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SEVERN ESTUARY FUNCTIONAL GROUP - WATER QUALITY

DRAFT

REPORT ON MONITORING OF ENVIRONMENTAL QUALITY IN THE SEVERN ESTUARY

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SEVERN ESTUARY FUNCTIONAL GROUP - WATER QUALITY

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SEVERN ESTUARY FUNCTIONAL GROUP - WATER QUALITY

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EXECUTIVE SUMMARY

This report examines water quality and related monitoring and briefly reviews historical effort, summarises existing and proposed programmes, identifies information gaps and presents proposals for rectifying those gaps. Proposals for continuing and new work include, as far as possible, financial resource implications, but detailed manpower and equipment needs have yet to be evaluated.

Major investigations of water quality were undertaken in the 1970's and indicated that the main body of the estuary was of good quality overall with any problem areas tending to be localised in nature.

In the 1980's joint monitoring effort was reduced to, essentially, a centre channel monitoring programme. Regions undertook their own monitoring programmes for nearshore waters. All Regions established inputs and water quality monitoring programmes, with varying degrees of effort being applied to biological, bioaccumulation and sediments monitoring. A substantial number of one-off investigations of local problems were undertaken.

The ongoing monitoring and special investigations programme is not well co-ordinated between Regions and there is a need for consistency of approach.

Proposals are made in the report for a co-ordinated monitoring programme evolving from the existing joint and local programmes. Interim objectives for this monitoring programme are:-

- **To determine overall temporal trends of quality of water, sediments and biology (including bioaccumulation) of the main body of the Severn Estuary.**
- **To determine the impact of individual groups of discharges.**

Key elements of the recommendations made in the report are summarised below:-

1. Existing Severn Estuary Centre Channel and Bioaccumulation monitoring data should be collated by SEFG-WQ and examined for trend analysis.

2. The review of biological investigations in the Severn Estuary initiated by SETWP in 1988 should be completed.

3. All consents for sewage and industrial discharges should be reviewed to require, as a minimum, provision of flow measurement facilities.

4. The existing Severn Estuary Centre Channel Monitoring Programme should continue in its present form, at an estimated cost of £16,000.

5. Data from the Paris Commission Inputs survey should be reviewed after 12 months, with a view to identifying those discharges which represent 90% of the input of each determinand for each Region and for the Severn Estuary as a whole.

6. A harmonised bioaccumulation programme should be designed and implemented by SEFG-WQ in accordance with the proposed NRA monitoring strategy, and at an estimated cost of £3,000 p.a.

7. The NRA Baseline Estuary Monitoring Programme should be co-ordinated by the SEFG-WQ and should begin at the earliest practical opportunity. Costs should be shared as agreed between the participating Regions and are provisionally estimated at £22,000.

   The one-off survey should take place in 1990.

8. SEFG-WQ should develop a common protocol for monitoring and investigation of environmental impact of discharges in the Severn Estuary to ensure a consistent approach.

9. The estimated cost to each Region of the 1990/91 joint programme will be:-

Severn-Trent	-	£ 12,300
Wessex	-	£ 12,300
Welsh	-	£ 12,300
South West	-	£ 4,100
TOTAL	-	£ 41,000

10. The SEFG-WQ should retrospectively report results of monitoring to SEMG in March of each year.

SEVERN ESTUARY FUNCTIONAL GROUP - WATER QUALITY

REPORT ON MONITORING OF ENVIRONMENTAL QUALITY IN THE SEVERN ESTUARY

1. INTRODUCTION

This Report has been commissioned by the Severn Estuary Management Group and forms one of three Reports covering Water Quality, Flood Defence and Fisheries issues respectively.

The objective for all three reports is to review existing monitoring and research programmes and to recommend programmes of work to make good any deficiencies.

This report examines water quality and related monitoring and briefly reviews historical effort, summarises existing and proposed programmes, identifies information gaps and presents proposals for rectifying those gaps. Proposals for continuing and new work include, as far as possible, financial resource implications, but manpower and equipment needs have yet to be evaluated.

The Functional Review Groups will subsequently plan the long term workload required for investigative work, particularly in relation to Statutory Quality Objectives and tidal power developments. They will also ensure a balanced input on matters relating to the Severn Estuary between the Regions into the NRA Corporate Plan and when appropriate develop a Catchment Plan for the Severn Estuary.

The report covers the Severn Estuary from its seaward boundary which, for the purposes of the former Severn Estuary Joint Committee (SEJC) was defined as extending landward from a line joining Morte Point, Devon to Worms Head, West Glamorgan, to Maisemore Weir, Gloucester. This seaward boundary approximates to the Territorial Sea Baseline, which for the Severn Estuary is a line not exceeding 24 miles enclosing the embayment. The NRA's limits for control of pollution extend 3 miles seaward of the

Territorial Sea Baseline. Clarification is being sought regarding the detail specification of the Territorial Sea Baseline.

2. HISTORICAL PERSPECTIVE

Major investigations of water quality were undertaken in the 1970's by SEJC in order to provide a consistent database against which to measure change. This work is summarised in a review published in Marine Pollution Bulletin (Vol.15, No.2., pp 41 - 47, 1984) and is reported in more detail in the 1st and 2nd Reports of the Survey and System Panel of the Severn Estuary Technical Working Party.

The investigational effort was reduced in the 80's as the earlier work indicated that the main body of the estuary was of reasonably good quality overall with any problem areas tending to be localised in nature. Each Region was responsible for monitoring its own nearshore waters and associated discharges, whilst the main body of the estuary was monitored for nutrients, physico chemical and microbiological determinands through quarterly centre channel surveys of water quality. Bioaccumulation was also monitored, with one site from the Cardiff area being reported to the Joint Monitoring Group of the Paris and Oslo Commissions.

2.1 Inputs

The inputs of contaminants to the estuary were quantified in a major programme in the late 70's (Phase 1 and 2 Inputs Programmes) and are reported in the First and Second (draft) Reports of the Systems and Survey Panel of the Severn Estuary Technical Working Party.

The main conclusions were:-

(a) Rivers contribute the greatest proportion of dissolved and particulate organic carbon, total oxidised nitrogen, silicate, suspended solids, copper, iron, manganese and nickel. They also make substantial contributions of orthophosphate, biochemical oxygen demand, mercury, cadmium, lead and zinc;

(b) Discharges of domestic sewage contribute the greatest proportion of ammonia and BOD. They also make substantial contributions of

orthophosphate, dissolved and particulate organic carbon, cadmium and chromium;

(c) Industrial discharges contributed the greatest proportion of orthophosphate, mercury, and chromium (During the 80's closure of fertiliser and chloralkali plans resulted in a major reduction in the input of ammonia and mercury). Industrial discharges also made substantial contributions of ammonia TSS, BOD, DOC, POC, cadmium, copper, iron, lead, manganese and zinc;

(d) Atmospheric deposition contributed the greatest proportion of lead and zinc as well as substantial amounts of cadmium, copper and nickel;

(e) Sludge dumping contributed only minor proportions of the metals entering the estuary with the exception of chromium which was present in substantial quantities;

(f) More than 60% of inputs of all contaminants enter the estuary upstream of the proposed Severn Barrage.

These inputs monitoring programmes were very resource intensive and it was not practical to continue them as a co-ordinated routine monitoring programme.

Provisional moves were made in the late 80's to undertake a further co-ordinated inputs survey concentrating primarily on synthetic organic chemicals. However, this initiative foundered because of the uncertainties caused by privatisation and was then superseded by the national Red List screening survey in 1989.

Notable changes to industrial inputs in the 80's include the closure of the BP Baglan Chlor Alkali plant (Mercury) and the Fisons Fertiliser Plant at Avonmouth (Ammonia).The ICI fertiliser plant at Avonmouth introduced new production methods in the mid 80's resulting in decreased TSS and mercury emmissions.

Substantial increases in organic load from Netheridge STW (Gloucester) and Frampton STW resulted from food processing industry

expansion in the mid 80's. The Blakeney STW was enlarged in 82-83 to allow for industrial development. Sewerage improvements throughout the 80's in the Avonmouth STW catchment reduced the number of crude discharges to the Avon estuary and increased the treated flow and sludge production from Avonmouth STW. In Wales, whilst the total input of sewage did not change significantly, outfall and sewerage improvements reduced nearshore pollution. The Y&P trunk sewer was diverted in the late 80's to Cardiff Eastern outfall, together with several crude sewage discharges to the Taff estuary. Completion of the Afan outfall scheme in 1986 removed all the crude sewage discharges from the Afan estuary, significantly improving its quality.

