and the Storm Tide Warning Service (Part 2 of the Report);
- the planning, co-ordination and financing of the coastal defence programme (Part 3), and
- the engineering, economic and environmental appraisal of coastal defence schemes (Part 4).

The National Audit Office employed a team of economists and engineering and environmental consultants to assist them in their examination.

6 The National Audit Office’s main findings and conclusions are set out below, linked with suggestions for further action.

Performance of coastal defences and the Storm Tide Warning Service

(a) The surveys initiated by the National Rivers Authority are providing much needed national and local information on the state of repair of sea defences. Keeping the information up to date and using it for effective forward planning will be a key task in bringing sea defences up to and maintaining the necessary standards. Similar information on coast protection works is needed as soon as possible to ensure an integrated approach to coastal defences as a whole. The Ministry, National Rivers Authority and authorities should set benchmarks for judging survey results and establish programmes and timescales for improving more vulnerable defences.

The Authority’s survey in 1990 of its own sea defences showed that almost one-sixth of defence elements were in need of significant or moderate works. One-sixth of elements had a residual life of five years or less. The percentage length of defence at risk would be a better measure of condition, but the Authority’s survey method did not permit such an analysis. The state of repair of defences also varied significantly between regions. Later surveys showed local authority sea defences to be in better condition; but 35 per cent of privately or corporately owned defences were in need of significant or moderate works although these generally protected small rural areas. The Ministry have recognised the need for similar information on coast protection works, but have yet to decide how and when this will be obtained (paragraphs 2.4 to 2.14).

(b) A more systematic review of the performance and adequacy of coastal defences is needed. The Ministry should introduce arrangements for evaluating the coastal defence programme as a matter of urgency and set up a pilot system of post-project appraisal of schemes with a view to its cost-effective introduction on a national basis. The Authority have embarked on a valuable initiative for assessing the adequacy of tidal and river defences against national target standards of protection and should set a timetable for introducing similar arrangements for sea defence.

There is no information available nationally to assess the performance or adequacy of coastal defences. The Ministry’s arrangements for the evaluation of the coastal defence programme have been under discussion with the Treasury since 1989. At the three Authority regions visited by the National Audit Office there were no systems of post-project appraisal to assess the performance of schemes against intended standards of protection and the severity of events experienced. Nor were there arrangements to
identify and disseminate more immediate lessons from the design and construction of schemes and cost and time overruns. However past experience did influence the choice and approach to future works and is also subject to wider debate at the Ministry’s annual conference of river and coastal engineers. The National Rivers Authority plan to introduce post-completion appraisal procedures in 1992–93 (paragraphs 2.15 to 2.26).

The Ministry’s study of the cause of damage to beaches during the 1989–90 storms is an important step, but the widespread flooding and damage sustained in these storms indicates the need for wider and more authoritative performance assessment (paragraph 2.21).

The National Rivers Authority are developing national target standards of protection to allow assessment of the adequacy of river and tidal defences and they are looking to extend the use of target standards to sea defences (paragraphs 2.22 to 2.23).

(c) The Ministry and the National Rivers Authority have made progress in improving storm surge forecasting and clarifying arrangements for the organisation and operation of national and local flood warnings; but some work remains outstanding on strengthening local systems and monitoring performance of the Storm Tide Warning Service. Under current arrangements the role of the police is vital in the prompt communication of warnings to district councils and the reliability of these arrangements needs to be kept under careful review.

The Welsh Affairs Committee Report on the flooding at Towyn drew attention to delays in transmission of warnings to district councils by the local police and considered that the involvement of so many agencies was a recipe for delay. In 1990 the Ministry undertook a fundamental review and revised their guidance on the national Storm Tide Warning Service. Following further updating in August 1991 revised guidance was issued to all organisations participating in the warning systems (paragraphs 2.27 to 2.32).

The National Audit Office noted, however, that operational arrangements for the National Rivers Authority’s local warning systems had still to be clearly set out and agreed with other parties in one of the three regions visited. There were also some problems with late or non-receipt of warnings by district councils in some areas. In September 1991 the Authority launched a review of their procedures and reminded Chief Constables of the role of the police in relaying warnings (paragraphs 2.33 to 2.34).

The Storm Tide Warning Service have responded positively to problems raised by the National Rivers Authority and they expected further improvements in the Service. However the Ministry’s arrangements for reviewing performance could be improved by introducing further performance measures and through a more formal annual review, possibly involving key users; the Ministry should also consider improving accountability by publishing an annual report on the Service’s activities (paragraphs 2.35 to 2.37).

Planning, co-ordination and financing of coastal defences (d) The coastal defence programme relies upon good local planning to ensure that the level of funding is soundly based and resources directed towards higher priority and more urgent works. The National Rivers Authority have taken steps to improve their planning and to develop national priorities for sea defences. The Ministry have
established broad priorities and have taken action to assess the implications of climate change but could support improved planning by developing and publishing their strategy for coastal defence and issuing linked guidance to district councils.

Although the Ministry have overall responsibility for the coastal defence programme, they have yet to fully develop and publish a national strategy but they believe they have the main components in place. The Ministry have set broad priorities for flood and coastal defence and in December 1991 the Minister announced plans to develop a national strategy. A main feature of the Ministry’s planning is determining future funding needs, based upon the plans submitted by the National Rivers Authority and district councils. However, the quality and depth of local plans are variable and some bodies consulted by the National Audit Office expressed concern at the lack of guidance on national planning and priorities. The Ministry intend to improve planning by publishing a national strategy and building on existing guidance to operating authorities (paragraphs 3.2 to 3.7).

The National Rivers Authority have recently set out a programme of management action to develop greater planning, co-ordination and national direction in their flood defence programme. They intend to introduce during 1992–93 10-year ‘needs’ plans for all regions and a national system for setting priorities (paragraphs 3.8 to 3.9).

The Ministry’s policy on climate change and sea level rise is that defences should be constructed to meet current assessments of risk, but designs are expected to be flexible so that they can be raised if higher protection is needed. The National Rivers Authority follow this policy. Many of the organisations consulted in September 1991 commented on the absence of guidance to district councils on the implications of climate change for coastal defence works. In November 1991 the Ministry issued guidance for district councils on the allowances for sea level rise to be used in the design of defences (paragraphs 3.11 to 3.15).

(e) Coastal groups are a recent and valuable innovation to promote better co-ordination between coastal defence agencies. As well as reviewing the effectiveness of these groups in due course, and learning lessons, the Ministry should also consider providing greater support to the development of improved regional information on coastal processes to assist local planning and co-ordination.

There has been concern over the years that the division of coastal defence responsibilities between some 160 bodies has led to a piecemeal approach and inhibited a more strategic view. The authorities have themselves set up ‘coastal groups’ over the last five years to improve co-ordination; and such groups now cover the majority of the coastline but they have no statutory powers or formal standing. The Ministry have also recently set up a national coastal defence forum involving coastal groups and the National Rivers Authority to identify research needs and promote strategic planning (paragraph 3.16 to 3.23).

Improved co-ordination will depend in part on the availability of good information on coastal processes. The Ministry have grant-aided a major study on the East Anglian coast but in other areas data is collected on a more piecemeal basis (paragraph 3.22).
(f) Consultation between local authorities and the National Rivers Authority on developments in flood risk areas needs to be strengthened; this is under review by the Department of the Environment and new guidance is planned.

Joint guidance by the Ministry and the Department of the Environment in 1982 advised planning authorities to consult water authorities, now the National Rivers Authority, when development is proposed in a flood risk area. However, there has been concern that the current guidance and practice of authorities does not adequately address flood risks when approving development. The National Audit Office noted that co-operation between planning authorities and the National Rivers Authority varied in the three regions visited. Following Towyn, the Department of the Environment plan to issue revised guidance during 1992 and expect this to deal with defining flood risk areas where development will be discouraged (paragraphs 3.24 to 3.27).

The Department of the Environment are reviewing more general planning policy for coastal areas, and expect to issue draft guidance for consultation in Spring 1992. In addition, the Select Committee on the Environment are carrying out an inquiry into planning in the coastal zone, and their report is expected in early 1992 (paragraph 3.30).

(g) The financing of coastal defence is complex. The Ministry could provide coastal defence agencies with a clearer statement of the arrangements to help ensure that the allocation of resources is fully understood; and there may be benefits in simplifying the financing arrangements.

The greater part of capital expenditure on coastal defences is financed from central government funds, directly through Ministry grants and indirectly through Revenue Support Grant to local authorities taking account of their income from the associated community charge and redistribution of business rates. There has been increasing concern over the impact of rising costs on county councils who, although not responsible for coastal defence, play a key role in financing the local costs by making contributions to district council schemes and paying levies to the National Rivers Authority (paragraphs 3.31 to 3.37).

A recent Authority review concluded that their system of local committees may not provide sufficient flexibility in the use of funds to meet higher priority works. They advised regions that there could be benefits in decisions on programmes and funding being taken on a regional basis. Such arrangements already exist in six regions but arrangements have remained unchanged in the other three (paragraphs 3.33 to 3.34).

Although the Ministry have taken steps to clarify the basis of coastal defence funding through Revenue Support Grant, they have not provided a full explanation of the system to district and county councils; they considered that sufficient guidance was already provided by the Department of the Environment. A number of organisations consulted expressed concern at the complexity of the system including the treatment of coastal defence expenditure in Revenue Support Grant. Several organisations suggested that the Ministry's grant arrangements need to be simplified, possibly by introducing a single category of coastal defence and a rationalisation of grant rates. The Ministry intend to reduce the number of grant rates used on coast protection and to align them with the rates available for sea defence from April 1992 (paragraphs 3.38 to 3.40).
Better guidance to authorities would help to improve the standard, content and presentation of appraisals for coastal defence schemes, with greater assurance that projects are cost-effective. Such guidance could usefully be backed up by further programmes of training for practitioners.

In recent years the Ministry have introduced the concept of strategy plans for evaluating a series of projects; these are particularly necessary where the most appropriate solution to a coastal problem requires a very long-term programme of works possibly over large sections of the coastline. However, the Ministry have taken some time fully to develop their approach to strategy plans and have yet to issue guidance to authorities (paragraphs 4.5 to 4.9).

Ministry guidance to authorities needs to be improved to ensure that appraisals include adequate evaluation of options; and further advice would assist authorities in the identification and evaluation of the full range of assets at risk from flooding and erosion. In the schemes examined by the National Audit Office authorities made a number of omissions and errors in their economic appraisals; and intangible benefits and environmental effects were not always considered and rarely quantified. There was a significant lack of sensitivity testing to take account of uncertainties in scheme design and impact. There was insufficient evidence to establish just how critical these shortcomings were to the economic evaluation of the schemes; but the standard of appraisals submitted necessitated much reworking by the Ministry (paragraphs 4.10 to 4.22).

The coverage, depth and quality of Ministry guidance to coastal defence agencies has improved significantly since 1985, but it is spread around in a wide range of official guidance notes and quasi-official manuals. There is very little guidance on the evaluation of coast protection works to be undertaken by district councils. The Ministry plan to issue further guidance on the appraisal of schemes during 1992 and to encourage authorities to train staff (paragraphs 4.33 to 4.35).

