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# Coastal Water Surveillance Strategy

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ENVIRONMENT AGENCY

**Information Services Unit**

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# 1. Introduction

## 1.1 Purpose

This document proposes a strategy for long term coastal water surveillance. It is designed to effectively and efficiently monitor the state of the coastal water environment, meet all Business Needs, and comply with relevant Environment Agency (EA) policy and duties.

## 1.2 Background

The Environment Act (1995) requires the EA to carry out its duties using a holistic and integrated approach in order to protect and enhance the environment. This management philosophy will enable the Agency to effectively assess and report on the state of the environment and to contribute, as guided by Ministers and Government towards the national aim of achieving Sustainable Development.

This strategy is therefore designed to comply with this management approach. It assesses coastal water quality using a scientifically robust method incorporating both statutory and UK/internationally obligations for marine monitoring, together with our surveillance duties necessary to report on the state of the marine environment. It will therefore enable not only the effect of pressures on the marine environment to be assessed but also the way in which quality is influenced by, for example the application of legislation and national and local policy. Consequently this strategy should enable the Agency to address questions such as : -

- What is the fate of contaminants entering coastal waters from estuaries around England and Wales ?
- What are the benefits of, for example the Urban Waste Water Directive (91/271/EEC) and Nitrate Directive (91/676/EEC) on coastal water quality and are these benefits sustainable ?
- What are the benefits of Integrate Pollution Control (IPC) on discharges to coastal waters ?
- How will this strategy enable the EA to comply with the likely requirements of the EU Framework Directive ?

## 1.3 Strategy Development

The strategy has been developed following a review of the coastal water surveillance programme and is built on top of statutory and national/international commitments. Selected locations are therefore representative of coastal water quality for defined lengths of coastline. They include all coastal water Dangerous Substances National Network Sites which are designed to assess environmental concentrations of List 1 substances and the National (Marine) Monitoring Programme (NMP) sites which assess the impact of estuaries on coastal waters. The selected locations form the basis for future monitoring and are designed to enable the state of the coastal water environment

and the impact of major quality issues to be assessed.

## 2. Key Objectives

The key objectives of the strategy are to :

- (i) establish and periodically report the quality of coastal waters around England and Wales ;
- (ii) identify long term spatial distribution and temporal trends of chemical and biological quality;
- (iii) establish and maintain a classification system compatible with others in the UK and European Union ;
- (iv) provide information to develop and implement the needs of new legislation and policy ;
- (v) provide background information to improve the understanding of processes in the coastal environment;
- (vi) provide Value For Money by providing simple, meaningful, measures of environmental assessment and the potential cost of improvements.

## 3. Overall Philosophy

The monitoring programme is based on sound science and reliable data to understand environmental variability, and assess trends. The strategy requires the implementation of :

*a surveillance programme* of coastal waters to assess the quality of water, sediment and biota at defined locations along the coastline of England and Wales.

This format will provide a robust scientifically based strategy which, additionally will defray criticism of the UK for insufficient understanding of the coastal water environment.

The strategy should meet the objectives and enable the Environment Agency to :

- "form an opinion of the general state of pollution of the environment" {Environment Act (Section 5.2b)} ;
- demonstrate full implementation of its duties and responsibilities in coastal waters ;

- satisfy internal and external requests for general assessment of coastal water quality ;
- understand trends in water quality to enable targeting of for example, remedial measures ;
- provide good historic information to underpin future investigations into the behaviour of specific compounds ;

To achieve the objectives the surveillance programme will : -

- apply standard national methodologies ;
- provide high quality data ;
- ensure continuity of monitoring over time ;
- provide comprehensive spatial coverage which is representative of a defined area ;
- be consistent with other schemes, for example the NMP, established MAFF off-shore waters programme, European Environment Agency (EEA) policy and recommendations from the EEA Marine Topic Centre in Italy ;
- identify new locations and additional parameters to be monitored.

## **4. The Strategy**

### **4.1 The National Coastal Baseline Survey**

#### **4.1.1. Introduction**

This section outlines the recommended revisions to the National Coastal Baseline Survey required to improve the monitoring of coastal waters in England and Wales. The recommendations build on the work of the original baseline survey, which operated from 1991 until present, with further modifications based on the results of case studies carried out during 1996.