The Barry West outfall was commissioned in late 1989 and bathing water quality at Barry is expected to improve substantially as a result.

2.2 Water Quality Centre Channel

Throughout the Phase 1 and Phase 2 inputs investigations and subsequently on an approximately quarterly basis, the quality of the main body of the estuary has been routinely monitored using a helicopter to collect samples. The sampling run follows the centre channel of the estuary from a point mid way between Nash Point, South Glamorgan and Hurlestone Point, Somerset, to Maisemore, Gloucester, the tidal limit. Samples are analysed for nutrients, chlorophyll, solids, metals, certain pesticides, and coliform bacteria; insitu measurements are made of temperature, DO and salinity.

These studies concluded that the main body of the Severn Estuary is not greatly affected by pollution. Except for the localised impact of major outfalls, the chemical composition of the water is fairly uniform with regard to depth and width but it varies along the central axis.

Dissolved oxygen levels are generally high, although about 20 km of the upper reaches and some sub-estuaries, notably the Usk, experience oxygen depletion during spring flood tides as a result of resuspension of particulate organic matter. Photosynthesis is inhibited in the main body because of the naturally highly turbid nature of the water. As the water becomes less turbid seaward, the

concentration of chlorophyll-a increases, with substantial seasonal variation.

Concentrations of nutrients (Ammonia, Total Oxides of Nitrogen, Orthophosphate, and Silicate) generally decrease with increasing salinity. There are some local discontinuities reflecting local inputs. On average concentrations of TON and Silicate are enhanced throughout the estuary compared with what might be expected from simple dilution of freshwater. Orthophosphate levels are elevated in the lower half of the estuary.

The concentrations of dissolved Cadmium, Lead, Nickel and Zinc exhibit geographical variations which reflect their inputs. In all cases the annual average concentrations comply with the relevant List I or List II EQS although individual samples may on occasion exceed the EQS value. EQS compliance of copper has caused some concern with average concentrations approaching the standard of 5 μg/l as an annual average in several areas of the estuary. Investigations have been undertaken to determine its degree of organic complexation in the dissolved phase in order to make use of the derogation provided for the organically complexed fraction. Substantial initial reductions in the level of dissolved Cadmium were observed in the mid 70's due to reductions in the major input although levels appear to have stabilised now.

The centre channel data collected since the SETWP reports has not been systematically reviewed or subjected to detailed trend analysis. There is no reason to believe that the picture will have changed greatly and in fact the reduction of some major inputs in the 80's may have resulted in a slight improvement.

2.3 Bioaccumulation and Sediments

No co-ordinated assessment of bioaccumulation around the shores of the estuary has been undertaken. Concentrations of metals in commercial shellfish and fish taken from the estuary are not significantly higher than in other coastal waters. However, some non commercial species do show elevated concentrations, particularly those in the intertidal zone.

Data on Cadmium, Mercury, Zinc, Lead, Copper and Nickel in Mytilus edulis from Cardiff Flats has been reported annually from the early 80's onwards to the Joint Monitoring Programme of the Paris and Oslo Commissions. This site - which was at best extremely marginal, with few specimens spread over a wide area - was destroyed in the gales of 1989/90. Severn-Trent and Welsh Regions have maintained bioaccumulation monitoring programmes for organisms relevant to their areas. Wessex Region has collected samples but a backlog of analysis has developed. The programmes are summarised in Section 3.

Concentrations of metals in the sediments were monitored throughout the estuary in Phases I and II but have not been regularly monitored in a coordinated manner since. Sediment metal concentrations were found to be elevated in comparison to some other estuaries.

2.4 One-Off Investigations

2.4.1 Severn Trent

Saline Intrusion

Special surveys have been carried out over a 4 - 5 day period at times of high tides. A quality/flow model has been developed to predict high chlorides at Gloucester to protect the Purton water supply intake.

Measurement of DO sag in the Upper Estuary

This is associated with high tide conditions. Numerous DO surveys have been undertaken over the last 10 years. Continuous monitors have been used to record DO concentrations.

Netheridge STW

Major investigations have been undertaken on the effect of the Netheridge effluent on the quality of the estuary. Continuous DO monitors have recently been installed upstream and downstream of the effluent discharge. Microbiological quality of the estuary has also been monitored routinely.

Lydney STW and Sewer

The distribution of phenol in the estuary arising from a trade effluent has been monitored in special one-off surveys.

Blakeney STW

The impact on the estuary of toxic metal concentrations from the partially treated discharge from Blakeney STW has been investigated.

Frampton STW

The local low water ponds were investigated in 1987/8 to determine the impact of the Frampton effluent.

2.4.2 Wessex

ICI Severnside Radioisotope Tracing Exercise

In 1988 a radio-active tracer was discharged for 12.3 hours from the ICI outfall in order to validate a dispersion/mixing zone model developed in conjunction with WRC . The 'Wessex Explorer' and BMT RIB monitored the activity over 24 hours. Results were forwarded to WRC, but no report has yet resulted from this work.

Kingston Seymore/Wick St Lawrence

In 1988 automatic samplers were positioned on outfalls from these STWs. Grid patterns were developed for high water and low water tides to determine the relative inputs of bacterial loadings from the two STW's. Sediment samples were collected for biological assessment.

Avonmouth

Water samples were collected along a length of coast either side of the Avonmouth STW outfall during 1988. The samples were assessed for bacterial quality to determine the extent of the effluent plume and its likely impact on bathing beach quality at Clevedon.

Gordano Site

Radar float tracking and some current metering was undertaken in 1987 to determine the likely effluent dispersion in the estuary from the Gordano Valley sewerage scheme.

Burnham

In 1989 surveys were undertaken to assess reasons for bacterial contamination of the beach at Burnham, to define bacterial pollution in the Burnham area, and to trace sources of the pollution. Four grid patterns were undertaken during spring and neap tidal cycles.

Marine Biology

Marine Biology surveys have regularly been undertaken in the following areas:-
Minehead, Gordano and Portishead Docks, Avonmouth Docks, River Parrett, Sludge Dumping grounds and Kingston Seymour.

Coastwatch

Samples of biota including Patella, Mytilus and several species of seaweed, have been taken annually each spring since the mid 70's. However a substantial backlog of analysis has built up which is now begining to be addressed. Tissue samples will be analysed for List I and II substances.

The following sites are sampled:

Severn Bridge, Severn Beach, Avonmouth, Portishead, Clevedon, Sand Point, Black Rock, Brean Down, Lynmouth and Ilfracombe.

2.4.3 Welsh

Nearshore Severn - water quality and hydrography.

Welsh Water Authority undertook a number of surveys through the late 70's and early 80's to determine the quality and movement of nearshore waters between Severn Bridge and Nash Point. Data was

collected on surface and subsurface current velocity and direction, wind velocity and direction, tidal levels, fiver flows and salinity profiles. A total of 24 "synoptic" surveys using helicopters to collect water samples from up to 70 sites were also undertaken. Samples were analysed for nutrients, solids, salinity and soluble metals.

Impact Assessment - Discharges to Nearshore Severn

In the early 80's a series of specific investigations of a combined total of 8 major industrial and sewage discharges in the Newport - Cardiff area were undertaken. These covered discharge quality and toxicity, effluent dilution and dispersion, and impact of the discharges on the benthic macrofaunal population structure and distribution. The results were used to develop strategies for individual effluent improvements schemes.

Bioaccumulation Surveys

In the late 70's major surveys of bioaccumulation were undertaken, although not reported until the early 80's. A total of four phases of investigation were undertaken, covering the whole South Wales coastline. Tissues from a variety of biological specimens including Mytilus edulis, Patella vulgata, Littorina littorea, Patella sp., Fucus vesiculosus, and Fucus serratus were examined in all phases for metal content and, in some of the surveys, for organochlorine pesticides.
Water samples collected at the time of biota sampling were also analysed for the same parameters.
A detailed protocol for future bioaccumulation surveys was established building on the experience gained as a result of these surveys.

Copper Speciation

Theoretical and practical investigations were undertaken in the late 80's, in conjunction with WRC and IMER, to establish the degree of humic complexation of copper in the main body of the estuary. The results indicated that complexation is only likely to be significant at low salinities.