Authorities have paid attention to environmental impacts in designing coastal defences; but there is scope for developing fuller guidance on environmental aspects of coastal defence work and disseminating it more widely. The Ministry should consider with the relevant authorities ways in which consultation and management procedures could be improved to protect environmental interests.

Since 1988, following implementation of a European Community Directive, the environmental effects of most major projects must be assessed before development consent is granted. Under the legislation, environmental assessment may be required for sea defence but not coast protection works. The government is considering whether specific statutory requirements should be introduced for coast protection works (paragraphs 4.25 to 4.26).

Some National Rivers Authority regions have introduced internal guidelines on good environmental practice and specific guidance on sea defence projects to supplement the more general guidance issued by the Ministry and the Department of the Environment. There may be benefits in making this more widely available. The Department of the Environment plan to produce further guidance on the preparation of environmental statements and on the appraisal of environmental information (paragraphs 4.24 to 4.27).
Environmental matters were for the most part carefully addressed at the design stage of schemes examined but there were some omissions in consultation with relevant environmental agencies. Although authorities took a number of positive measures to maintain or enhance Sites of Special Scientific Interest subsequent procedures failed to prevent damage to some sites. The conservation bodies consulted considered that greater prominence should be given to environmental factors in the design, appraisal and implementation of schemes. Consultation arrangements could also be improved particularly for emergency works. In July 1991 the Ministry announced that they will be instituting periodic reviews of the environmental impact of the coastal defence programme involving the main conservation bodies and representatives of coastal defence authorities (paragraphs 4.28 to 4.32).

General conclusions

7 The current arrangements for coastal defence involve a large number of bodies with different roles and responsibilities. This reflects in part the need to secure an appropriate balance between local choice and central government financial support but is also the result of historical arrangements. There are obvious advantages in operational responsibilities resting at local level, to take full advantage of local opportunities and reflect local circumstances, risks and priorities; but there is a need for more positive action by the Ministry in assessing the achievements of the programme and in providing the various bodies involved with better guidance to ensure the requisite standards of planning, consultation and scheme appraisal.

8 The interrelationship between defences and coastal processes, the greater use of natural defences and the increasing spending on the programme all point to the need for strategic planning and a national lead. The Ministry's recent commitment to a national strategy is therefore welcome. The National Rivers Authority have recognised the need for greater co-ordination and planning and they have set about their task vigorously since their creation in 1989; nevertheless they still have some way to go in bringing together their regions into a coherent whole. But their powers do not extend to coast protection. The Ministry are relying mainly on coastal groups to provide the necessary co-ordination and strategic focus, and will need to keep a close watch on their effectiveness.

9 The statutory distinction between sea defence and coast protection results in differences in treatment and approach. In the Green Paper in 1985 the government recognised the problems inherent in administering two separate statutory codes and favoured an integrated approach to national and local administration and financing of a single category of coastal works. Action was deferred as other legislative changes commanded greater priority. The Ministry consider that these issues have been addressed in part through the transfer of responsibility for coast protection works to the Ministry and more recently with the rationalisation of grant rates. In view of the increasing importance of planning and co-ordination in coastal defence, the growing cost of the programme, the increasing significance of environmental protection and the need to deal with rising sea levels, the development of a national strategy provides a further opportunity to return to these important issues.
Part 1: Introduction

Background

1.1 Many urban and rural areas along the English coastline depend on coastal defences to protect them from flooding or erosion by the sea or tidal waters. These defences take many forms, often used in combination. About a third of the coastline is protected by man-made structures such as sea walls, banks and groynes; other areas are safeguarded by natural features such as sand dunes, beaches and salt marshes but these may require some intervention to provide sufficient protection. Different types of defence are illustrated in Appendix 1.

1.2 The potentially disastrous effects of the failure of defences were clearly illustrated in 1953 when storms hit the East coast of Britain. Defences were breached in over 1,200 places and 300 lives were lost. A more recent reminder of these dangers occurred during the Winter of 1989-90. A series of major storms left South coast defences breached in numerous places and beaches were swept away. A breach of a sea wall at Towyn on the North Wales coast in February 1990 resulted in flooding of 2,800 properties and the evacuation of over 5,000 people. Thus maintaining effective defences can have a major impact in preventing loss of life and reducing commercial, personal and environmental damage.

1.3 Works to protect the English coastline are divided into two categories:

- **Sea defences** (including tidal defences), which protect against the flooding of low-lying areas, are usually built by the nine English regional offices of the National Rivers Authority under the Water Resources Act 1991. Maritime district councils may also carry out sea defence works under the Land Drainage Act 1991, but rarely do so in practice. The Authority also have a general duty of supervision over all sea defences and can act in default of other authorities;

- **Coast protection** works to prevent the erosion of land and encroachment by the sea are built under the Coast Protection Act 1949. These works are usually carried out by the 89 maritime district councils. Other organisations such as harbour authorities, British Rail and private landowners may also carry out both sea defence and coast protection works. The distinction between the two categories of works is blurred since some defences protect against both flooding and erosion. In this Report the term coastal defence is used to describe both types of work.

Allocation of responsibilities

1.4 Prior to 1985 the Department of the Environment were responsible for coast protection and the Ministry of Agriculture, Fisheries and Food were responsible for sea defence. The Ministry assumed responsibility for coast protection in 1985, and now have overall policy responsibility for ensuring the adequacy of coastal defences in England. Operational responsibilities for coastal defences rest with the National Rivers Authority and maritime district councils (Figure 1). The Ministry also fund the Storm Tide Warning Service operated by the Meteorological Office which provides warnings of surge tides. National Rivers Authority regions provide local warnings usually via the police and together with maritime district councils and emergency services are responsible for acting on these warnings. Since the National Rivers Authority was created in 1989, the Ministry have developed a close working relationship with the Authority resulting in joint consideration of many policy and operational issues.

Funding

1.5 The Ministry pay grant towards capital expenditure incurred by the National Rivers Authority and maritime district councils for the construction and improvement of coastal defences. Grant is not available to other owners of defences. Maritime district councils meet their share of capital...
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Figure 1: Responsibilities for sea defence and coast protection in England

<table>
<thead>
<tr>
<th>Policy Responsibility</th>
<th>Ministry of Agriculture, Fisheries and Food</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water Resources Act 1991</td>
</tr>
<tr>
<td></td>
<td>Land Drainage Act 1991</td>
</tr>
<tr>
<td></td>
<td>Coast Protection Act 1949</td>
</tr>
<tr>
<td>Operational Responsibility</td>
<td>Storm Tide Warning Service (operated by Meteorological Office)</td>
</tr>
<tr>
<td></td>
<td>National Rivers Authority (9 regions)</td>
</tr>
<tr>
<td></td>
<td>County Councils</td>
</tr>
<tr>
<td></td>
<td>Maritime District Councils (89)</td>
</tr>
</tbody>
</table>

Warning and information service to National Rivers Authority and local police forces
General supervision for sea defence
Sea and tidal defences
Construction of defences in default of district and county councils

1.6 Grant-aided capital spending on coastal defence in 1990–91 totalled £58 million including £32 million met by Ministry grants (Table 1).

Table 1: Grant-aided capital expenditure* on coastal defence 1990–91

<table>
<thead>
<tr>
<th></th>
<th>Ministry grants</th>
<th>National Rivers Authority</th>
<th>Maritime district councils</th>
<th>Total grant-aided capital expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea and tidal defence</td>
<td>£18</td>
<td>£11</td>
<td>—</td>
<td>£29</td>
</tr>
<tr>
<td>Coast protection</td>
<td>£14</td>
<td>—</td>
<td>—</td>
<td>£29**</td>
</tr>
<tr>
<td>Total £million</td>
<td>£32</td>
<td>£11</td>
<td>£15</td>
<td>£58</td>
</tr>
</tbody>
</table>

Notes: *National data is not readily available for coastal defence capital works undertaken by the National Rivers Authority and district councils without Ministry grant aid, or for revenue expenditure which is not normally eligible for Ministry grant aid. **Includes some district council sea defence schemes.

1.7 Expenditure on coastal defence has increased in the wake of the 1989–90 storms and is planned to rise further to meet the costs of renovating damaged defences and replacing ageing defences on the East coast. Ministry grant has also increased and is expected to exceed £55 million a year by 1994–95. In the longer term expenditure may need to increase further in response to the possible rise in sea levels associated with global warming. In addition the Ministry and the National Rivers Authority spend around £1.5 million a year on coastal defence research.

Government Green Paper

1.8 In 1985 the government produced a Green Paper on the 'Financing and Administration of Land Drainage, Flood Prevention and Coast Protection in England and Wales'. The Green Paper favoured an end to the statutory distinction between sea defence and coast protection. It proposed the integration of the two into a new category of 'coastal works', responsibility for which would lie with the water authorities with the possibility of powers being delegated to district councils in seaside resorts. The Green Paper also discussed alternative financing arrangements for coastal defence. The Green Paper was shortly followed by the transfer of...
responsibility for coast protection from the Department of the Environment to the Ministry (paragraph 1.4). However action was deferred on other matters in the Green Paper with the introduction of the Water Act 1989, which created the National Rivers Authority to take over various functions of the water authorities including sea defence.

1.9 The National Audit Office focused on the work of the Ministry and the National Rivers Authority in relation to coastal defences in England. They examined:

- the performance of coastal defences and the Storm Tide Warning Service (Part 2 of the Report);
- the planning, co-ordination and financing of the coastal defence programme (Part 3); and
- the engineering, economic and environmental appraisal of coastal defence schemes (Part 4).

The examination did not cover inland river defences, which together with sea and tidal defences are included in the term 'flood defence'. Nor did the examination extend to Wales, although the Welsh Affairs Committee's July 1990 Report on the flooding at Towyn, and the government's response to that report, are referred to inasmuch as they are relevant to arrangements in England.

1.10 The National Audit Office interviewed officials and examined papers at the Ministry and the National Rivers Authority, including local offices of the Ministry, and the Authority in Anglian, Southern and North West Regions. A questionnaire was used to obtain information from the National Rivers Authority and maritime district councils on 105 grant-aided coastal defence schemes all of which had been completed since 1985, and 20 of these schemes were examined in greater detail (Appendix 2). A team of economists and engineering and environmental consultants* examined current guidance on the appraisal of schemes and carried out an in-depth review of eight schemes. The National Audit Office agreed the scope and methods of their examination with the Ministry. In addition the National Audit Office sought the views of a wide range of national and local organisations involved in coastal defence (Appendix 3).

* The team comprised Posford Davviers Engineering and Environmental consultants, Professor D W Pearce (Economist, University College, London), Mr R K Turner (Economist, University of East Anglia) and Dr C Newbold (Environmental consultant).
Part 2: Performance of coastal defences and the Storm Tide Warning Service

Background

2.1 Coastal defences are generally built to last for many years—for example, a sea wall may have an expected life of 50 years or more. Defences must therefore be regularly inspected and maintained so as to perform effectively throughout their life.