The section outlines the background to the original coastal baseline survey, before describing the refined approach. The development of a holistic monitoring programme is discussed. Options for carrying out the proposed revisions are made, and the cost of these proposals described.

#### **4.1.2. Background**

The coastal zone of England and Wales represents a key environmental and economic resource. Some 40% of the manufacturing industry and 26% of the population are sited close to the coast, which will directly affect the water quality of this region. Moreover, wider uses are now being made of coastal waters, particularly in terms of increased

recreation. This will increase pressures on environmental resources, for example the 10% of protected reserves found within the coastal zone (DoE, 1996).

The coastal environment is highly dynamic both temporally and spatially. A baseline survey of water quality must therefore account for this variability in its design and implementation. The high variability means the collection of limited samples will not provide any indication on the health of the coastal environment as a whole.

The National Coastal Baseline Survey has been in operation from 1991 to 1997, under both the National Rivers Authority and the Environment Agency. This survey represents the most intensive survey of the coastal waters of England and Wales carried out to date, and the results will provide an important input to an assessment of coastal water quality over these years (State of the Pollution of the Coastal Environment, 1998).

In 1996 the coastal baseline survey was modified as an interim measure to include just two ship-based baseline surveys with limited sampling. Modifications were the removal of the requirement for both continuous aerial surveillance and the collection of underway data between laboratory sample sites. As an addition to the standard baseline, a number of sites were studied intensively in a grid pattern to investigate spatial variability around baseline sampling sites.

The results from these grid surveys have been analysed to investigate their implications for the continuation of the baseline survey (Reid *et al.*, 1997). This study noted that the design of the grid surveys did not allow full consideration to be applied to the effects of spatial or temporal variability. A refined design to the grid survey was recommended which involved duplication of sampling at the baseline sampling site within the grid to indicate the level of temporal variability experienced during the survey.

Reid *et al.* (1997) also considered the temporal resolution of the baseline survey itself. This was found to be low, with moreover, a long duration period for the completion of each individual survey. Sampling at not longer than monthly intervals was considered to be necessary to provide full information on temporal variability within the full coastal zone.

Spatial variability was found to be high in each of the grid sites surveyed, with data collected at the baseline site within the grid not being representative of the whole grid. The grid sites showing highest spatial variability, measured in both the continuous track and from laboratory samples, were found to be close to estuarine inputs. Consideration should be given to the positioning of baseline sampling sites away from such inputs.

Further case studies were carried out to investigate the way in which aerial surveillance could be best used to support future baseline surveys (Environment Agency, 1997 *a & b*). The key results of these case studies was that aerial surveillance could be used to provide accurate spatial maps of both chlorophyll-*a* and suspended solids concentration. In both cases remote sensing techniques were found to have the same accuracy for estimating laboratory measurements as *in-situ* optical techniques such as fluorometry and transmissometry.

Calibration of CASI imagery for suspended solids concentration requires the production of site specific algorithms which may be applied within this area at different dates, removing the requirement for intensive *in-situ* sampling. Calibration of CASI imagery for chlorophyll-*a* concentration, however, requires the collection of simultaneous *in-situ* data, but a robust procedure for calibration has been established.

The recommendations from the case studies have allowed the revision of the baseline survey. The revised survey will build on the results of past surveys, whilst using new technologies to enable the collection of spatially and temporally more intense data from the coastal zone.

Two important modifications to the existing survey will be proposed. Firstly the revised survey will concentrate on coastal water quality, away from the influences of estuarine inputs and individual discharges. The estuarine effects will be considered as a separate survey. Some estuarine sites will, however be investigated, these being the outer NMP sampling sites to further the integration of these two surveys.

Secondly, the revised survey will not concentrate solely on water chemistry but will have a more holistic approach including the collection of biological and sedimentological data. This will enable the baseline survey to contribute more fully to an assessment of the state of pollution of the environment according to the Viewpoints on the Environment (Environment Agency, 1997 c).

#### 4.1.3. Survey Objectives

The revised baseline survey will be a fully integrated survey of the coastal zone of England and Wales, investigating the chemical and biological water quality in four dimensions. The survey will take full consideration of both the spatial and temporal variation within this environmentally important, yet highly dynamic region.