Effluent Toxicity

In 1986 a total of 38 effluents from around the Welsh coastline were screened for acute toxic effect using the MICROTOX microbial bioassay. Several discharges to the Severn Estuary were identified for further investigation, with a view to setting toxicity based consents.

Swansea Bay -Mercury Studies

In 1982-3 investigations were undertaken in relation to the BP Baglan discharge of Mercury (from a Chlor-alkali plant - now ceased). Inputs budgets for Mercury were established and bioaccumulation was measured in indigenous and transplanted Mytilus edulis. Water and sediment quality were also determined. In addition a study was made of the benthos population structure in the vicinity of the Baglan outfall.

Swansea Bay -Review of Environmental Quality

In 1983 the available data to date on the environmental quality of Swansea Bay was reviewed. Three reports were produced covering:-

- Dissolved organic and inorganic constituents - degradation of organic carbon, accumulation of persistent toxics, distribution and degradation of non persistant toxics,and nutrient enrichment.Determinands reviewed included BOD, Organic carbon, List 1&2 metals, pesticides, nutrients and phytoplankton.

- Bacterial contamination - sewage disposal and data on gross pollution and bacterial contamination of bathing waters were assessed in relation to published water quality standards. Determinands considered included aesthetic quality, E coli, tot.coliforms, salmonellae and viruses.

- Biological studies - covering intertidal biology and sediments, sublittoral biology in relation to general distribution and productivity,effects of specific discharges, zooplankton, and fisheries.

Swansea Bay -Status of Macrobenthic Infauna

A comprehensive assessment of the whole of Swansea Bay was undertaken between 1984 and 1987 to determine the overall impact of discharges, dredging, and sediment movement on benthic population structure and productivity. A large scale grid survey was undertaken to determine the population structure and four distinct faunal groupings were identified correlating with substrate and hydrodynamic conditions. There was evidence of a decline in environmental quality in Inner Swansea Bay and further studies were undertaken in an attempt to ascertain the cause. The results were not conclusive, as the possible impact of discharges was masked by gross sediment movements within the Bay. The impact of dredging and dredge spoil disposal further complicated interpretation of the data.

Swansea Bay Inputs

In 1983 intensive surveys of inputs to Swansea Bay were undertaken to assess the magnitude and relative effects of the numerous sources of bacteria to the Bay. Data was collected over tidal cycle, 24 or 48 hour periods for 38 inputs, 21 bathing sites, and 31 offshore water quality sites. Inputs were monitored for flow, E.coli, salinity and solids. Bathing waters were monitored for E.coli, salinity, temperature, aeshetic quality, and dissolved and particulate metals. In addition, offshore water quality was monitored for nutrients.

Outfall siting investigations

Throughout the 80's hydrographic and bathymetric studies were undertaken throughout nearshore waters in connection with proposals for sea outfall improvements at Cardiff Eastern P.S., Cardiff Western P.S., Porthcawl, Afan outfall, Baglan outfall, and Mumbles outfall. Typically bottom topography would be surveyed, and current meters deployed to obtain basic data for use in outfall site selection. Quantitative and/or qualitative dye releases were made from possible outfall diffuser sites in order to identify optimum locations for initial dilution and dispersion.

2.4.4 South West

Major environmental studies have been carried out (by contractors to South West Water Services Ltd.) in the Taw and Torridge estuaries and on the North Devon coast (from Baggy Point to Porlock) for Capital Scheme proposals.

The results of the Taw and Torridge study is available (in report format) from South West Water Services Limited.

It is expected that the results of the North Devon survey undertaken in 1989 will be similarly available when the report has been published.

3. INHERITED ONGOING MONITORING AND SPECIAL INVESTIGATIONS PROGRAMME

3.1 Objectives

The objectives of the monitoring in the present "inherited" programme have not been formally reported or defined, with the exception of the SETWP sponsored centre channel and bioaccumulation monitoring.

Each Region of the former Water Authorities established its own monitoring programme according to its perceived needs and resources.

Accordingly there is a 'core' of monitoring intended to monitor discharge quality and local effects of discharge for operational pollution control and statutory reporting purposes, together with a variety of water quality monitoring effort intended to provide spatial and temporal information on local water quality related issues.

3.2 Inputs Monitoring

Inputs have, throughout the 80's, been monitored essentially for pollution control and consent monitoring purposes rather than for

development of inputs budgets. Flow monitoring of discharges has been the exception rather than the rule.

Monitoring of discharges containing significant quantities of List 1 and 2 materials, together with sampling of receiving water quality have been undertaken since 1985/86 in accordance with implementation advice on the Dangerous Substances Directives.

There are differences between Regions in the frequency of monitoring for Dangerous Substances Directive EQS compliance purposes, - six times a year in Severn-Trent and Wales, four times in Wessex, and up to twelve times a year in South West Region.

3.2.1 Severn Trent

A total of 10 River, 4 Trade and 7 Sewage discharges are monitored at the frequency and for the determinands shown in Table 3.2.1

3.2.2 Wessex

A total of 15 River, 4 Trade and 11 Sewage discharges are monitored at the frequency and for the determinands shown in Table 3.2.2.

3.2.3 Welsh

A total of 16 River, 16 Trade and 18 Sewage discharges are monitored at the frequency and for the determinands shown in Table 3.2.3

3.2.4 South West

A total of 11(21) Rivers, 0(1) Trade and 4(17) Sewage discharges are monitored at the frequency and for the determinands shown in Table 3.2.4. Figures in brackets relate to the Taw and Torridge catchments which are just outside the present SEMG seaward boundary.

3.2.5 Paris Commission Survey of Riverine Inputs

This survey commenced in January 1990 and is intended to quantify the input via rivers, sewage and industrial discharges, of the determinands listed in Table 3.2.5. A total of 12 samples per input are required per annum. The inputs included in this survey are also listed in Table 3.2.5.

3.3 Water Quality

3.3.1 Centre Channel

The primary objective of the Centre Channel monitoring programme is to establish whether any overall deterioration or improvement has taken place through time, and whether the overall distribution of determinands remains consistent with the perceived inputs to the estuary. The results are also used to assess compliance with the EQS's set for List 1 and List 2 substances

The monitoring programme is undertaken by Wessex Region with analysis of samples by Welsh Region.

A total of 41 sites has been monitored 4 times a year; field observations and samples for laboratory analysis are taken at 20, whilst at a further 21 sites field measurements alone are taken. Samples are analysed for BOD-ATU, Nutrients, TSS_{105}, soluble metals, HCH, Drins, Coliforms. Field measurements are made for temperature, Dissolved oxygen and salinity. Further details are provided in Table 3.3.1.

Data are reported annually as part of the Joint Monitoring Programme of the Paris and Oslo Commission.

3.3.2 Routine Localised Surveys

Routine water quality surveys of the nearshore Severn Estuary and of sub-estuaries are also undertaken in each Region. These surveys are primarily undertaken in relation to monitoring effects of effluent

discharges for EQS compliance reporting purposes, or to determine extent of local oxygen depletion or ammonia elevation.

3.3.2.1 Severn Trent

Two neap tide (14 sites) and six spring tide (20 sites) surveys of the upper estuary are undertaken per year, together with 19 sites sampled at bankside. Determinands are sanitary parameters and nutrients while toxic metals are also monitored at selected sites.

3.3.2.2 Wessex

A total of 11 sites on the Avon estuary and 4 nearshore sites on the Severn at Avonmouth are monitored quarterly. Determinands include sanitary parameters, soluble List I and II metals and selected List I Organics.

3.3.2.3 Welsh

A total of 10 sites in the nearshore Severn Estuary between Uskmouth and Lavernock Point and 3 sites in Swansea Bay, together with 9 sites from sub-estuaries are monitored 6 times a year for List I and/or List II determinands.

A total of 12 estuarine sites (11 estuaries) are monitored for sanitary determinands and nutrients 12 times a year.

3.3.2.4 South West

A total of 9 sites on the Taw/Torridge Estuaries at 4 tidal states and at up to 3 depths are monitored 4 times a year for sanitary determinands and bacteria.

3.4 Bioaccumulation

3.4.1 Severn Trent

5 sites on the upper Severn are sampled 5 times a year and analysed for List I and II metals and organochlorines. Seaweeds, periwinkles and shrimps are analysed. Surveys commenced in 1977/78.

3.4.2 Wessex

9 sites on the South bank of the Severn Estuary are sampled annually in spring. Limpets, mussels and several seaweed species are analysed for List I and II substances. A substantial backlog of samples awaits analysis.