2.2 Coastal defences are designed to alleviate but not eliminate all risks of flooding or erosion and may not provide full protection against extreme weather events. The Meteorological Office therefore operate a Storm Tide Warning Service, under the general direction of the Ministry, to provide early warning of high surge tides. These warnings are relayed to the National Rivers Authority regions and local police so that the risk of flooding can be assessed in the light of expert local knowledge and action taken locally to ensure the safety of people and prevent or minimise possible damage.

2.3 The National Audit Office examined:

- the information available on the state of repair of coastal defences;
- the arrangements for assessing the performance of coastal defences; and
- the operation of the Storm Tide Warning Service.

State of repair

2.4 All agencies responsible for coastal defences need up to date information on their general state of repair to ensure that they are maintained in good condition and to identify and prioritise necessary works. Assessment of the residual life of individual defences is also important in planning future repair and replacement programmes.

2.5 The National Audit Office found that prior to 1991 the information available nationally on the state of repair of coastal defences was fairly limited and often out of date. The last major review was carried out in 1980 when a Department of the Environment survey examined the extent, adequacy and general state of repair of coast protection works. The survey concluded that the condition of defences varied but for the most part they were in a sound condition. It also noted that defences had been built or were planned in the near future for virtually all areas requiring protection. However, the survey and the associated maps were produced in a format which could not be readily updated; and there had been no subsequent reviews or reassessments to revise or re-evaluate the 1980 data. At a local level individual district councils often record and monitor the state of repair of their own defences.

2.6 In addition water authorities (which were responsible for sea defences prior to the creation of the National Rivers Authority) were required under the Water Act 1973 to carry out regional surveys of their coastal defence works. However, these surveys largely comprised a register of identified problems rather than an assessment of the state of repair of the defences; and most surveys were originally prepared 10 to 15 years ago, although some regions had updated them periodically. Following the flooding at Towyn in 1990 the Authority found that much of the basic data on the ownership, length and location of sea defences was out of date.

2.7 Recognising the inadequacies of existing data and in the light of a statutory requirement in the Water Act 1989, the Authority in 1990 embarked on a survey of all sea defences in England and Wales. Each region carried out their own survey in accordance with nationally-set criteria. The survey was, however, based on visual inspection and...
assessments of the condition of defences because time constraints did not permit a more detailed assessment of structural capability. Each defence was broken down into its separate 'elements', for example walls, embankments, groynes. The survey of the Authority's own sea defences showed that:

- almost one-sixth of elements were in need of significant or moderate works or replacement, although half of these elements were groynes or other structures which were ancillary to the main defences (Figure 2); and
- one-sixth of elements had a residual life of five years or less.

2.8 There were also significant differences between Authority regions in the condition and the residual life of their sea defences. For example:

- although the proportion of elements requiring significant or moderate works ranged between 9 and 17 per cent for most regions, Severn Trent reported that none of their defences needed such works compared with 41 per cent in Yorkshire (Figure 3); and
- the proportion of elements with a residual life of five years or less ranged from seven per cent in Anglian to 72 per cent in Yorkshire (Figure 4).

Whilst the percentage length of defence at risk would be a better measure of the condition of defences, the Authority's survey method did not permit such an analysis. It is nonetheless reassuring that the region with the highest percentage of elements in a poor condition (Yorkshire) is also the region with the shortest length of defences.

2.9 Interpretation of the survey results is not straightforward. For example, assuming defences have an average life of 50 years and a steady pattern of construction over the years one could expect that on average around ten per cent of elements would have a residual life of five years or less, but the survey showed an average of 17 per cent. The survey results may reflect the damage sustained in the 1989–90 storms and the fact that many defences built in the wake of the 1953 floods are approaching the end of their useful lives. However, neither the Authority nor the Ministry have set any standards or benchmarks against which the results of the survey might be judged, nationally or regionally.

Figure 2: Condition of National Rivers Authority sea defences in England

Note: The survey and its results are based on an examination of the separate elements of each defence, for example, walls, embankments, groynes.
Figure 3: National Rivers Authority sea defences in need of significant or moderate works, by region

<table>
<thead>
<tr>
<th>Region</th>
<th>Total defence length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severn Trent</td>
<td>31 km</td>
</tr>
<tr>
<td>South West</td>
<td>23 km</td>
</tr>
<tr>
<td>Wessex</td>
<td>43 km</td>
</tr>
<tr>
<td>North West</td>
<td>69 km</td>
</tr>
<tr>
<td>Northumbrian</td>
<td>8 km</td>
</tr>
<tr>
<td>Anglian</td>
<td>363 km</td>
</tr>
<tr>
<td>Southern</td>
<td>144 km</td>
</tr>
<tr>
<td>Yorkshire</td>
<td>12 km</td>
</tr>
</tbody>
</table>

Percentage of defence elements needing significant or moderate works

Average 16%

Note: The survey and its results are based on an examination of the separate elements of each defence, for example: walls, embankments, groynes.

Figure 4: National Rivers Authority sea defences with a residual life of 5 years or less, by region

<table>
<thead>
<tr>
<th>Region</th>
<th>Total defence length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anglian</td>
<td>363 km</td>
</tr>
<tr>
<td>South West</td>
<td>23 km</td>
</tr>
<tr>
<td>Severn Trent</td>
<td>31 km</td>
</tr>
<tr>
<td>North West</td>
<td>69 km</td>
</tr>
<tr>
<td>Wessex</td>
<td>43 km</td>
</tr>
<tr>
<td>Northumbrian</td>
<td>8 km</td>
</tr>
<tr>
<td>Southern</td>
<td>144 km</td>
</tr>
<tr>
<td>Yorkshire</td>
<td>12 km</td>
</tr>
</tbody>
</table>

Percentage of defence elements with a residual life of 5 years or less

Average 17%

Note: The survey and its results are based on an examination of the separate elements of each defence, for example: walls, embankments, groynes.
2.10 The Authority subsequently asked each region to review their future maintenance and capital programmes. Particular attention was to be given to the:

- 16 per cent of elements classified as in need of significant or moderate works;
- 5 per cent of elements with a residual life of less than two years; and
- 22 per cent of elements rated as high priority for refurbishment due to the low standard of protection they provided.

The three regions visited by the National Audit Office (Anglian, Southern and North West) confirmed that they had reviewed and adjusted their medium-term plans in the light of the survey results. The Authority also expect all regions to ensure that their survey data is kept up to date.

2.11 During 1991, the Authority instigated further surveys of local authority and privately or corporately owned sea defences, which account for around one-third of all sea defences in England. British Rail carried out a separate survey of their own defences and the findings have been included in the survey results for privately or corporately owned defences. Although the proportion of defence elements with a residual life of five years or less was similar for the three groups (National Rivers Authority, local authority and privately or corporately owned) the condition of defences varied markedly. Eight per cent of local authority defence elements were in need of significant or moderate works compared with 16 per cent for the National Rivers Authority and 35 per cent for private or corporate owners (Figure 5).

2.12 Although a large proportion of privately or corporately owned defences were in a poor condition, the Authority subsequently found that many of these defences protected small areas of low grade rural land. The inter-related nature of coastal defences means that weaknesses in defences under one group of owners may adversely affect the operation of defences elsewhere. The Authority are

![Figure 5: Condition of National Rivers Authority, local authority and privately or corporately owned sea defences in England](chart)


Note: The survey and its results are based on an examination of the separate elements of each defence, for example: walls, embankments, groynes.
therefore now reporting the survey's findings to all owners, and discussing programmes of upgrading where the condition of defences is deemed inadequate. They also embarked on a survey of tidal defences in England in June 1991.

2.13 The surveys set in hand in 1990 and 1991 are important steps in providing the Ministry and the Authority with much needed information at national and local level on the state of repair of sea defences, enabling comparisons to be made of the condition of defences in different regions as a basis for effective forward planning and prioritisation of projects and decisions on the future scale and allocation of funds.

2.14 The National Rivers Authority surveys do not however include coast protection works as these fall outside the Authority's general duty of supervision for sea defence. The Ministry have recognised the need for similar information on coast protection works, but have yet to decide how and when this will be obtained.

Assessing performance of coastal defences

Evaluation arrangements

2.15 The Ministry currently publish a number of indicators for the flood defence and coast protection programme, for example the number of new schemes, the area of land and number of properties protected, and length of defences improved. However, these are indicators of activity and work done: there is no management information available nationally which seeks to assess the operational performance or effectiveness of coastal defences. The Ministry have generally relied on their fifteen regional engineering staff to monitor the problems faced and results achieved in the management of the coastal defence programmes in their respective regions.

2.16 In 1989 the Treasury asked the Ministry to carry out an evaluation of their flood defence and coast protection programme. The Ministry proposed two main ways of assessing achievements against their objective of ensuring that defences provide adequate protection:

- the proportion of coastline adequately protected, with adequacy assessed using target standards of protection. However the Ministry have not decided how to establish target standards of protection; and
- past performance of schemes by comparison of the cost, life, benefits and standard of protection achieved against those envisaged at the time the scheme was designed. This was to be addressed through post-project appraisal of individual schemes.

2.17 The Ministry and the Treasury discussed the evaluation proposals in December 1991 and agreed that these needed to be developed further prior to implementation. In the National Audit Office's view there is a clear need to introduce better measures to evaluate the performance and results of the coastal defence programme. Their absence is a significant gap in current arrangements and hinders effective management and targeted effort. Evaluation arrangements should be agreed and implemented as a matter of urgency.

Analysis of incidents

2.18 Since 1989-90 the National Rivers Authority have published annual data on major flooding incidents although the data do not distinguish between inland and coastal flooding. Reports of incidents by regions enable the Authority to maintain an overview of the incidence and impact of flooding in those areas for which they are responsible. The Ministry seek to maintain a general overview of major flooding incidents but do not collect comprehensive data on flooding or erosion incidents. They regard these as an unreliable measure of coastal defence performance because:

- the number of incidents and the extent of flooding or erosion will depend on the severity of the weather. Some years bring relatively few threats, whereas others pose far greater risks; and
- some degree of flooding or erosion may be entirely consistent with the design standard of the defence, and therefore incidents need to be viewed against the intended level of protection, which will vary locally.
Immediately after the last major storms in 1989–90 the Ministry carried out a broad assessment of the extent and cost of damage to defences. They estimated this to be around £30 million, with possible longer term costs of £30 million or more to replenish beaches. A later and more detailed survey of the damage sustained in these 1989–90 storms carried out by the Institution of Civil Engineers revealed:

- damage to defences in six National Rivers Authority regions and 46 district councils in England;
- incidents of flooding in many of these authorities due to breaches or overtopping of defences and damage to over 80 walls, banks and other structures;
- erosion damage to 16 kilometres of cliffs mainly on the South coast and damage to almost 100 kilometres of beaches; and
- considerable damage to roads, land, property and possessions.

The Ministry considered that these results were broadly in line with their earlier assessment.