This refined survey will provide information on the state of pollution of the coastal environment. With reference to the Viewpoints on the Environment (Environment Agency 1997c) the survey will provide input into the following:

- **Key biological populations, communities and biodiversity**

Collection of benthic samples from buoy sites will provide information on this

- **Compliance with environmental standards and targets**

The data collected will provide an indication of baseline water quality against which to compare measurements taken in areas of higher anthropogenic influence

- **The health of the environment**

Biological effects measures eg. Oyster Embryo Bioassay

Indications on the presence of algal blooms and regions of eutrophic waters from calibrated aerial surveillance

- **Long term reference sites**

The buoy sites will be established as long term reference sites, with standard measurement protocols allowing comparison over time.

The results of the baseline survey will be reported annually, within six months of the end of the intensive survey phase for each littoral cell. This will allow timely inclusion of the results into State of Environment Reporting.

#### 4.1.4. Survey Plan

##### **Moored Instrumentation Packages**

A recommendation of the analysis of the grid surveys (Reid *et al.*, 1997) was that to fully investigate temporal variability a moored system should be used, which would allow the collection of continuous data.

Instrumentation has been developed at the National Centre for Environmental Data and Surveillance to allow the collection of temporally continuous physical and water quality data at remote systems. This system, Proteus, also consists of a buoy development which is suitable for use in estuarine environments.

In order to provide the robustness required for use in the coastal zone the instrumentation must be deployed on larger buoys. It is proposed that the instrumentation be deployed on buoys owned by Trinity House. In addition to the physical security offered by the size of these buoys they have the added advantage of being protected from tampering by law.

The purpose of monitoring with these buoys is to provide small scale temporal variability of coastal baseline water quality. It is important, therefore that they should be sited as far as possible from estuarine inputs. This means that the variability being measured would be an integrated effect of terrestrial inputs and offshore processes.

Consideration has been given to the number of moorings required to provide a baseline of water quality. The coastal zone has been divided into eleven sections based on the flow of littoral sediment (HR Wallingford, 1993). These littoral cells provide a good basis on which to divide the water quality of the coastline as gross movement of water bodies will mimic the movement of sediment. Boundaries between sediment cells are of two main types: littoral drift divides and sediment sinks. Drift divides usually correlate with abrupt changes in the coastline, such as headlands, whereas sediment sinks are points at which sediment transport paths naturally meet. The positions of the littoral cells are shown in figure 1.

It is proposed that one continuous monitoring buoy be placed towards the centre of each

littoral cell. This requirement has been combined with the necessity for the buoy to be positioned away from estuarine inputs and Trinity House buoys selected upon which to place the instrumentation. The proposed position and the name of the buoys are shown on figure 1.

The suitability of these selected sites will be verified by investigation of CASI imagery and continuous track data from previous baseline surveys. This will indicate the observed spatial variability at these sites, allowing repositioning if required.

The instrumentation package deployment would be a phased program, with the buoys being deployed over a period of five years. This will allow both a phasing of costs and the parallel development of data handling systems. The proposed deployment schedule is shown in the Gantt chart (Table 1).

### **Intensive Littoral Cell Surveys**

The objective of these surveys is to monitor the temporal variability of sections of the coastal zone. The review of data from the grid surveys (Reid *et al.*, 1997) indicated that the temporal variability could be modelled using monthly surveys of the coastal zone. It is recognised that this represents too large a task for the whole coastline in any one year. It is therefore proposed to survey two littoral cells each year on a five year rolling program. The cells to be surveyed would be those in which a new buoy is positioned. The survey would therefore provide support for the buoy in its first year of operation.

These intensive surveys would complement the buoy measurements, enabling the temporal variability measured by the buoys to be put into wider spatial context.

The use of intensive surveys will allow the development of a more holistic approach to coastal monitoring. The surveys would consist of a combination of chemical and biological measurements. Continuous track measurements of physical and chemical parameters would be collected using the Towfish and Skalar as in the present baseline survey. Additionally, the Continuous Plankton Recorder would be used to measure the phytoplankton and zooplankton populations and variability through the littoral cell. Sampling sites within the cell would measure sediment quality and biodiversity using sediment grabs. Consideration will be given to the use of toxicity indicators such as oyster embryo larval bio-assays which could be phased in over the first years of the survey.