3.4.3 Welsh

4 sites on the North bank of the Severn Estuary are sampled annually in Dec/Jan. and analysed for cadmium and List II metals. Fucus specimens are obtained at all sites and Mytilus at the 2 most seaward. The programme has run from 1979.

3.4.4 South West

There is currently no routine programme for bioaccumulation.

3.5 Sediments

Severn Trent is the only Region to regularly monitor estuarine sediments. 12 sites in the upper estuary have been monitored twice per year since 1984 for List I and II metals.

3.6 Biology

Severn Trent is the only Region routinely monitoring estuarine biology. Welsh, Wessex and South West Regions have all undertaken site specific special biological surveys at various locations and over various timescales, generally to determine the impact of specific discharges or groups of discharges on macrofaunal population structure and diversity.

The Severn Trent programme is intended to assess macrofaunal population dynamics and is undertaken at 9 sites which have been sampled 3 times a year since 1987.

3.7 Proposed Special Investigations 1990 onwards

3.7.1 Severn Trent

In order to determine the effect of the Netheridge STW effluent on water quality the use of continuous monitors to measure DO concentrations in the estuary upstream and downstream of the discharge will continue in 1990. No other special surveys are planned.

3.7.2 Wessex

Burnham/River Parrett

It is intended to undertake a study of the stretch of coastline from Burnham-on-Sea and into the estuary of the River Parrett. The aim of this investigation is to ascertain the extent of bacterial pollution, and to monitor the effect of chlorination of the effluent from West Huntspill STW on the bacteriological quality of the estuary around Burnham. Samples will also be taken to assess the extent of bioaccumulation of organic compounds and metals in the estuary.

Long Sea Outfalls

Surveys are to be undertaken off Minehead, Kingston Seymour and Gordano outfalls to determine the dispersion of bacteria over a tidal cycle. Once this has been established and the affected area defined, studies of chemical, physical and biological parameters will be undertaken in order to build up a three dimensional picture of the area influenced by discharges from the outfalls.

3.7.3 Welsh

Monsanto Discharge

In order to determine the current impact of this complex effluent a biological/environmental impact assessment of the nearshore Severn Estuary in the vicinity of the Monsanto discharge will be undertaken in 1990, together with a further examination of toxicity of the discharge. It is intended to extend these studies in

subsequent years to include the other major discharges examined in the 83-85 study.

Usk Estuary

A survey of PCB's in the Usk Estuary and adjacent nearshore Severn will be undertaken in 1990 in order to assess the impact of the Ponthir STW and Monsanto discharges. Concentrations will be determined of PCB's in discharges, water column, sediments and possibly biota.

Aerial Inputs

The SEJC established a research project with WRC to further refine aerial inputs of metals to the estuary and to develop a simple model of aerial deposition. The project now forms part of the NRA R&D Programme.

The main sampling effort ends in April 1990 when the equipment will be redeployed for smaller scale investigations at Northwick and Flatholm, to investigate maritime influences further. The project is due to end in December 1990.

3.7.4 South West

No work is scheduled within the Severn Estuary, but bioaccumulation studies and investigations into the quality of non designated shellfisheries will begin in the Taw and Torridge estuaries.

4. Proposals for a Co-ordinated monitoring Programme to be undertaken by Severn Estuary Management Group

4.1 Interim Objectives

Any major expansion and/or fundamental review should await the final determination of Statutory Quality Objectives and development of the Severn Estuary Catchment Management Plan.

Therefore it is recommended that the interim objectives of the proposed future programme should be the same as previously pending such a fundamental review, i.e.:-

- **To determine overall temporal trends of quality of water, sediments and biology (including bioaccumulation) of the main body of the Severn Estuary.**

- **To determine the impact of individual groups of discharges.**

The proposals for future co-ordinated monitoring included in this report are therefore designed to enhance and consolidate the existing programme to better achieve these limited interim objectives.

The Severn Estuary Monitoring Programme should therefore contain the following elements, described below:-

1. Centre Channel Monitoring

62. ParCom/Red List Inputs Monitoring

3. Bioaccumulation

4. NRA Baseline Estuary Monitoring

5. Development of a consistent approach to monitoring localised effects of individual major discharges.

Note that it is considered inappropriate at this time to develop an estuary-wide programme of biological surveillance because of the physical characteristics of the estuary. This is consistent with the approach previously adopted, which is endorsed by SEFG-WQ.

The various elements of the proposed joint programme are described below.

4.2 Centre Channel Monitoring

The existing centre channel helicopter survey should continue with a total of 41 stations monitored 4 times a year. At 20 stations, in accordance with previous practice, samples should be taken for analysis of sanitary determinands, nutrients, chlorophyll, soluble metals, selected List I organics and microbiological determinands.

At all stations measurements should be made, in situ, of Salinity, D.O. and Temperature.

The estimated cost for 1990/91 of this exercise is:-

sampling and transport of samples (Wessex)	£ 10000
analysis (Welsh)	£ 6000
Total	£ 16000

4.3 Inputs

4.3.1 ParCom

Throughout 1990, and for the subsequent future the input of substances specified by the Paris Commission will be monitored 12 times a year for those inputs which together contribute 90% of the total UK input of the substance of interest. As 1990 is the first year of the survey, and for some of the determinands very little information exists, the number of sites initially monitored is probably in excess of the number actually required. The data should be reviewed after 12 months of the survey with a view of reducing the number of sites monitored.

The number of sites monitored in the Severn estuary for the ParCom survey is as follows:-

Severn Trent	-	6
Wessex	-	14
Welsh	-	47
South West	-	1 (4 including Taw/Torridge catchment)

The costs of the Paris Commission survey should continue to be funded individually by each Region, and not out of the SEMG budget.

4.3.2 Red List

There remains considerable uncertainty about the requirements for further Red List monitoring pending thorough appraisal of the Red List Screening Survey 1989. It seems probable that most Red List discharges will already be incorporated in the ParCom Survey and may require addition of the Red List substance to the ParCom suite of determinands.

Costs should again continue to be funded by each Region separately.

4.3.3 **It is recommended that for both ParCom and Red List input surveys, those discharges which are found in the initial survey to be significant inputs, must, at the earliest opportunity, be subject to accurate flow measurement and recording.**

It is also recommended that SEFG-WQ review the ParCom Survey after 12 months with a view to identifying those discharges likely to contribute 90% of the input of input of the ParCom suite of determinands to the estuary.

4.4 Bioaccumulation

4.4.1 Bioaccumulation monitoring should be harmonised between the Regions in accordance with the proposed NRA Bioaccumulation protocol (Appendix 2). This is presently being considered by E&Q Functional Group and any future programme should be in line with their recommendations.

It is important that the species chosen for monitoring, together with the survey period, sampling method, sample preparation and analytical programmes, are as far as possible co-ordinated between Regions and that the participating laboratories regularly intercalibrate. It is, of course, appropriate for Regions to add to the progamme but not at the expense of the 'core' programme. Details of the revised programme remain to be resolved, pending a final decision by the E&Q Functional Group, but it is intended to commence sampling in Jan/Feb 1991.

4.4.2 The proposed analytical suite is:- Cadmium, Mercury, Lead, Zinc, DDT (and derivatives), PCB's, HCB, Drins. Costs for the programme are estimated to be circa £100/sample (covering collection, transport,preparation and analysis). Assuming there will be 15 sites, and that 2 species will be monitored at each site, a budgetary estimate of the total cost is **£3000**.

Costs for other organics analyses have yet to be resolved but are likely to be considerably in excess of the metals analysis.

4.5 Baseline Estuary Quality Monitoring Programme

4.5.1. A draft national programme for baseline monitoring of estuaries and coastal water is currently under consideration by E&Q Managers and is attached - Appendix 3.

4 sites need to be selected, representative of salinity regimes 0-10, 10-20, 20-30, and at the limit of estuarine influence (Intermediate site).

The estuarine sites are to be monitored for physico chemical, water quality and microbiological determinands four times a year, corresponding to the seasons, and once a year in winter for benthos, sediment, bioaccumulation (in molluscs and algae) and oyster embryo bioassay samples.

The intermediate site is to be monitored for physico chemical determinands, benthos and oyster embryo bioassay once a year in winter.

There is also a one-off organics survey to screen for organics in water, sediments and biota at estuarine and intermediate sites.

4.5.2. Costs of implementing the routine programme are provisionally estimated as follows:-

1) Operational cost of sampling

- crew, subsistance, fuel and transport to labs.= £500 /day

Allow 3 days for sampling 4 sites and 3 days weather window.