The Ministry have not investigated whether defences performed better or worse than expected in these storms. But in view of the widespread damage to beaches on the South coast, the Ministry set up a study to examine the causes of damage and the measures and information needed to guide the future use and management of beaches.

The National Audit Office’s examination suggested that there would be benefits in building up a national record of incidents of flooding and erosion. Although such information would need to be treated with caution it is of major public interest and would, together with other available and proposed measures, provide a valuable analysis over time of the success of coastal defences nationally and in individual regions. The Ministry’s study of the cause of damage to beaches and remedial action needed is an important move in this direction, but the widespread flooding and damage sustained in the 1989–90 storms underlines the need for wider and more structured assessment of the performance of defences.

Protection targets

The National Rivers Authority generally design defences to protect against a storm with the risk of recurrence which is cost-effective and commensurate with current land use. They are developing national target standards of protection based broadly on land use and the likely scale of damage from flooding. The targets, which are currently at the draft proposal stage, will generally provide for greater protection for urban areas than for rural areas (Table 2).

<table>
<thead>
<tr>
<th>Land use band</th>
<th>Target standard of protection (based on expected frequency of storm event)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A mainly urban</td>
<td>100–200</td>
</tr>
<tr>
<td>B less dense urban</td>
<td>50–200</td>
</tr>
<tr>
<td>C isolated urban</td>
<td>10–100</td>
</tr>
<tr>
<td>D mostly agricultural</td>
<td>2.5–20</td>
</tr>
<tr>
<td>E predominantly agricultural</td>
<td>less than 5</td>
</tr>
</tbody>
</table>

Note: *Defences are built to protect against a storm event of a particular magnitude, quoted in terms of the storm’s expected frequency. A ‘1 in 200’ years event would refer to a storm whose magnitude might be expected to occur once in every 200 years on average.*

Whilst the Authority’s standards of protection currently relate to maintenance of rivers they are looking to extend the concept to sea defences, although no timetable has been set. The Authority plan to assess the adequacy of defences by comparing actual levels of protection against these target standards. The Ministry are reviewing the Authority’s approach to target standards of protection and expect to issue guidance later in 1992 to help provide a systematic basis for planning defence works. The work will be a fundamental part of their policy evaluation arrangements (paragraphs 2.16 and 2.17). The National Audit Office consider that the introduction of target standards is a useful initiative to assess the adequacy of defences and as a broad basis for planning future defences. The rigorous application of standards to individual projects may produce a result different from that generated through the economic valuation of costs and benefits (see Part 4). The Ministry and the Authority have yet to resolve this potential area of difficulty.
Post-project appraisal

2.24 Treasury guidance on economic appraisal stresses the importance of post-project appraisal in providing feedback on performance achieved, particularly with a view to improving the appraisal, design, management and implementation of future projects. In the absence of any central assessment of the performance of coastal defences, the National Audit Office examined the extent to which projects were reviewed locally.

2.25 The eight schemes examined by the National Audit Office's consultants generally appeared to be in a good state of repair and four schemes had been tested by major weather events and survived well. None of the schemes had been subject to post-project appraisal although authorities took account of past experience on schemes in their approach to future works (Appendix 4).

2.26 Although the National Rivers Authority regions visited by the National Audit Office considered the general impact of storms in terms of the extent and cause of flooding and damage to defences and the need for future remedial work, there were no systems of post-project appraisal in place to examine the performance of individual defences against the severity of events experienced, design criteria and the intended standard of protection. Nor did regions carry out any formal review of the causes of cost and time overruns on projects (paragraph 4.22) or problems arising in the design and construction of schemes, although past experience did influence the choice and approach to future works. The Ministry told the National Audit Office that experience on schemes was also the subject of wider debate at the Ministry's annual conference of river and coastal engineers. The Authority plans to introduce post-completion appraisal procedures in 1992-93.

The Storm Tide Warning Service

2.27 The Storm Tide Warning Service was set up in the wake of the 1953 floods to provide warnings of high surge tides on the East coast. It was extended to provide an information service to the West coast in 1978 and the South coast in 1984. The Ministry are responsible for the overall management and co-ordination of the Service but rely on the Meteorological Office for its day to day operation.

2.28 The Service issues primary warnings of surge tides to the National Rivers Authority regions and county police forces on the East coast. The regions consider the warnings received in the context of local information on tides, winds and waves; assess the risk of flooding; and issue secondary flood warnings as appropriate to the local police. Similar arrangements operate for the West and South coasts but the Service provides information rather than formal warnings due to technical limitations in the surge model and atmospheric forecasts for those areas.

2.29 In all areas it is the role of the police to relay flood warnings to local authorities, other emergency services and the general public. In 1990-91 the Service issued 32 initial warnings of surge tides for the East coast with danger levels being reached on 14 occasions. They also issued alerts on six occasions for the West and South coasts.

Organisation of warning systems

2.30 Prompt communication of warnings is essential and all parties involved in warning systems need to be fully aware of the procedures to be followed, the basis on which warnings and information are issued and of the links with the other parties involved. In July 1990 the Welsh Affairs Committee Report on the flooding at Towyn drew attention to the need for the National Rivers Authority offices to be open to take and relay information as soon as it is received from the Service and for all organisations responsible for major sea defences to be involved in the warning systems. The Committee also pointed to delays in the transmission of warnings to district councils by the local police in North Wales. They considered that the involvement of so many agencies in the transmission of warnings was a recipe for delay and recommended that the National Rivers Authority assume sole responsibility for disseminating warnings to councils and other bodies responsible for sea defences.

2.31 In response to the Committee's Report, the government pointed out that the National Rivers Authority were setting up 24-hour control rooms in all regions; the emergency
services had been alerted at the earliest possible time at Towyn and that there was no formal flood warning service for the North Wales coast. The government also reconfirmed the key role of the police. They considered that the Authority should concentrate on monitoring of storm conditions and emergency action and that the police were better equipped to handle communications with councils.

2.32 The Ministry update the procedural instructions for the operation of the Storm Tide Warning Service annually. In 1990 they undertook a fundamental review and in September 1990 issued revised instructions which provided a step-by-step guide to the provision of warnings and information by the Service and formalised arrangements for the West and South coasts. In August 1991 the instructions were updated further and issued to all organisations participating in the warning systems.

2.33 At the National Rivers Authority regions they visited, the National Audit Office noted that:

- Anglian Region had issued guidelines on the provision of local flood warnings and operated a 24-hour control centre. The Region issued warnings direct to all district councils and other major owners of defences, as well as to the police. The Anglian Coastal Authorities Group told the National Audit Office that district councils received warnings from the police but these sometimes appeared to be out of date;

- North West Region had also issued guidelines and had introduced a 24-hour control centre. The Region had clarified responsibilities for relaying warnings to all relevant district councils and other major owners. They reported few problems with onward transmission of warnings by the police to district councils. The Region had retained responsibility for contacting other major owners; and

- Southern Region made use of the 24-hour facilities provided by Southern Water Services at the time of the National Audit Office visit, but subsequently introduced a fully integrated regional emergency control system in September 1991. The Region had also to update their guidelines for two of their three divisions but issued these revised guidelines in January 1992. Regional staff were also unclear about the extent of the Region's role in issuing warnings for areas at risk other than those involving its own defences. The police were responsible for relaying warnings to district councils. Several councils had reported late or non-recpt of warnings, and despite efforts by all parties involved some problems remained. The Region also expected the police to contact other major owners, but these arrangements had not been formally confirmed.

2.34 The National Audit Office noted that problems with transmission of warnings had also been reported in some other regions. In response to concern about local variations in the handling of flood warning systems, the National Rivers Authority launched a national review of their flood defence emergency procedures in September 1991. At the same time the Authority reminded Chief Constables of the responsibilities of the police in relaying warnings.

Reviewing performance

2.35 The National Audit Office found that the Storm Tide Warning Service had responded positively to problems raised by regions. In the three regions visited:

- Anglian were the only major user of the East Coast Warning Service. The Region had occasionally experienced late receipt of warnings and inaccurate surge tide prediction during 1989 and 1990. They had taken up these problems with the Service and now considered that the system worked well; and

- North West and Southern Regions used the information service for the West and South coasts respectively. Both Regions were largely satisfied with the Service, but pointed to the technical constraints faced by the Service in providing sufficiently accurate and timely data to facilitate fully effective local warning systems particularly for the South coast. North West Region were reviewing the scope for more specific local warnings for tidal flooding.

The National Audit Office noted that the Ministry and the Service expected further improvement in forecasts following the introduction in Spring 1991 of improved atmospheric forecasting and surge models.
2.36 The Ministry told the National Audit Office that the main procedures for reviewing the performance of the Storm Tide Warning Service were through an annual report of activities provided by the Service and occasional feedback from the National Rivers Authority. A Ministry internal audit report on the Service in July 1991 concluded that although the annual reports did review the completeness and accuracy of East coast warnings, an assessment of the timeliness of information and of the performance of the service to the South and West coasts were also needed. Internal audit also recommended a more formal Ministry annual review of the Service's activities. In the National Audit Office's view such a review would also provide a focal point for decisions on how the Service could be improved so as to meet national priorities and users' needs. The Ministry have yet to decide whether to introduce further performance measures, but intend to introduce more formal reviews of the Service.

2.37 The National Audit Office recommend that, when this work has been taken further, the Ministry should consider publishing an annual report on the Service, with key performance data. As well as enhancing public accountability for the Service's activities this would also help to underline the inter-relationships between its work and the other organisations involved in coastal defence.
Part 3: Planning, co-ordination and financing of coastal defences

3.1 Effective coastal defences require an integrated approach. Defences can have long-term and sometimes irreversible effects on the surrounding environment. They may also affect the natural coastal processes which operate along substantial lengths of coast and across many administrative boundaries. It is therefore essential that the coastal defence programme is both well planned and co-ordinated. The National Audit Office examined:

- how the programme is planned including the extent to which plans take into account sea level rise;
- how the various agencies responsible for coastal defence co-ordinate their plans and activities;
- the operation of planning controls in flood risk areas; and
- the impact of financing arrangements on the planning of coastal defences.

Planning of the coastal defence programme

Ministry planning

3.2 There is no plan or other document which fully sets out an agreed forward strategy for the coastal defence programme. The Ministry believe they have in place the main components of a strategy although these have yet to be brought together into a strategic framework. In December 1991 the Minister announced plans to develop a national strategy for flood and coastal defences. Several of the organisations consulted told the National Audit Office that there was a need for a national strategic framework for sea defence and coast protection works within which individual defences could be considered; some envisaged that this should be incorporated within a wider strategy for use of the coastal zone.

3.3 In the absence of a fully developed and published strategy, the Ministry have sought to influence the size and content of the coastal defence programme by:

- setting broad priorities for the programme;
- advising on the content of authorities’ forward plans;
- setting a limit on the amount of expenditure which will attract Ministry grant aid; and
- appraising individual schemes before providing grant aid (dealt with in Part 4 of this Report).