It is proposed that airborne remote sensing will be used to measure the chlorophyll-*a* and suspended solids concentration across the full three mile limit within the littoral cells and to indicate the presence of thermal fronts which will have implications on data interpretation. Remotely sensed data will be collected only synchronously with *in-situ* data to allow accurate calibration of the imagery.

Airborne remote sensing will also be used as part of at least one intensive survey to investigate the tidal variability in temperature, chlorophyll-*a* and suspended solids of this cell.

## Nationwide Survey

It is proposed that twice yearly the full coastal zone will be monitored using a combination of laboratory samples and continuous track data. This will provide the continuum with the previous years data and will produce a "snapshot" measurement of coastal water quality at two seasons. The survey will also join the results of the two intensive surveys and allow these to be put into context.

The positions of the baseline sampling sites have been modified to remove the influence of estuaries. This modification has been carried out using the results from the similarity analysis of baseline laboratory sampling sites (National Rivers Authority, 1995). The new sites have been chosen to correspond with those areas having a high spatial relationship with neighbouring sites and are shown in figure 1. The baseline survey will also "pick up" the outer estuary sites of the National Marine Monitoring Plan (NMP), allowing a more direct comparison between these two surveys. Furthermore, this will allow the development of a comparable survey for the investigation of estuarine quality.

### 4.1.5. Costings

	COST (£ K)
Moored Instrumentation Package • 2 Buoys per annum at £75 k	150
Boat Surveys • National Baseline • Intensive Littoral Cells	42 51
Laboratory Costs • National Baseline • Intensive Littoral Cells	12 20
Continuous Plankton Recording	29
Satellite Imagery	100
Aerial Surveillance	90
<b>TOTAL</b>	<b>494</b>

NB: This represents a cost saving of 13% compared to historic budgetary cost for coastal monitoring of £570 K.

## **4.2 The National Marine Monitoring Plan (NMP)**

The National Marine Monitoring Programme (NMP) was set up at the request of the Government through the Marine Pollution Monitoring Management Group (MPMMG). The Agency is a major partner in the programme and as such is committed to a continued involvement, which thus means that the NMP forms a key part of the overall coastal waters monitoring strategy. This is a national commitment and as such has a must do status in the Agency's total environmental monitoring programme. The first phase of the NMP, up until the end of 1997, was designed to identify spatial variation in the chemical and biological quality of the coastal and estuarine environment. The next phase of the NMP will move more towards long term trend monitoring as a representative selection of sites around the UK. A review has been set up under the auspices of the NMP Working Group to devise this new temporal trend programme. The review is due to be completed in September 1998 with a view to implementing the new programme in 1999. The new programme will be implemented by the Agency and detailed in the Environmental Monitoring Programme.

## **4.3 Way Forward**

Specification of moored instrumentation package, investigation of repackaging of Proteus instrumentation.

Complete negotiations with Trinity House

Specification of laboratory sampling suite, integration with NMP limits of detection

Investigation of various techniques for biological assessment to include sample siting and sampling protocols for benthic grabs

## **5. Consultation, Review Period and Refinements**

### **5.1 Consultation**

Consultation with other statutory bodies, regulators and industry nationally and internationally will be undertaken as appropriate.

### **5.2 Review Period**

There will be a three year review period, which will allow feedback from the surveillance data and other surveys, such as JONUS and NMP, to be included.

### **5.3 Refinements**

The Surveillance Programme must retain flexibility. The programme should develop, evolve and be refined continuously.

## 6. REFERENCES

DoE, 1996. Review of the potential effects of climate change in the United Kingdom. Department of the Environment, 1996.

Environment Agency 1997a. Calibration of CASI imagery for high concentrations of chlorophyll-a in turbid waters. National Centre for Environmental Data and Surveillance, March 1997.

Environment Agency 1997b. Development and testing of suspended solids algorithms. National Centre for Environmental Data and Surveillance, March 1997.