- £3000/survey

4 surveys - **£12000/year**

2) Analytical costs

	Cost/Sample	No. samples pa	Tot Cost
Water	£100	4 x 4 = 12	1200
Bioaccumulation	£90	2 x 4 x 1 = 8	720
Sediments	£70	4 x 4 = 4	280
Oyster larva bioassay	£?500?	4 x 4 = 4	2000?
(external contract)		Total	**4100**
		Say	**£4000**

4.5.3. Analytical costs for the one-off organics survey are estimated to amount to circa £1500 per sample. Collection etc. costs are assumed to be included in the costs of the routine programme.

Total estimated cost of one-off survey = 4 sites x £1500 = **£6000**

4.5.4. Total Budgetary Cost of Estuary Baseline Monitoring Programme for 1990/91 is therefore estimated to be:- **£22000**

4.6 Impact Assessment

It is evident that, historically, each Region has evolved significantly different approaches to investigating and monitoring the environmental impact of discharges. It is important that the NRA demonstrates a coherent approach to the monitoring and adopts a consistent frequency and intensity of monitoring for similar types of discharges in similar locations.

It is recommended that the SEFG-WQ develops such a common protocol for implementation throughout the Severn Estuary.

5. **Recommendations**

1. Existing Severn Estuary Centre Channel and Bioaccumulation monitoring data should be collated by SEFGWQ and examined for trend analysis. The results should be reported to SEMG. Trends should subsequently be assessed and reported no less frequently than every 2 years.

2. The review of biological investigations in the Severn Estuary initiated by SETWP in 1988 should be completed and the results reported to SEMG.

3. All consents for sewage and industrial discharges should be reviewed to require, as a minimum, provision of flow measurement facilities representative of the flow of the discharged effluent. Discharges considered significant because of their composition or nature should, in addition, be required to have flows continously recorded and flow proportional sampling facilities provided.

4. The existing Severn Estuary Centre Channel Monitoring Programme should continue in its present form. The total cost of this programme is estimated to be £16000.

5. Data from the Paris Commission Inputs survey should be reviewed after 12 months, with a view to identifying those discharges which represent 90% of the input of each determinand for each Region and for the Severn Estuary as a whole. After the first year of ParCom sampling the input budget for the Severn estuary should be reported to SEMG.

6. The separate bioaccumulation programmes currently undertaken by each Region should be reported and reviewed by the SEFG-WQ. A harmonised programme should be introduced in accordance with the proposed NRA bioaccumulation monitoring strategy. The costs of this programme are estimated to amount to £3,000 and should be shared in the agreed proportions between the participating Regions. Each Region should fund its additional bioaccumulation programme.

7. The NRA Baseline Estuary Monitoring Programme should be co-ordinated by the SEFG-WQ and should begin at the earliest practical opportunity. Costs should be shared as agreed between the participating Regions and are provisionally estimated at £22,000.

   The one-off survey should take place in 1990.

8. SEFG WQ should develop a common protocol for monitoring and investigation of environmental impact of discharges in the Severn Estuary to ensure a consistent approach.

9. On the basis of the above proposals and assuming a 3:3:3:1 split between Severn-Trent, Wessex, Welsh, and South West Regions, the operational cost to each Region of the 1990/91 joint programme will, excluding salary costs, be:-

   Severn-Trent - £ 12,300

   Wessex - £ 12,300

   Welsh - £ 12,300

   South West - £ 4,100

   TOTAL - £ 41,000

10. The SEFG-WQ should retrospectively report results of monitoring to SEMG in March of each year.

TABLES

TABLE 3.2.1.

SEVERN TRENT REGION - INPUTS TO SEVERN ESTUARY

INPUT SURVEYS

Freshwater Inputs

River	Grid Ref.	Frequency/Year	Analysis
			Harmonised
River Severn	SO 845 278	52	Monitoring
River Leadon	SO 776 234	12	RE & EA
River Chelt	SO 896 256	12	RE
Gloucester/Sharpness Canal	SO 693 044	52	RE & ES
Hatherley Brook	SO 840 214	12	RR
River Frome	SO 758 089	16	RE & nitrite
Cannop Brook	SO 650 014	12	RE
Cinderford Brook	SO 697 074	8	RR
Westbury Brook	SO 718 139	12	RR
Horsbere Brook	SO 828 209	4	RR
Trade Inputs			
Bristol Waterworks (New)	SO 687 045	4	AB
Bristol Waterworks (Old)	SO 687 045	4	AB
H. Lyes, Slaughterhouse	SO 755 155	4	AB
Sewage Effluent and Sewer			
Netheridge (Gloucester) STW	SO 808 161	52	FM & phenols
Lydney STW	SO 637 006	26	FM
Blakeney STW	SO 691 060	26	FM
Newnham Sewer	SO 694 120	4	FM
Lydney Sewer	SO 636 006	12	AB & phenols
Frampton STW	SO 736 085	6	FD
Westbury STW	SO 714 134	12	FD

Analysis

Freshwater Inputs

RR - TON, BOD, NH , pH, chloride, SS, conductivity
RE - RR + toxic metals, hardness, Ca, Mg
EA - Pesticides, herbicides and mothproofing agents
ES - Alkalinity, TOC, SO, boron, orthophosphate, fluoride, arsenic, pesticides

Trade

AB - TON, BOD, NH, SS, chloride, pH, toxic metals

Sewage Effluent

FD - TON, BOD, NH, pH, chloride, SS, COD
FM - FD + toxic metals

TABLE 3.2.2.

WESEX REGION - INPUTS TO SEVERN ESTUARY

	INPUTS		
River	Grid Ref.	Frequency/Year	Analysis
R. Avon at Netham	ST 616 727	4	S,SM,O
R. Brue at Highbridge	ST 302 477	4	S,SM,
Congresbury Yeo	ST 382 658	12	S
Banwell River	ST 353 661	12	S
River Pill	ST 028 434	12	F
Aller and Horner Water	SS 892 485	12	F
Hawkcombe Stream	SS 882 482	12	F
Portbury Ditch	ST 478 773	26-52	F
New Blind Yeo	ST 399 699	26-52	F
R. Brue at Highbridge	ST 346 458	26-52	F
Huntspull River	ST 292 458	26-52	F
Doniford Brook	ST 092 432	26-52	F
Washford River	ST 058 426	26-52	F
River Avill	SS 998 455	26-52	F
R. Axe	ST 341 564	26-52	F
Sewage			
Kingsweston Rhine			
Discharge	ST 513 798	4	S,SM,TM,O
High Tide	ST 513 801	4	S,SM,O
Low Tide	ST 510 803	4	S,SM,O
Holesmouth			
Discharge	ST 519 806	4	S,SM,TM,O
High Tide	ST 518 808	4	S,SM,O
Low Tide	ST 514 809	4	S,SM,O
Stupp Pill			
Discharge	ST 529 819	4	S,SM,TM,O
High Tide	ST 526 821	4	S,SM,O
Low Tide	ST 516 823	4	S,SM,O
Black Nore Sewer	ST 445 765	12	S
Kingston Seymour STW	ST 389 681	26-52	S
Wick St Lawrence STW	ST 364 665	26-52	S
Black Rock o/f	ST 305 588	26-52	S, SM
West Huntspill STW	ST 301 468	26-52	S
Portbury Combined o/f	ST 490 775	proposed	S
Minehead Sewer o/f	ST 974 468	proposed	S
Doniford sewer	ST 090 433	proposed	S
Trade	ST 538 832	4	S,SM,TM,O
ICI			
Discharge	ST 538 832	4	S,SM,TM,O
High Tide	ST 521 841	4	S,SM,O
Low Tide	ST 521 841	4	S,SM,O
Allbright and Wilson	ST 476 773	4	S
Hinkley Point P.S. STW	ST 215 468	12	S
R.O.F. Effluent	ST 303 452	26-52	S,SM,TM,O

TABLE 3.2.2 KEY

S	-	Sanitary Parameters	- BOD, TSS, pH. NH_3, NO_3, NO_2, Cl, OPO_4.
S.M.	-	Soluble Metals	- Cr, Ni, Cu, Zn, Cd, Hg, Pb, As.
T.M.	-	Total Metals	- Cr, Ni, Cu, Zn, Cd, Hg, Pb, As.
O	-	Organics	- Carbon Tetrachloride, Chloroform, Lindane, alpha-HCH, Drins, Pentachlorophenol
F	-	Fisheries Directive parameters	