3.4 In 1985 the Ministry established broad priorities for the sea defence component of the coastal defence programme; these priorities were intended to give greater emphasis to the protection of people and urban property rather than protection of agricultural land. Protection of urban areas was already the dominant feature of coast protection works. The Ministry have pursued these priorities mainly through the liaison between their regional engineers and the authorities, particularly when authorities submit their forward programmes and put forward individual schemes for grant aid.

3.5 The Ministry have not regularly or systematically monitored achievements against these priorities, although they do review each year the number of properties and area of agricultural land protected by new schemes. In 1990 the Ministry confirmed that less than 40 of the 270 flood defence schemes approved (which include sea defence) for grant between 1987 and late 1990 afforded protection to agricultural land alone. The majority of schemes provided urban benefits alone. The National Audit Office’s own analysis also showed an increase since 1986–87 in the proportion of sea and tidal defence schemes providing urban protection. The shift in priorities agreed in 1985 was therefore being carried through in practice.
3.6 A main feature of the Ministry's planning is to determine the future funding for coastal defence, based upon the medium-term plans and expenditure profiles submitted to them in an agreed format by the National Rivers Authority and maritime district councils. Whilst the Ministry do not issue instructions or guidance to the Authority or councils on the content of these plans and profiles the Ministry's regional engineers review them in the light of their local knowledge of problems and their assessment of the capacity of the agencies to carry out their proposed programmes. They also assess the priority of each scheme taking into account the Ministry's priorities, need, urgency and economic benefits. The Ministry subsequently set limits on the expenditure which will attract grant aid for each region.

3.7 The National Audit Office noted that the quality and depth of local plans are variable (paragraphs 3.8 to 3.10). For example, the Ministry's 1991-92 allocation of £4 million to the National Rivers Authority's North West Region was based on a medium-term plan of £4.5 million. However the plan included all works regardless of the Region's capacity to carry them out, and a number of projects which would not be eligible for grant aid; as a result the Region subsequently expected to incur only £2.4 million grant eligible expenditure. The Ministry have transferred the surplus allocation to other regions. A number of district councils and coastal groups consulted by the National Audit Office expressed concern at the lack of current guidance on national planning and priorities; however others considered that the annual Ministry conference on coastal defences provided a useful lead on policy changes, priorities and national developments. The Ministry informed the National Audit Office that they intend to improve planning by publishing a national strategy for coastal defence and building on existing guidance to operating authorities.

Planning by the National Rivers Authority

3.8 The National Rivers Authority have already recognised that their flood defence programme (which includes sea, tidal and river defences) needs greater planning, coordination and national direction. They are therefore developing and plan to publish a national Flood Defence Strategy for implementation from April 1992. Action already underway for improving coordination includes:

- a national survey of the condition of the Authority's and others' sea defences (paragraph 2.7);
- development of common standards of protection, for application throughout the regions (paragraph 2.23); and
- development of a national system of planning and prioritisation (paragraph 3.9).

This will provide a national framework for decisions on regional programmes. The greater uniformity of practice and management information which will result from these initiatives should also provide a basis for improved performance measurement.

3.9 All National Rivers Authority regions produce a medium-term plan showing estimated expenditure on individual schemes for five years ahead. In 1990 the Authority found that few regions used any formal system of prioritisation for capital works and that there was a need for better screening of projects before they were included in medium-term plans. The National Audit Office noted too that the quality of planning varied significantly at the three regions visited:

- Anglian Region, which accounts for almost 40 per cent of the Authority's expenditure, had taken a number of valuable steps to improve their planning since 1988-89. The Region had prepared a 10-year Statement of Needs in which each scheme was given a priority and urgency ranking. Their medium-term plan was based on the higher priority and urgent schemes only, taking into account manpower available and the likely financial resources available from both the Ministry and county council levies. The Region have also sought to develop, through their Sea Defence Management Study (paragraph 3.22), a technically sound and regionally coherent management strategy for their coastline; and

- Southern Region and North West Region did not operate formal systems for establishing priorities: problems and schemes were identified and priorities determined largely by local staff. Their medium-term plans were mainly reactive and reflected projects inherited from the former water authorities and major works
needed in the wake of the storms of 1977 (North West Region) and 1989-90 (Southern Region). North West Region had, however, undertaken a broad survey of their defence problems in 1989 as a basis for more forward-looking planning.

The Authority intend to introduce 10-year 'needs' plans for all regions and a national system for setting priorities for flood defence works during 1992-93.

Planning by district councils

3.10 District councils are responsible for shorter stretches of the coastline and therefore face a less extensive range of difficulties than National Rivers Authority regions. The Ministry nevertheless consider that planning is generally less well-developed in district councils, and has tended to be driven by the more immediate problems arising from storm events or ageing defences. However, this approach was beginning to change, with a number of councils seeking to develop longer term plans for the management of defences.

Sea level rise

3.11 One factor which could have serious implications for the planning of coastal defences is the effect of climate change, or global warming, on the sea level and the severity of storms. The most authoritative estimates of sea level rise are those of the Intergovernmental Panel on Climate Change. The Panel estimate the most likely rise in global mean sea level to be about 20 centimetres by the year 2030 assuming that few or no steps are taken to limit greenhouse gas emissions. The Ministry's first predictions of sea level rise were formulated in 1989 before the Panel reported but are broadly similar.

3.12 Whilst acknowledging the longer term prospect of sea level rise, the Ministry's policy, developed in 1989, has been that defences should be constructed to meet current assessments of risk; but designs are expected to be flexible so that defences can be raised if future forecasts confirm that higher protection is needed. Policy and best practice are to be kept under review as understanding of sea level trends, waves, surges and weather patterns develops. The Ministry have now adopted the Panel's best estimate for the present and combined it with regional modifications for earth crustal movements to form the basis of allowances for the design of coastal defences ranging from four to six millimetres a year.

3.13 The Ministry plan to increase spending on their flood and coastal defence research and development programme from £2.4 million in 1991-92 to £2.6 million in 1992-93. About half of this funding is committed to projects connected with climate change and its effects. They also set up an expert advisory committee in January 1991 to advise on the strategy for the future research programme. The committee have recommended a number of priority areas for research including the development of appropriate responses to climate change. They also identified the need for more effective dissemination of research findings by the Ministry and the National Rivers Authority in part by providing manuals of good practice.

3.14 The National Rivers Authority follow the policy set by the Ministry. They seek to ensure that designs are flexible and design defences to a level which allows for the most likely rate of global sea level rise, where this can be economically justified. Many of the interested bodies consulted by the National Audit Office in September 1991 expressed concern over the absence of guidance given to district councils on the implications of climate change for coastal defence works. The Ministry issued guidance for district councils on regional allowances for sea level rise in November 1991.

3.15 Several environmental agencies consulted were concerned that sea level rise posed particular threats to coastal habitats. They consequently saw a need for national guidelines to ensure that more strategic options for coastal defence are considered. Such options would include moving lines of defence further inland and allowing some coastal areas to retreat naturally.

Co-ordination between coastal defence agencies

3.16 In England, there are around 160 organisations which can undertake coastal defence works. And many other bodies, such as environmental groups and planning authorities, have an interest in the development and use of coastal areas. Co-ordination between coastal defence
agencies is particularly important because of the impact of defences on the processes which shape the coast, such as the erosion of cliffs and the movement of sand and shingle, which frequently operate across administrative boundaries. The effective use of 'soft' defences such as sand dunes relies heavily on such processes and consequently may require greater co-ordination and co-operation between the relevant authorities.

3.17 The adverse impact that defences can have on neighbouring parts of the coast, and the need for a co-ordinated approach, is illustrated by examples such as:

- at Hurst Spit in Hampshire, the County Council consider it almost certain that the increasing rate of erosion and consequent breaches of the spit in recent years are due mainly to the construction of concrete sea walls and groynes further to the west in Christchurch Bay, which interrupted the natural drift of replenishing material;

- at Hastings a gap had to be created in a solid concrete groyne to allow shingle to pass through and replenish the beaches which provide protection for cliffs further along the coast.

3.18 A number of agencies have expressed concern over the years that the division of responsibilities between so many different bodies has led to a piecemeal approach to coastal defence and inhibits a wider strategic view:

- the Welsh Affairs Committee, in their Report in July 1990 on the flooding at Towyn recommended that a single authority, the National Rivers Authority, be designated to ensure the co-operation of all bodies involved in coastal defences. In response, the government considered that the Authority already had sufficient powers for this purpose: for sea defences they have a general supervisory duty, they must consent to all other sea defence schemes before grant aid is provided and may act in default of other owners. The Authority's powers do not extend to coast protection although they must be consulted on all significant coast protection works;

- in 1991 the Nature Conservancy Council (now English Nature) published a report on Nature Conservation and Estuaries in Great Britain. They found that the management of estuaries was often fragmented as these were usually the boundaries between administrative areas. For example, the Humber Estuary is covered by 14 different local authorities; and

- a number of district councils and other organisations consulted by the National Audit Office saw a need to rationalise and clarify responsibilities. Nevertheless, many councils wished to retain some responsibility for coastal defence because of its impact on local tourism and amenities.

3.19 Under the Coast Protection Act 1949 the Minister has powers to establish a coast protection board covering more than one authority to protect coastal areas, but this procedure has never been used nor requested. However the authorities responsible for coastal defences have appreciated the need for greater liaison and have set up 'coastal groups' to improve co-ordination.

3.20 Most coastal groups have been set up over the last five years, some as recently as 1991, and they now cover the vast majority of the defended coastline (Figure 6). The main aims of such groups are to:

- seek a co-ordinated approach to all coastal engineering works by member authorities;

- reduce the risk of works adversely affecting the neighbouring coastline; and

- improve their understanding of coastal processes.

Several organisations consulted also envisaged an important role for coastal groups in developing long term strategies for the management of defences and the coast in their areas.

3.21 Coastal groups work on an entirely voluntary basis, since they have no statutory powers or standing. Several coastal groups consulted by the National Audit Office considered they needed a more formal role, with co-ordination and funding from central government.

3.22 The ability of coastal groups to improve co-ordination of coastal defences also depends on the availability of better information on the coastal processes in their area. The most comprehensive examination of coastal processes to date is that carried out on the
**Figure 6: Coastal groups in England**
(National Rivers Authority regions in italics)

- **North East Coastal Authorities Group**
  - Created November 1991
  - 6 agencies

- **River Ribble to Morecambe Bay Coastal Group**
  - Created February 1988
  - 10 agencies

- **Llandudno to Mersey Estuary Coastal Group**
  - Created May 1988
  - 8 agencies

- **Cornwall Coast Protection Advisory Group**
  - Created December 1990
  - 7 agencies

- **Devon Coast Protection Advisory Group**
  - Created October 1991
  - 8 agencies

- **Standing Conference on Problems Associated with the Coastline**
  - Created October 1986
  - 20 agencies

- **East Sussex Coastal Group**
  - Created September 1990
  - 8 agencies

- **Holderness Coast Protection Project**
  - Created April 1983
  - 2 agencies

- **Kent Coastal Group**
  - Created November 1990
  - 7 agencies

- **Anglian Coastal Authorities Group**
  - Created May 1987
  - 13 agencies

- **East Anglian coast by the National Rivers Authority. The study took four years to complete at a cost of £1.6 million and was grant-aided by the Ministry. All relevant agencies have been involved in this study and have access to the information produced. In other parts of the country data has been collected on a less comprehensive basis and often at the initiative of individual bodies although some coastal groups have sought to collect common data on defences and coastal processes.**

3.23 In September 1991 the Ministry set up a Coastal Defence Forum to further cooperation between parties responsible for coastal defences, identify research needs and promote strategic planning of coastal defences. The Forum includes representatives of the National Rivers Authority and all coastal groups and expects to meet every six months. This initiative has been welcomed by coastal groups.
Planning controls in flood risk areas

3.24 New housing or industrial developments in a flood risk area can have major implications for the standards of coastal defence required. As defences are improved to protect existing development, this encourages more development and thus increases the levels of risk and possible need for further defences. Guidance issued jointly by the Ministry and the Department of the Environment in 1982 advised planning authorities to consult the relevant water authority (now the National Rivers Authority) when development was proposed in a flood risk area.