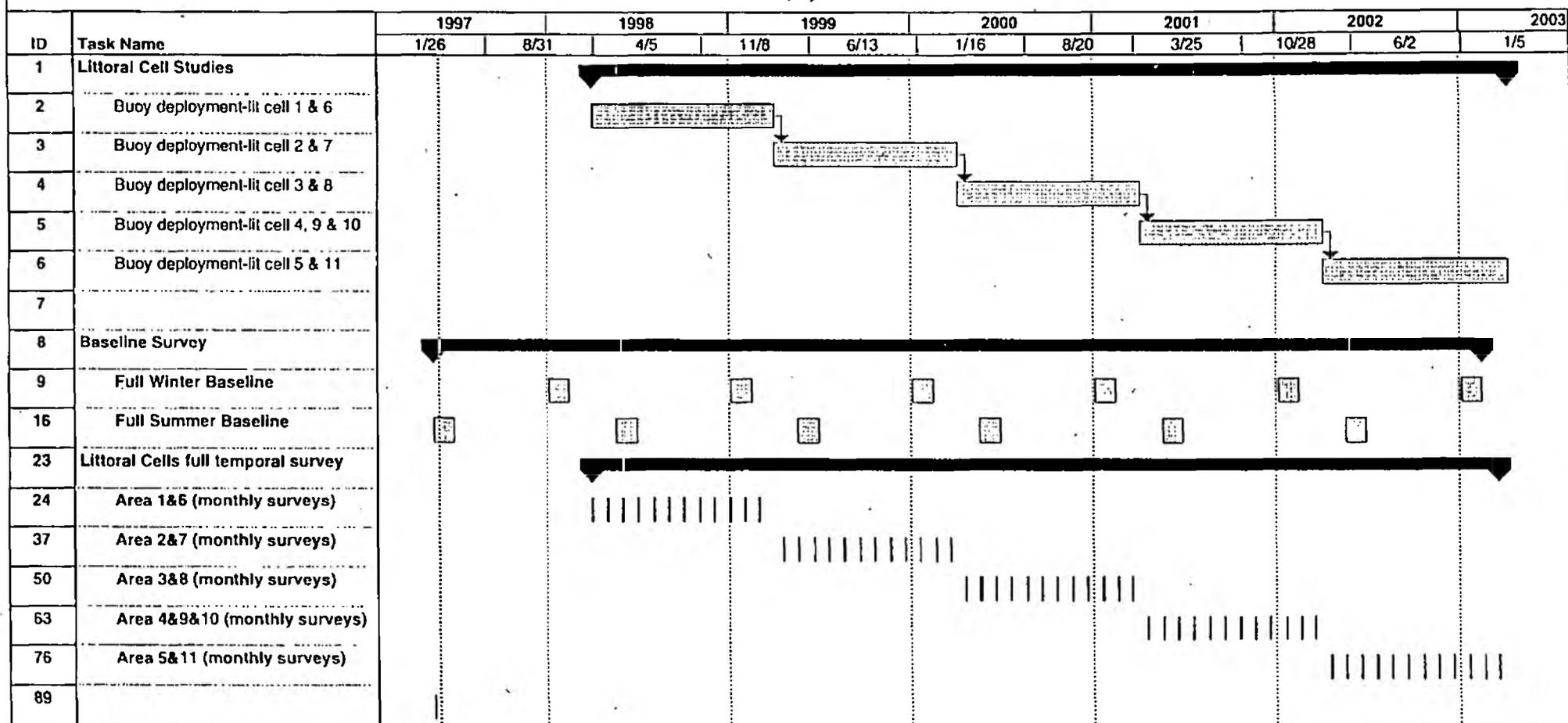
Environment Agency 1997c. Viewpoints on the Environment. Developing a National Environmental Monitoring and Assessment Framework.

HR Wallingford, 1993. Coastal Management: mapping of littoral cells. Motyka, J.M. and Brampton, A.H. Report SR 328, January 1993.

National Rivers Authority, 1995. Similarity analysis of baseline survey laboratory sampling sites. Duncan, A. National Centre for Instrumentation and Marine Surveillance, NC/MAR/011. November 1995.

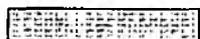
Reid, P.C., Planque, B. And Thomson, S. (1997) Investigation of spatial homogeneity of coastal waters. Draft Report to the Environment Agency, National Centre for Environmental Data and Surveillance. March 1997.