TABLE 3.2.3

WELSH REGION - INPUTS TO SEVERN ESTUARY

Rivers	Grid Ref.	Frequency/yr	Determinands /Purpose
Wye	SO 536 098	12	HM/ParCom
Usk	SO 346 056	12	HM/ParCom
Ebbw	SO 259 889	12	HM/ParCom
Lwyd	SO 330 924	12	HM/ParCom
Rhymney	ST 225 822	12	HM/ParCom
Taff	ST 171 781	12	HM/ParCom/ListI
Ely	ST 119 769	12	HM/ParCom
Cadoxton		12	S.List II
Thaw		4	S
Ogmore	SS 891 783	12	HM
Ewenny		12	ParCom
Kenfig		4	S
Afan		12	S
Neath	SS 772 989	12	HM
Tawe	SS 674 979	12	HM
<u>Sewage</u>			
Ponthir STW		12	ParCom/List/I&II
Hunger Pill o/f		12	"
Nash STW		12	" /List II
Shaftesbury o/f		12	"
WVTS		12	" /List II
RVTS		12	" /List II
Cardiff E		12	" /List I & II
Cardiff C		12	" /List I & II
Cardiff W		12	" /List I & II
Barry E		12	"
Barry W		12	"
Penybont STW		12	" /List II
Afan o/f			ParCom
Baglan o/f			" /List II
Mumbles			" /List II
<u>Industrial</u>			
Monsanto			ParCom/List I & II
BSC Llanwern M			ParCom/List II
BSC Llanwern F			ParCom/List II
St. Regis			" /List II
BSC Orb			" /List II
Wiggins Teape			" / "
BP Chemicals			" / "
Dow Corning RP			" / "
Dow Corning RO			" / "
Aberthaw P.S.			" / "
BSC Port Talbot			" / "
Mechema			" /List I & II
BP Baglan			" /List II
Spontex			" /

Table 3.2.3. cont.

Determinands

Par Com	-	Flow, Conductivity
	-	Ammonia, TON, NO_2, NO_3, TSS, OPO_4, Total P,
	-	Cadmium, Mercury, Copper, Lead, Zinc.
	-	PCB's, gamma - HCH
HM - Harmonised Monitoring	-	Flow, pH, Conductivity, Temp, DO, TSS, Dis Solids.
	-	BOD-ATU, NH_3, NO_2, NO_3, Organic N, OPO_4, Tot. P,
	-	Hardness, Magnesium, Calcium,
	-	Diss As, Cu, Cr, Fe, Ni
	-	Drins, HCH, Dichlorvos, Endosulphan, Malathion DDT, HCB, HCBD, PCP, Chloroprene, 3 Chlorotoluene Trifluoralin, Atrazine, Simazine, Organotin, Azinphos Methyl, Fenitrothion, PCB's, TCB, Chloroform, CCL_4, Tetrachloroethylene, Trichloro-ethylene, Dichloroethane.
S - Sanitary	-	BOD, TSS, pH, DO, Nutrients

TABLE 3.2.4.1 - SUMMARY

SOUTH WEST REGION - INPUTS TO SEVERN ESTUARY AND TAW/TORRIDGE ESTUARY

TABLE 3.2.4.1 - SUMMARY

SOUTH WEST REGION - INPUTS TO SEVERN ESTUARY AND TAW/TORRIDGE ESTUARY

SUMMARY OF INPUTS

TIME PERIOD 1980 - 1989

PURPOSE	FREQUENCY	SEWAGE	INDUSTRIAL	RIVERS	TOTAL	GRAND TOTAL
LIST I & II	UP TO 12/YR	4 (17)	0 (1)	11 (21)	15 (39)	54
RED LIST	3 SURVEYS IN 1989	1 (1)	0 (0)	0 (3)	1 (4)	5
HARMONISED MONITORING	26 YR	-	-	0 (3)	0 (3)	3
PARIS COMMISSION SURVEY	NIL	-	-	-	-	-
TIME PERIOD 1990						
PURPOSE	FREQUENCY	SEWAGE	INDUSTRIAL	RIVERS	TOTAL	GRAND TOTAL
LIST I & II	UP TO 12/YR	4 (17)	0 (1)	11 (21)	15 (39)	54
RED LIST	12/YR	1 (1)	0 (0)	0 (3)	1 (4)	5
HARMONISED MONITORING	26/YR	-	-	0 (3)	0 (3)	3
PARIS COMMISSION SURVEY	12-24YR	1 (0)	0 (0)	0 (3)	1 (3)	4

River monitoring commenced in the early 1980's covering similar numbers of sites as at present.

Work in the tidal catchements commenced in 1986 at the majority of sites.

The figures in brackets relate to the Taw and Torridge catchments.

The grand total is the sum of the two figures in the 'TOTAL' column.

Future work is likely to include bioaccumulation work at sites in the Taw and Torridge estuaries. Work will also be carried out on the non EC Designated shellfisheries in the Taw and Torridge estuaries.

TABLE 3.2.4.2

SOUTH WEST REGION - INPUT MONITORING - SEVERN ESTUARY
& TAW/TORRIDGE ESTUARY

INPUT	N.G.R	ROUTINE SANITARY	LI/LII METALS	LI/LII PESTICIDE	LI/LII CTC/PCP	BACTERIA (E.COLI)	BACTERIA (1)	RED LIST	PARIS COMM	ROUTINE RIVER	ROUTINE RIVER METALS	ROUTINE RIVER + PO4	COLOUR/pH TURBIDITY	ALGOLOGY	CHLORO PHYLL
ILFRACOMBE, CHEYNE OUTFALL	SS 5221 4814			Y		Y		Y	Y						
HELE VILLAGE, ILFRACOME OUTFALL	SS 5370 4807	Y	Y	Y	Y										
COMBE MARTIN OUTFALL				Y		Y									
LYNMOUTH OUTFALL		Y	Y	Y											
SANDAWAY HOLIDAY PARK		Y													
WATERMOUTH COVE HOLIDAY PARK		Y													
SMUGGLERS COTTAGE, LEE		Y													
LEE ABBEY, LYNTON		Y													
FORELAND POINT LIGHTHOUSE		Y													
RIVER LEE										Y					
LOWER SLADE RESERVOIR												Y			
RIVER WILDER										Y					
RIVER HELE										Y					
RIVER STERRIDGE										Y					
RIVER UMBER										Y					
RIVER HEDDON										Y					
EAST LYN RIVER				Y								Y			
WEST LYN RIVER				Y								Y			
BARBROOK RIVER										Y					
FARLEY WATER										Y					
BADGEWORTHY RIVER										Y					
TAW AND TORRIDGE CATCHMENTS		45	24	34	9	7	3	4	2	22	16	27	10	12	6

TABLE 3.3.1

SEVERN ESTUARY CENTRE CHANNEL

Severn Estuary Helicopter Surveys

Site Names differ from Wessex

Sample Sites	NGR
Between Hurlstone Point and Nash Point	
West Colver Buoy	
NW from Steepholme	
Tail Patch Buoy	
English and Welsh Grounds (IS THIS SW RIDGECLIFFE BUOY!)	ST 3050 7280
North Elbow Buoy	
East Middle Buoy	
South of Hidden Oil Tanks (→ N-01 BEACON?)	
Newcombe (Portishead Point)	
Charston Rock Beacon	
Counts Buoy	
Mills Flats Buoy	
Sharpness Dock	
Severn Awre Cottage	SO 7100 0830
Newham Church	SO 6930 1140
u/s pylons - Lower Dunball	SO 1140 7330
Middle Rosemary Bend	SO 7600 1460
u/s Pylons below Elmore - Minsterworth Ham	SO 1650 7900
Below Lower Parting	ST 8140 1870
Hyde Rock	

The parameters for which these samples are analysed are:-

Temperature
Dissolved Oxygen mg/l and %
ATU-BOD
Ammonia
Total Oxidised Nitrogen
Nitrite
Nitrate
Chloride
Orthophosphate
Salinity
Chlorophyll
Silica
Conductivity
Suspended Solids
Total Dried Solids at 105°C
Soluble Cadmium, mercury, lead
alpha-HCH and gamma-HCH
Aldrin, dieldrin and endrin
Total Mg
Soluble Ni, Cu, Zn, Cd, Hg, Pb, Mn, As
Total Coliforms
Faecal coliforms
Faecal streptococci