3.25 However, there has been concern that the present guidance and practice of authorities does not adequately address flood risks, for example:

- the Welsh Affairs Committee in their Report in July 1990 on flooding at Towyn recommended that the 1982 guidance to planning authorities should be re-issued; and

- a meeting of coastal groups in July 1990 considered that the guidance was not strong enough and that planning authorities were often reluctant to turn down planning applications despite the consequences for coastal defences.

3.26 All three National Rivers Authority regions visited by the National Audit Office had publicised their policies of general opposition to development in flood risk areas unless developers are required to carry out the necessary protection works. But the level of co-operation between planning authorities and the Authority varied:

- in Anglian Region co-operation was good; the Region are consulted on all planning applications and there are regular meetings with local authority planning departments;

- North West Region had not experienced major problems in consultation with planning authorities in coastal areas, but were seeking to improve liaison generally through wider publicity of their policy; and

- Southern Region considered that local authorities did not always consult them on relevant developments in flood risk areas. They had well-defined procedures for liaising with local authorities in Kent and were planning to extend these to the rest of the Region.

The National Rivers Authority considered that planning authorities should at planning approval stage, require developers to commit themselves to contribute to schemes which protect new developments.

3.27 Following the flooding at Towyn, the Department of the Environment undertook to review the 1982 guidance. They expect to issue updated guidance during 1992 which will deal with, amongst other things, defining flood risk areas where development will be discouraged.

3.28 In response to concern about the effects of sea level rise and the increasing costs of defences, some county councils have sought to establish exclusion zones whereby further development will not be permitted in flood risk areas. However it is the district councils which have responsibility for deciding planning applications and thus whether to support such policies in making planning decisions.

3.29 In recent years there has been growing pressure for a national policy or strategy for the management of coastal areas, including coastal defence works. For example, the Marine Conservation Society and the Royal Society for the Protection of Birds have both suggested that a central government unit should be set up to co-ordinate marine and coastal management.

3.30 The Department of the Environment are conducting a review of more general planning policy for coastal areas and expect to issue draft guidance for consultation in Spring 1992. In addition, the Select Committee on the Environment are carrying out an inquiry into planning in the coastal zone, and their report is expected in early 1992.

Impact of financing arrangements

3.31 The greater part of capital expenditure on coastal defences is financed from central government funds, through Ministry grants and indirectly through the Revenue Support Grant to local authorities, taking account of their income from the associated community charge and redistribution of business rates.
The partial funding of coastal defence expenditure through the Revenue Support Grant system means that such works compete with the many other services provided by local authorities, and are subject to the wider controls exercised over local government spending.

3.32 The Ministry aim, through variable grant rates, to provide higher grant support on schemes where local needs are high and resources are low. The system is set out in more detail in Appendix 5. The 1985 Green Paper, as noted in paragraph 1.8, discussed alternative financing arrangements such as fixed Ministry grant rates or the allocation of block grants to authorities to finance approved programmes of works instead of scheme-specific grants, but the system has remained largely unchanged.

3.33 In each National Rivers Authority region, flood defence committees approve the forward programme of works and the associated levy on county councils. In six regions levies are raised by a region-wide committee, but in Anglian, Southern and Wessex Regions this responsibility lies with the committee for each district within the regions. Subject to certain statutory exceptions the levy raised by each committee in respect of each district may only be used to fund the Authority's flood defence function in or for the benefit of that district. Consequently these arrangements do not ensure that funds are spent on higher priority works viewed for the region as a whole. For example, within Anglian Region lower priority works were being carried out in one district whilst higher priority works were deferred elsewhere.

3.34 Authority officials reviewed these arrangements in 1990 and concluded that the system of local committees had in some instances caused problems where schemes required funding in excess of the realistic means of the committee involved, and that there could be a need for greater flexibility in the use of funds to meet top priority works. They therefore advised regions that there could be advantage in decisions on programmes and funding being taken by regional committees with local committees having advisory status. However, statutory power to change the committee structure rests with the regional flood defence committees and committee arrangements have remained unchanged in Anglian, Southern and Wessex Regions.

3.35 Although the National Rivers Authority and district councils are responsible for coastal defences, county councils play a key role in financing the local costs incurred on schemes. They are obliged to contribute towards the cost of coast protection schemes carried out by district councils. They are also represented on each of the National Rivers Authority's flood defence committees and pay levies to the Authority.

3.36 In the National Rivers Authority regions visited by the National Audit Office, the financial impact of the proposed levies for 1991–92 on county councils was a matter of considerable debate within flood defence committees. Nevertheless the National Audit Office found that this concern did not appear to have a major effect on spending nationally in 1991–92: the actual levies set by committees of around £157 million were just two per cent below the levy forecast used by the Ministry and the Department of the Environment in setting the national Standard Spending Assessment for flood defence.

3.37 Several bodies consulted by the National Audit Office also pointed to increasing concern amongst county councils at their lack of control over funding demands falling upon them to meet district council schemes. The National Audit Office noted that although county councils are required to make statutory contributions towards the expenditure incurred by district councils for coast protection work, the level of contribution is for agreement between the councils involved; but only one disputed case had been submitted to the Ministry for determination since they took over responsibility for such work in 1985. However, since April 1990 there have been instances of counties and districts failing to understand the significance of the new local government financial arrangements for the level of contribution from county councils. The Department of the Environment have suggested to authorities that the simplest solution is for county councils to make only token contributions to the cost of schemes. This is because districts now receive Supplementary Credit Approvals to the value of non grant-aided capital expenditure, and their Standard Spending Assessments include...
an element to cover the capital financing costs: the token contribution from county councils will be reflected in the Standard Spending Assessment for coast protection so long as it is recorded in the appropriate return supplied to the Department of the Environment each year.

3.38 Prompted by their concerns about the continued willingness of county councils to fund their share of the costs of growing programmes of work the National Rivers Authority sought clarification from the Ministry on the financing of coastal defence through Revenue Support Grant. In November 1990 the Ministry and the Department of the Environment issued a joint statement on the treatment of coastal defence expenditure in Revenue Support Grant calculations, which provided some assurance that increased local spending would be reflected in future years’ Standard Spending Assessments and Revenue Support Grants. The Ministry did not seek to provide a full explanation of the system or circulate this to individual district and county councils in view of the general guidance already provided to local authorities by the Department of the Environment on the operation of the Revenue Support Grant and Standard Spending Assessments.

3.39 A number of organisations consulted also expressed concern at the complexity of the financing system, particularly:

- the treatment of coastal defence expenditure in Revenue Support Grant calculations; and
- the varying rates and conditions of Ministry grant aid.

3.40 Several district councils and other groups suggested to the National Audit Office that the Ministry’s grant arrangements needed to be simplified, possibly by introducing a single category of coastal defence works and a rationalisation of grant rates. The Royal Society for the Protection of Birds advocated a complete overhaul of grant rates, with much better targeting of funds to works which satisfy defined national priorities. From April 1992 the Ministry intend to reduce the 15 different grant rates currently used for coast protection works to five and align these with the rates available for sea defence.

3.41 In recent years there has been increasing recognition that natural or ‘soft’ defences such as beach renourishment may be used either in place of or to supplement hard defences such as sea walls. Such defences are likely to require greater and more frequent maintenance — such as the annual recycling of shingle — than is needed for traditional hard defences. However, grant aid is only available on initial works and subsequent replenishment of initial works — for example, after five years or a major storm event — but not for annual maintenance. Several district councils expressed views to the National Audit Office that the lack of grant aid for high-cost or large-scale maintenance works, discouraged the use of ‘soft’ defence solutions to coastal defence problems.

3.42 The problem of funding beach maintenance was highlighted after the 1989-90 storms where many beaches were severely depleted, particularly along the South coast, with the costs of repair estimated at least £30 million over five years. In 1991 the Ministry reviewed whether the grant arrangements provided sufficient encouragement to authorities to carry out desirable beach management. They concluded that these works should be eligible for grant aid and are now seeking Treasury approval to this change.
**Part 4: Engineering, economic and environmental appraisal of coastal defence schemes**

**Background**

4.1 National Rivers Authority regions and maritime district councils seeking grant aid for works must generally obtain prior approval from the Ministry. To be eligible for grant aid authorities must demonstrate that schemes are technically sound, economically worthwhile and environmentally sympathetic. To this end, scheme proposals include an economic appraisal, which evaluates the costs and benefits to demonstrate whether the scheme is economically worthwhile. In carrying out their appraisals, the Authority and the councils are expected to follow guidelines issued by the Ministry.

4.2 The Ministry scrutinise scheme proposals, including the economic appraisal to ensure they meet Ministry criteria, and make revisions where necessary before approving grant aid. Schemes costing over £6 million also require Treasury approval. Schemes financed solely from local funds or paid for by private landowners are generally exempt from detailed Ministry scrutiny although all such coast protection schemes require approval.

4.3 Although prior approval is not required for emergency works carried out under the Coast Protection Act, for example following major storms, Ministry approval is required before grant aid is provided. In each of the last five years, more than 30 per cent of coast protection schemes, representing 15 per cent by value, have been classed as emergency works (paragraph 4.31). Such schemes are not subject to the usual consultation and appraisal procedures but they must meet basic technical, economic and environmental criteria. For sea defence, the Ministry allows the cost of significant emergency works to be included in subsequent schemes coming forward for grant aid which will be appraised in the usual manner, but emergency works not forming part of a scheme are not eligible for grant aid.

4.4 The National Audit Office set out to examine whether scheme appraisals and evaluation procedures:

- incorporated a sufficiently strategic perspective;
- considered all practicable options;
- identified and correctly valued all relevant costs and benefits;
- paid due regard to uncertainty; and
- gave proper attention to environmental considerations.

As part of their examination the National Audit Office commissioned an external team of specialist economists and engineering and environmental consultants (paragraph 1.10) to assess whether the guidance available to authorities was sufficient to ensure satisfactory standards of appraisal and to carry out an in-depth examination of eight grant-aided schemes. The schemes selected were completed after 1985 and were approved for Ministry grant aid between 1985 and 1988 with the appraisals being mainly carried out in the early 1980s. A summary of the consultants' conclusions on these eight schemes is at Appendix 4. Their full report has also been made available to the Ministry and the National Rivers Authority.