Table 1: Deployment Schedule



Project:  
Date: May 29, 1997

Task



Summary



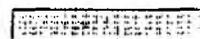
Rolled Up Progress



Progress



Rolled Up Task



Milestone



Rolled Up Milestone



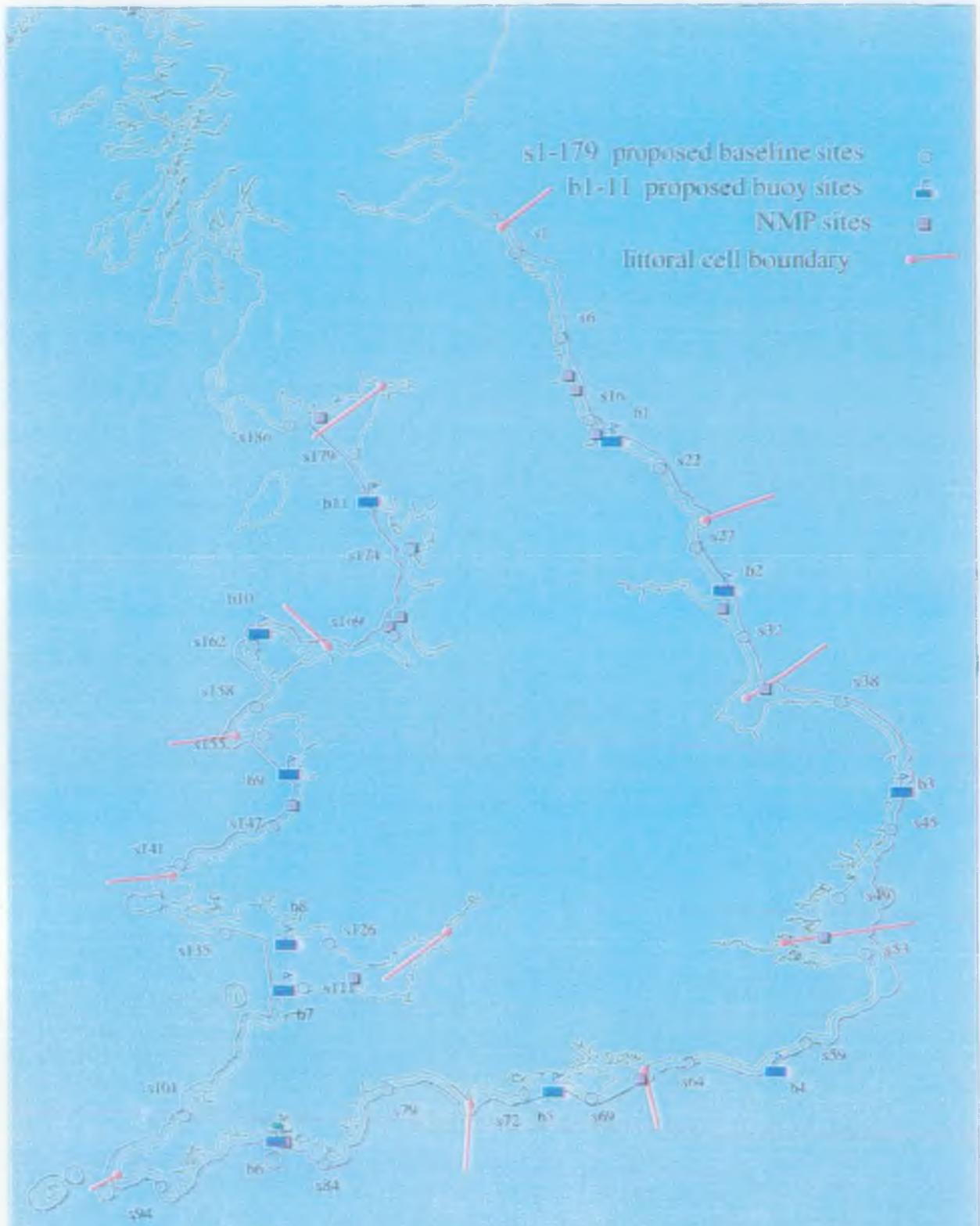


Figure 1  
 Revised Coastal Baseline Monitoring Strategy