FIELD MEASUREMENTS SITES	NGR
Cockburn	
Chittening channel	
Line of Railway Tunnel	
Halfway to Bridge Centre Channel	
Sedbury Cliffs	
Inward Rocks	
Ledges Buoy	
Ledges Buoy	
Hayward Rock	
Old Severn Rail Bridge	
Off Poulton Court	SO 6920 0570
Severn Hock Cliff	SO 7260 0890
u/s pylons - off Northington	SO 0960 7030
d/s End. Strand-Arlington Warth	SO 1310 7130
Framlode Lock	SO 7510 1060
u/s Pylons - top end Longrey Sands	SO 7520 1270
Minterworth Chute	SO 7680 1680
Lower Rea	SO 8010 1820
d/s Bend - Upper Ham Green	SO 8030 1780
Upper Parting	SO 8720 2170
Arkleworth	SO 8190 2510
Haw Bridge	SO 8430 2780

Parameters Measured in situ:-

Salinity

Dissolved oxygen

Temperature

TABLE 3.2.5 Par Com Survey

Discharges monitored and determinand Suite

Severn Trent	Wessex	Welsh	South West
Rivers			
R. Severn @ Hawbridge	R. Avon	R. Wye	R. Torridge
R. Chelt conf.	R. Parrett	R. Usk	R. Taw
R. Frome conf.	R. Tone	R. Lwyd	
R. Cam conf.		R. Ebbw	
R. Leadon conf.		R. Rhymney	
		R. Taff	
		R. Ely	
		R. Thaw	
		R. Ogmore	
		R. Ewenny	
		R. Afan	
		R. Neath	
		R. Tawe	
Sewage			
Netheridge STW	Avonmouth	Ponthir	Ilfracombe
	Weston S-Mare	Hunger Pill	
	Bridgewater	Nash STW	
	Kingston Seymour	Shaftesbury o/f	
	Kingsweston	WVTS	
		RVTS	
		Cardiff E	
		" C	
		" W	
		Barry E	
		Barry W	
		Penybont STW	
		Afan o/f	
		Baglan o/f	
		Mumbles	
Industrial			
Severn Trent	**Wessex**	**Wales**	**South West**
	CSC	Monsanto	
	ICI	BSC Llanwern M	
	Albright & Wilson	" " F	
	ISC	St. Regis Paper	
	British Cellophone	BSC Orb	
	ROF	Wiggins Teape	
		BP Chemicals	
		Dow Corning R	
		Dow Corning Sq	
		BSC Port Talbot	
		Mechema	
		BP Baglan	
		Spontex	

Determinands

Mercury, Cadmium, Copper, Zinc, Lead
gamma-HCH, PCB's
Nitrates, Orthophosphates, Total N, Total P, Suspended Particulate Matter, Flow

APPENDIX 1

MEMBERSHIP OF SEVERN ESTUARY FUNCTIONAL GROUP - WATER QUALITY

Dr. C Pattinson (Chairman)	
Environmental Appraisal Manager	Welsh Region
Mr. D Brewin	
Principal Officer - Environmental Quality	Severn-Trent Region
Mr. D Palmer	
Regional Manager -Catchment Control	Wessex Region
Mr. R Grantham	
Tidal Waters Officer	South West Region
Mr. C Chubb (Technical Secretary)	
Senior Environmental Regulation Scientist	Welsh Region

APPENDIX 2

DRAFT NRA BIOACCUMULATION MONITORING PROTOCOL

DRAFT

DRAFT GUIDELINES FOR A BIO-ACCUMULATION PROGRAMME IN THE MONITORING OF PERSISTENT CONTAMINANTS - FOR ESTUARIES AND COASTAL WATERS

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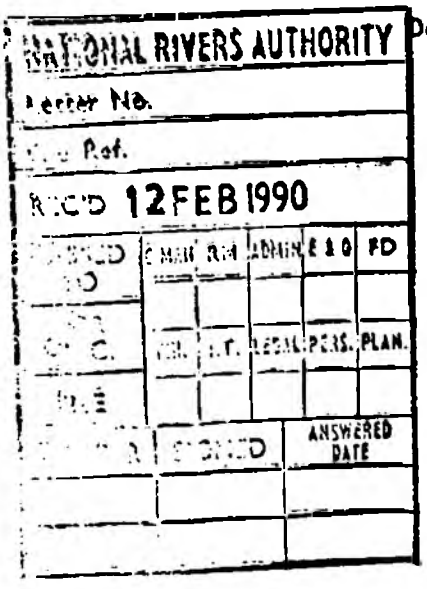

Document Ref: BB/N.R.A./NAT.89/6.1

June 1989

1. OBJECTIVES

i) To propose a scheme for monitoring trends in the levels of persistent contaminants in the marine and estuarine environments.

ii) To provide a coherent framework for coordinating bioaccumulation work in the N.R.A.

iii) To present a protocol for the provision of data in connection with the North Sea Task Force.

iv) To present a protocol for the provision of data in connection with the requirements of the Oslo and Paris Commission programmes.

v) To present a protocol for the provision of data in connection with various E.C. Directives.
(Black List, Grey List, Red List, TiO_2).

2. INTRODUCTION

Fundamental Considerations

Biological material offers several benefits over other materials for the assessment and monitoring of persistent contaminants (p.c's) in the marine/estuarine environment:

1. Levels are time-averaged or integrated over an extended period of time.
2. Results generally reflect the biologically available levels of p.c's.
3. The phenomenon of 'bio-magnification' usually provides concentrations of p.c's which are amenable to analysis by readily available routine techniques/procedures.

These advantages have led to the widespread adoption of bioaccumulation work in pollution monitoring and environmental appraisal programmes both in the U.K. and internationally. (The most universally cited example being the global "mussel-watch" approach. [5]).

Specific Considerations

Any bio-accumulation programme requires careful planning and execution particularly with respect to the selection of 'target' species and the rigour and consistency of the methods. Many species are totally inappropriate because they are too scarce, too difficult to handle or because they regulate the body-burden of contaminants in some way. Indeed, it is generally recognised that no one species is capable of acting as a universal "indicator". The criteria for the selection of suitable species have been listed and discussed by several authors (2,4,6,7). Furthermore, for each appropriate target organism various biological factors must be taken into account and standardised. The principal factors are the number of specimens required to 'smooth out' variation between individuals, and the influences of size/weight/age,

and time of year, all of which relate to variability associated with the growth and reproductive state of the organism. (For a more detailed discussion see 8). This document sets out practical guidelines which will minimise the influence of the numerous complicating factors which can otherwise distort or completely invalidate the results generated.

3. SELECTION OF TARGET SPECIES

It must be recognised that different types of organism will reflect levels of p.c's in different ways, according to the pathways by which accumulation takes place. For example, seaweeds tend to respond to ambient dissolved concentrations of chemicals, whilst deposit feeding animals will generally relate to the levels of p.c's associated with sediments. Consequently, a comprehensive programme must include species which indicate the availability of p.c's in the dissolved, particulate and sedimentary phases. These are summarised in Table 1.

TABLE I

Target Species	Environmental Compartment (phase)
Fucus vesiculosus (Bladder wrack) Fucoid algae	Dissolved constituents
Mytilus edulis (Mussel) Ostrea edulis (Native oyster) Cerastoderma edule (Cockle)	Dissolved and particulate p.c.'s
Patella vulgata (Limpet) Littorina littorea (Common Winkle)	Dissolved and detrital constituents
Macoma balthica (Blatic tellin) Nereis diversicolor (Ragworm)	P.c.'s present in sediments

In addition to the above, certain species of flat-fish may be considered for specific contaminants or particular locations.

The minimum sampling programme must include a species from each of the first 2 groups so that the dissolved and particulate phases will be monitored.

(1) Based on ICES criteria

(2) Uncertainties exist over sample size for this species. This number may therefore be an over-estimate - subject to revision.

(3) In practice, small worms (less than ca.50mm) will be difficult and unduly onerous to collect. Unusually large specimens (ca.200mm) should be avoided. Size does not appear to have much influence on accumulation.

(4) Range may vary slightly according to species.