**A strategic perspective**

4.5 Coastal defence works can have a major impact on other parts of the coast and on the surrounding environment. In addition, individual schemes may form part of much larger projects over a long period where the benefits can only be fully realised after the whole project is complete. In these
circumstances it is unlikely that the component schemes can sensibly be appraised in isolation. These two factors underline the importance of taking a more strategic view, both geographically and over time, in identifying options and appraising schemes.

4.6 For sea defence schemes the Ministry can give 'agreement in principle' to large schemes which are to be carried out over a long period by a series of contracts. In these circumstances agreement in principle would be on a programme of works lasting up to five years. The costs and benefits of the whole programme are appraised at the outset although each phase of the programme must still be vetted for engineering and environmental soundness. However, the Ministry do not have the statutory power to give agreement in principle to coast protection schemes. Agreement in principle allows authorities to take a longer term view, although the five year horizon may fall short of that needed for full strategic planning.

4.7 In recent years the Ministry have recognised that the most appropriate solution to some coastal problems may require very long-term programmes of works sometimes extending over large sections of the coastline. They have therefore introduced the concept of strategy plans, with the benefits and costs of such long-term programmes assessed at the outset, and individual works separately considered for approval in the context of the agreed programme. Strategy plans have to date been within a single authority's boundaries, but this may change with one cross-boundary plan currently under consideration within the Ministry. Existing agreement in principle arrangements will nevertheless continue to play an important role in the regular monitoring of progress and continued relevance of sea defence schemes.

4.8 Two of the schemes examined by the National Audit Office formed part of long-term strategy plans (Table 3). The Ministry have taken some time fully to develop their approach to these strategy plans. Although the cost of the project stages involved in each strategy exceeded the Ministry's delegated limit of authority of £6 million, the Ministry did not seek Treasury agreement until 1990—more than three years after the strategies were put forward by the authorities concerned and after major works had already started on each project. This delay was in part caused by uncertainty within the Ministry on the appropriate handling of these kinds of cases.

4.9 Although the Treasury have now agreed to the principle of strategy plans they have yet to approve these two cases. As noted in Table 3, in both cases the Treasury expressed reservations on the lack of full evaluation of a range of options for such large-scale programmes of investment. In both cases the Ministry and the authorities involved are giving further consideration to these issues.

Table 3: Strategy plans for Morecambe and for Lincolnshire

<table>
<thead>
<tr>
<th>Morecambe</th>
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<tr>
<td>Following major flooding in 1977 and 1983, Lancaster City Council planned to improve Morecambe's coastal defences through beach renourishment and improvements to existing sea walls. In 1987 the Council submitted proposals for a £12.9 million programme of works over the next 10 to 12 years.</td>
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<tr>
<td>The Ministry considered the strategy to be sound but would not commit themselves to a 10- to 12-year programme. The first two phases costing £3.5 million were approved as separate schemes, but relied heavily on the economic justification for the strategy as a whole.</td>
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<tr>
<td>In May 1990 the Ministry sought Treasury approval for an updated strategy which included works arising from the 1989-90 storms.</td>
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<tr>
<td>Treasury did not give approval due to concern over the inadequate consideration of options and insufficient clarity over the level of protection being sought.</td>
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Lincolnshire

- In May 1986 Anglian Water Authority sought Ministry approval for a 30-year programme of replacement works along the Mablethorpe-Skegness coast costing £35 million. Subsequent individual schemes were approved in line with this overall strategy.
- In September 1990 the Ministry sought Treasury approval to an updated strategy costing £116 million to £179 million over 50 years.
- Treasury agreed to the strategy approach in principle, but did not approve this strategy due to the inadequate consideration of options in the appraisal.
- Anglian Region of the National Rivers Authority have commissioned a study to consider alternative, more strategic options for protecting that length of the Lincolnshire coastline.
Identification of options

4.10 The Ministry’s guidance requires authorities to identify and consider all feasible options to solve the problem, including the consequences of doing nothing. The review of schemes by the National Audit Office and their consultants revealed that although most appraisals considered alternative options, few were evaluated in depth and the ‘do nothing’ or ‘do minimum’ option was rarely considered. In general, only the preferred engineering option was fully evaluated. For example, of the eight schemes reviewed by the consultants (Appendix 4):
- only one fully considered alternative engineering options;
- six gave limited or inadequate consideration and one gave no consideration to alternative options;
- only three schemes gave adequate consideration to the consequences of doing nothing;
- in all schemes there was limited consideration of the cost effectiveness of different standards of protection; and
- in one scheme a more strategic approach could have significantly influenced the range of options available.

As a result, authorities submitted schemes that were acceptable by engineering and economic criteria, but which were not necessarily the most cost-effective solution.

4.11 The National Audit Office also noted that the Treasury had over the years expressed dissatisfaction with the standard of appraisals on some of the schemes submitted to them for approval by the Ministry, especially in respect of the identification and evaluation of options. Although Treasury guidance emphasises the need to evaluate a range of options, this is not adequately reflected in Ministry guidance to the Authority or district councils.

Valuation of costs and benefits

4.12 The Ministry require that schemes demonstrate a predicted benefit-cost ratio of one or greater to qualify for grant aid. Of the 295 grant-aided schemes approved since 1986 for which data is available, 30 per cent had a predicted benefit-cost ratio of two or less; and around one per cent had a ratio of less than one (Figure 7). However, these ratios must be treated with some caution because they are largely based upon tangible costs and benefits only and, as described in the following paragraphs, the National Audit Office examination revealed both under- and over-estimation of costs and benefits in scheme appraisals.

4.13 Although a predicted benefit-cost ratio of one may demonstrate that the scheme concerned is economically worthwhile, it does not establish that it is the most cost-effective solution. The Treasury have advocated that benefits must be estimated as precisely as possible and a range of options should be presented using benefit-cost ratios and net present values (reflecting the difference between costs and benefits after discounting) to compare worth particularly for high-cost, long-term strategies. However, only one of the eight schemes reviewed in depth by the consultants and two of the 20 schemes examined by the National Audit Office had been selected and approved on the basis of a range of options evaluated using net present values. The National Audit Office found that the full benefits were rarely identified once a predicted benefit-cost ratio of one had been reached. The Ministry should encourage greater use of net present values, alongside benefit-cost ratios, to compare alternative solutions.

4.14 In the schemes examined in depth by the National Audit Office’s consultants, authorities made a number of omissions and errors in their valuations of costs and benefits (Appendix 4):
- maintenance costs were wrongly excluded for three schemes;
- discounting techniques were applied correctly on only two of the eight schemes;
- property damage was generally well addressed but recreational, traffic or services benefits were not adequately assessed in any of the schemes;
- there was confusion over the treatment of benefits to local tourism and caravan sites;
- significant problems arose with double-counting of benefits for one scheme; and
agricultural benefits featured in three of the schemes but were properly assessed in only one case.

Similar problems arose on the 20 schemes examined by the National Audit Office.

4.15 Intangible costs and benefits — for example, certain environmental or amenity impacts, the risk to life or the health and social effects of stress resulting from flooding are not quantified easily. Treasury guidance, whilst acknowledging the difficulties, emphasises the importance of attributing monetary values to such impacts wherever possible. In the schemes reviewed by the consultants these factors were often not considered at all and rarely quantified. Although most schemes already had an acceptable predicted benefit-cost ratio based on tangible benefits alone, on two of the schemes the Ministry assessed the benefit-cost ratio at less than one, but approved the schemes on the basis that there were offsetting intangible benefits; however these and other environmental benefits and costs were not quantified.

4.16 The National Audit Office recognise that techniques for measuring environmental impacts are better established than at the time of appraisal for the schemes examined. The Department of the Environment have recently published guidance on principles for identifying and quantifying environmental impacts in policy appraisal for use by government departments and the wider public sector.

4.17 The Ministry’s regional engineers test the robustness of scheme appraisal results by excluding any dubious or intangible benefits and confirming that schemes can be justified on tangible benefits alone. In 11 of the 20 schemes reviewed by the National Audit Office, the Ministry’s regional engineers, after reworking the benefits assessments, reduced the benefit-cost ratios estimated by the authorities, sometimes drastically.
4.18 It is difficult to say, without a great deal of further time and effort, just how critical the shortcomings in the evaluation of tangible and intangible costs and benefits were to the economic evaluation and justification of the schemes examined, although the amounts in question could have been considerable. Nevertheless, what is clear is that the valuation of costs and benefits has presented substantial problems for practitioners; that standards of evaluation are very variable; and that the extent and nature of errors and omissions have necessitated much reworking by the Ministry.

4.19 The National Audit Office concluded that current guidance to authorities does not provide sufficient advice to practitioners in both the identification and evaluation of the full range of assets at risk from flooding and erosion and need to be further developed, particularly in respect of the measurement of intangible costs and benefits. Such guidance could usefully be backed up by further training programmes for practitioners.

Environmental considerations

4.20 Uncertainty is often a key consideration in evaluating coastal defence projects because they aim to protect against rare but potentially catastrophic events. The valuation of benefits and costs which are subject to uncertainty may be highly sensitive to changes in key assumptions, such as those on water levels and erosion rates. The usual tool for dealing with uncertainty in economic appraisals is sensitivity analysis, which tests how far appraisal results are affected by changes in key assumptions. This helps to establish the degree of confidence that may be placed on the results of the appraisal and highlights those variables which have a crucial effect on the calculations and may therefore need further investigation.

4.21 In the schemes examined in depth by the National Audit Office's consultants there was a significant lack of sensitivity testing on such uncertainties as extreme water levels, erosion damage, construction costs and the expected take-up of agricultural benefits. Only one of the schemes examined adequately applied the principles of sensitivity analysis to benefits. Although Ministry guidance stresses the need to test the sensitivity of engineering and hydraulic data it does not refer to the need for sensitivity analysis on social and economic factors and climatic change predictions which can be equally important in determining appraisal results.

4.22 The need for sensitivity analysis is underlined by for example, the wide variation between authorities' at-tender estimates and the final cost of schemes. Responses to the National Audit Office's questionnaire revealed differences ranging from cost underruns of 34 per cent to overruns of 94 per cent, although 45 per cent of schemes had a cost outturn within five per cent of estimate (Figure 8). Although cost overruns may indicate weaknesses in project control, they are also caused by factors which are largely beyond the control of authorities, for example, adverse weather and unexpected site conditions.
4.25 Following implementation of a European Community Directive in 1988, environmental assessment must be undertaken for most major projects whether public or private which are likely to have significant environmental effects, before development consent is granted. In such cases the developer must prepare and submit an environmental statement setting out the developer’s own assessment of the likely environmental effects. The statement must be publicised and sent to statutory consultees, and the statement and any representations from consultees and the public must be considered by the local planning authority or other decision taking body.

4.26 In accordance with the Directive and the United Kingdom implementing regulations, environmental assessment is required for sea defence works where they are judged likely to have significant environmental effects. Environmental assessment is not required for coast protection works although the government is considering whether such a requirement should be introduced. Meanwhile, the Ministry consider that environmental interests should be safeguarded through local authorities’ consideration of environmental effects in planning permission procedures and their own approval arrangements for all coast protection works.

4.27 The Department of the Environment have produced general guidance about environmental assessment procedures and to help local planning authorities decide when an environmental statement is required. They also plan to produce guidance on good practice in the preparation of environmental statements and to develop further guidance on the appraisal of environmental information.

4.28 The schemes reviewed by the National Audit Office’s consultants were not subject to formal environmental assessment because construction was underway or completed before the relevant legislation was introduced. Nevertheless, environmental matters were for the most part carefully addressed at the design stage, although there were some problems with consultation procedures. For example, the Countryside
Commission had not been consulted on any of the schemes reviewed. This was particularly significant in one case where an open vista across a salt marsh was destroyed. And in 30 per cent of the sea defence schemes covered by the National Audit Office’s questionnaire, authorities had not consulted environmental bodies at the appraisal stage even though the Ministry strongly advise that they should do so.

4.29 Sites of Special Scientific Interest featured in five of the schemes reviewed. Although authorities took a number of positive measures to maintain or enhance these sites, particularly during scheme design, subsequent procedures failed to prevent damage in some schemes:

- there was damage to a site between Deal and Sandwich after changes in land use, following the announcement of a sea defence scheme, delayed the setting of site boundaries. The Nature Conservancy Council (now English Nature) were unable to put in place management agreements with farmers to remedy the problem; and
- at Pilling and Cockerham, and at Herne Bay, the failure of contractors and authorities to keep to agreements resulted in damage to sites.

In contrast, the Anglia Region of the National Rivers Authority had taken particular care to conserve salt marsh and mudflats and generally protect the Sites of Special Scientific Interest affected by schemes.

4.30 The conservation bodies consulted considered that there was a need for national and regional strategies to give due emphasis to environmental protection and that authorities should give greater prominence to environmental factors in the design, appraisal and implementation of schemes. English Nature saw the consultation mechanisms as a helpful but not complete solution since they had to concentrate their resources on prime conservation sites.

4.31 Nevertheless, English Nature considered that consultation had improved greatly over recent years, although there was room for further improvement in consultation by district councils. For example, emergency coast protection works are not subject to the normal consultation procedures, although authorities are advised to inform English Nature of such works within a Site of Special Scientific Interest as soon as possible. English Nature told the National Audit Office that the lack of consultation on emergency works undermined the effectiveness of environmental safeguards and considered that timetables for most emergency works would permit some measure of consultation. The National Audit Office noted that in each of the last five years over 30 per cent of grant-aided coast protection schemes, representing 15 per cent by value, were emergency works (Figure 9).

4.32 To promote greater environmental awareness at national level, the Ministry announced in July 1991 that they would be instituting periodic reviews of the environmental aspects of the flood and coastal defence programme; the first meeting was held in December 1991 and involved the main conservation bodies, including English Nature and the Countryside Commission and representatives of coastal defence authorities.

Coverage and quality of guidance

4.33 The National Audit Office recognise that the appraisals for the schemes examined were mainly carried out in the early 1980s. Since 1985 the Ministry have, through research, interim guidelines and associated training programmes, improved the coverage, depth and quality of guidance available to authorities on the appraisal of coastal defence projects. However, the existing guidance has been issued in a wide range of official guidance notes and quasi-official manuals; and many of these, particularly those issued before 1985, are inconsistent and do not address in detail the specific problems generated by coastal defence schemes. Guidance is particularly needed on the evaluation of coast protection works undertaken by district councils, although this was partly remedied by interim guidelines issued in 1987.

4.34 Some regions of the National Rivers Authority had developed guidance for their own use aimed at achieving a more consistent and structured approach to scheme appraisal. However, such guidance varied from region to region and in some cases ran...
Figure 9: Proportion of coast protection works classified as emergency works 1986–87 to 1990–91

Source: Ministry of Agriculture, Fisheries and Food.

counter to guidance issued by the Ministry, particularly in respect of determining the most appropriate flood defence standards.

4.35 The Ministry plan to issue further guidance to authorities on the appraisal of coastal defence schemes during 1992 and to encourage authorities to train staff. The guidance will incorporate the results of research commissioned by the Ministry in 1986 and is expected to cover the main principles of appraisal and the assessment of coastal defence benefits, including amenity and environmental benefits.
Appendix 1
Examples of coastal defence works


2. Sea defence at Manningtree, Essex. A tidal embankment with concrete blockwork upper revetment and rip rap revetment at the toe of the bank.

3. Coast protection at Bournemouth. A beach recharge scheme where sand dredged from the entrance to Poole Harbour is pumped ashore through a floating pipeline to provide a wider, higher beach.
4. Sea defence at Clacton, Essex. Two fishtail-shaped rock groynes act to reduce the loss of the recharged beach through longshore drift.

5. Sea defence at Pevensey Bay, East Sussex. A series of traditional wooden groynes help to retain the recharged beach.

6. Coast protection at East Cliffe, Herne Bay. Rock armour placed at the base of the cliffs to retard erosion. In the distance a sea wall and series of groynes provide the coastal defence.

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4. Shephard Hill Civil Engineering Ltd.
5. David Bowie Photographic.
6. Posford Duvivier Engineering and Environmental consultants.
Appendix 2
Schemes reviewed by the National Audit Office and their consultants

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<tr>
<th>Scheme</th>
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<tr>
<td>Lion Point Breakwater</td>
<td>National Rivers Authority (Anglian)</td>
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<tr>
<td>Heybridge Tidal Defences Stage 2</td>
<td>National Rivers Authority (Anglian)</td>
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<td>Kings Lynn Tidal Defences Stage 2</td>
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<tr>
<td>Kings Lynn Tidal Defences Stage 7</td>
<td>National Rivers Authority (Anglian)</td>
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<tr>
<td>Tidal Mattress J</td>
<td>National Rivers Authority (Anglian)</td>
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<td>River Bure Erosion Control Work</td>
<td>National Rivers Authority (Anglian)</td>
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<tr>
<td>South Breydon Wall Stage 1</td>
<td>National Rivers Authority (Anglian)</td>
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<td>Mablethorpe-Skegness Part 14 Phase 2</td>
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<td>Willop Outfall Renovation</td>
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<td>Pagham Harbour Revetment</td>
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<td>Bolton-Le-Sands Sea Defence</td>
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<td>East Pier Watchet Sea Defences</td>
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<td>Caister Sea wall Phase 2</td>
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<td>Town Hall Breakwater Phase 1</td>
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<td>Southshore Baths Sea wall</td>
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<td>West Somerset District Council</td>
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<td>Great Yarmouth Borough Council</td>
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<td>Waveney District Council</td>
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</tr>
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<td>Worthing Borough Council</td>
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<td>Lancaster City Council</td>
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Appendix 3
Organisations consulted by the National Audit Office

River Ribble to Morecambe Bay Coastal Group
Tidal Dee Users Group
Llandudno to Mersey Estuary Coastal Group
Devon Coast Protection Advisory Group
Cornwall Coast Protection Advisory Group
Standing Conference on Problems Associated with the Coastline
East Sussex Coastal Group
Kent Coastal Group
Anglian Coastal Authorities Group
Holderness Coast Protection Project

Ministry of Defence
The Crown Estate
British Railways Board
Institution of Civil Engineers
Association of District Councils
Association of County Councils

Countryside Commission
English Nature (formerly Nature Conservancy Council)
The National Trust
Royal Society for the Protection of Birds
Council for the Protection of Rural England
### Appendix 4

Summary of findings on schemes examined by the National Audit Office’s consultants

<table>
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<tr>
<th>Key</th>
<th>Scheme type - sea defence (SD) or coast protection (CP)</th>
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<th>South West</th>
<th>North West</th>
<th>Anglian</th>
<th>Tyne</th>
<th>Dee</th>
<th>Severn-Bath</th>
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<td>Initial grant approved cost estimate (£ million)</td>
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<td>1.63</td>
<td>1.26</td>
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**Performance**

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**Identification of costs and benefits**

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**Valuation of costs and benefits**

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**Environmental matters**

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**Sites of Special Scientific Interest**

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**Notes:**
1. Benefit-cost ratio for the comprehensive scheme, no separate ratio for the individual scheme examined.
2. Schemes were approved for Ministry grant aid between 1985 and 1988, with the appraisals being mainly carried out in the early 1980s.
3. The sea defence schemes were appraised, submitted and managed by Southern, North West and Anglian Water Authorities, prior to the creation of the National Rivers Authority in 1989.
Appendix 5
Financing of coastal defence expenditure

Expenditure plans
The National Rivers Authority and maritime district councils assess local needs and submit capital expenditure plans to the Ministry each year. These plans form the basis of the Ministry’s annual bid to Treasury for coastal defence grant funding and for the locally financed element to be funded via the Revenue Support Grant mechanism.

Allocation of Ministry grants
The Ministry control National Rivers Authority grant-aided expenditure by setting an annual grant earning ceiling for each region which limits the expenditure that will attract grant aid in the year. The regions then submit schemes for approval within their total grant earning ceiling. District council expenditure on sea defence and coast protection is not controlled on such a local basis — schemes are approved individually within the total grant provision available to the Ministry. The Ministry also set grant rates for each Authority region or district council ranging from 35 per cent to 85 per cent which aim to provide higher grant support where needs are high and local resources are low.

Local financing
The residual capital costs of grant-aided schemes, the costs of all non grant-aided schemes and all revenue expenditure are financed from local funds:

- National Rivers Authority spending is funded primarily from levies on the county councils;
- for district council grant-aided schemes the Ministry issue supplementary credit approval at the same time as grant is approved, to give the council borrowing powers to fund the residual capital costs.

All local costs of coastal defence are financed ultimately through the local authority Revenue Support Grant and associated Community Charge arrangements. These local costs (including the costs of borrowing) are reflected in Standard Spending Assessments for local authorities: Revenue Support Grant is paid to district councils to enable all authorities (including county councils) to spend at the level of their Standard Spending Assessment while setting the same Community Charge for standard spending in all areas after taking account of income from the business rate. The financing of capital expenditure on coastal defence is shown in the diagram overleaf.
Financing of capital expenditure on coastal defence

Notes:  
* District councils may also undertake sea and tidal defence works.
** County councils precept on all district councils in their area under normal local government financing arrangements.

Payment and accounting for Ministry grant

The Ministry pay interim grant claims up to a total of 95 per cent of the approved cost of each scheme:

- for sea and tidal defence schemes, grant may be paid in advance based on quarterly estimates of approved expenditure;
- for coast protection schemes, grant is only payable in respect of actual expenditure.

The balance of grant is payable on submission of the final audited account for the scheme.

Ministry grant expenditure is disclosed in the Ministry's annual Appropriation Accounts (Class III, Vote 4). Local expenditure is accounted for in the National Rivers Authority Annual Accounts and local authority Statements of Accounts.