In general it is advisable to take more than the stipulated number of specimens to allow for subsequent loss or rejection of unsatisfactory material. Where readily available, consideration should be given to collecting a second sample batch at the same location either to facilitate duplicate analysis if resources permit, or for storage/archiving. Within the specified size ranges every effort should be made to collect material of the same size, and this size group should be adopted as the specification for subsequent sampling at that location. Appropriate field observations should be recorded at the time of sampling to provide information on any visual evidence relating to possible contamination (e.g. beached chemical containers) and to add the capacity for assessment of aesthetic quality considerations. (Litter). Samples should be returned to the laboratory in cooled containers (but NOT frozen). Each sample should be placed in a clearly labelled plastic bag or clean polythene bucket with seal-tight lid. In the case of sediment dwelling organisms (Cerastoderma, Macoma and Nereis) a small amount of sediment from the sampling site should be included in the package.

Collection methods:

a) Seaweed, mussels and the gastropod molluscs can be simply collected by hand from the rock surfaces on which they live, although limpets will require the use of a stout blade to prize them off.

b) Cockles, Macoma and Nereis will need to be dug for using a fork or small spade, depending on the nature of the sediment and picked out from the sediment by hand or with plastic forceps.

c) Flatfish can be collected by use of a push-net, or small beam trawl deployed from a boat.

4. SAMPLING CONSIDERATIONS

The major criteria for sampling each of the target species are summarised below in Table II.

TABLE II

Target species	No.of specimens	Size (range) mm	Time/Season for collection	Tidal/shore position
F.vesiculosus	25-30	250-300	February	Mid-shore
Fucoid algae (A)	25-30	200-300	February	Mid-shore
M.edulis	50(1)	25-45(1)	Mid.Jan-Mid.Mar	Mid-shore
O.edulis	25	60-100	Jan-Mar	Shallow sub-tidal
C.edule	50	25-40	Jan-Mar	Mid-shore
M.balthica	25+	12-18	Jan-Mar	Mid-shore
N.diversicolor	100?(2)	N/A(3)	Aug/Sept?	Mid-shore
P.vulgata	50	ca.40 (Diameter)	Mar-May	Mid-shore
L.littorea	30	ca.20	Aug/Sept-Nov.	Mid-shore
Flatfish(B)	30*	150-250(4)	Late June-Sept	Shallow areas

* Analysed individually

Notes:

(A) Where F.vesiculosus cannot be obtained, other fucoid algae may offer a satisfactory substitute, but a mixture of species should NOT be used in any one sample. F.serratus should be collected as the first choice alternative on open coasts.

(B) Flounder, Plaice, Dover Sole or possibly Dab may be collected but species must be analysed separately

5. SAMPLE PREPARATION

It is essential to remove extraneous matter from all samples so as to measure only the contaminants in the tissues. This is achieved by external cleansing and/or depuration of gut contents to remove superficial or ingested sediment, and food material. Furthermore, in many cases only selected tissue or tissues are appropriate for particular analyses and dissection is therefore necessary to obtain the relevant material. For example, the shells of molluscs must be removed prior to analysis. The main facets of sample preparation for each target organism are summarised in Table III.

TABLE II

Target Species	Storage prior to cleaneing/ preparation	Cleaneing	Depuration
F.vesiculosus	Refrigeration (up to 10 days)	Scrubbing and washing	N/A
Fucus spp.	"	"	N/A
M.edulis	No	Scrape off growth on shells and scrub clean	48 hrs in clean water
O.edulis	"	"	"
C.edule	Kept cool and in sediment (up to 24 hrs)	Scrubbing and washing	3 to 4 days in clean water
M.balthica	"	"	7 days in clean water
N.diversicolor	"	Gentle washing (in fine sieve)	6 days in acid-washed sand 1 day in clean water only
P.vulgata	No	Thorough washing in clean water	-
L.littorea	No	"	-
Flatfish	Refrigeration (up to 24 hrs)	Thorough washing + gentle scrubbing - remove mucilage and attached matter	-

II

Storage prior to dissection	Tissue Selection	Storage prior to analyses	Reference for further details
No	Old thallus only	Refrigeration Analyse a.s.a.p.	(1), 3
No	"	"	
✓ (Deep frozen)	Remove shells	Can be frozen but best analysed immediately	
"	"	"	
✓ (Deep frozen)	"	"	3
✓ (Deep frozen)	"	"	3
✓ (Deep frozen)	N/A (Whole animals)	Equivalent to storage prior to dissection	11
✓ (Deep frozen)	Remove shells	Can be frozen but best analysed immediately	3
(✓)* (Deep frozen)	Remove shells after boiling for 1 min. or steaming	"	3
✓ (Deep frozen)	Remove white muscle tissue- dorsal fillet, R.H.S. Remove liver (for hydro-carbon analyses)	"	

* Not recommended

Notes: (To Table III)

Washing may usually be carried out with tap water, although clean sea water (if available in sufficient quantities) is probably better. Where cleansing is not followed by depuration, material should be shaken to remove surplus water, or blotted dry.

Depuration should be carried out using water of appropriate salinity according to the area of collection.

Long-term storage is best carried out prior to dissection since losses from whole animals are probably much less than those from cut tissues especially when these have been previously frozen.

If material has not been stored prior to dissection prepared tissue may be stored for an extended period prior to analysis.

The effects of storage have not been well researched, and the recommendations in Table III and accompanying notes are therefore only general guidelines. The U.S. EPA have suggested that material may be stored deep-frozen ($-20^{0}C$) for 6 months to a year, although where tissue is analysed for mercury a period of 1 month has been proposed.

6. ANALYSIS/DETERMINANDS

Details of analytical procedures will be provided elsewhere, and a full list of chemical determinands is given in the Estuaries and Coastal Waters monitoring programme. This section seeks to identify those determinands which can be most effectively monitored by the various target organisms and to identify those determinands which are not satisfactorily estimated by particular species. In addition, relevant biological determinands required e.g. wet weight are also tabulated. The available information is summarised in Table IV. It must be emphasised that assessments are related to indicator reliability for each environmental compartment (phase) as identified in Table I.

TABLE IV

Target Species	Determinands efficiently accumulated/monitored	Determinands NOT reliably monitored	Biological Determinatio
F.vesiculosus) Fucoid algae)	As, Cd, Co, Cu, (Hg), Ni, (Se) (Sn) Zn Fe?	Cr, Pb,	Dry wt. General condition
P.vulgata	Cd, Cu (Ag), (Hg), (Pb)	As	Wet wt.- she Dry wt.- she
L.littorea	Ag, (As), Cd, Pb (Hg)	Co, Ni, (Cr), (Mn) (Fe) (Zn)	"
M.edulis	Cd, (Co) Cr, (Hg), Pb, (Se) (Sn)	Cu, Zn, As, Ag	Wet wt.+ she Dry wt.- she
O.edulis	Cu, Zn, and probably most other metals		"
C.edule	(Ag), (As), (Ni) (Cd)	Cu, Zn	"
M.balthica	Ag, As, (Cr), Hg, Se	Cu, Zn?	Wet wt.- she Dry wt.- she
N.diversicolor	Co, Cu, (Ag), (Hg)	Zn, Fe, Mn	Wet wt.,Dry
Flatfish * (Flounder) (Platicthys flessus)	Hg, Pesticides (CHC), PCB's	Most metals	Sample wet w Dry wt. Length Sex Lipid conter

Notes: ( ) in column 2 denote moderate efficiency .

( ) in column 3 denote poor reliability

Metals not identified in either column may be taken to have some relationship between environmental levels and concentrations in the target organism, although the strength of the relationship is probably not as good as might be considered desirable.

* Analyses and measurements on individual specimens for metals/white muscle analyses. Pooled samples of 5 (or more if small) livers will be needed for hydrocarbon determinations and associated lipid content.

Determinations of whole animal wet weights should be made prior to freezing.

N.B. Results for fish tissues are conventionally reported on a wet weight basis.

Each set of analyses should be accompanied by analysis of a standard reference material.

It may be noted that for some p.c's in certain compartments, there is no recommended organism which acts as a reliable monitor, e.g. Zn in sediments.

Accumulation of heavy metals has been well researched, but little or no information exists on the effectiveness of most of these organisms in accumulating organic compounds. Petroleum hydrocarbons have been 'monitored' in mussels, but it has been suggested that the levels present only reflect very recent exposure to these compounds (10). Clearly the efficacy of using bioaccumulation to monitor persistent organic contaminants requires urgent research.

7. DESIGN OF A NATIONAL PROGRAMME

i) Spacing of sampling sites:

It is recommended that for Fucus spp and invertebrates a minimum of one monitoring point should be established for each 150km section of coast in addition to the proposed baseline sites in each major estuary. Fish collection areas may be more appropriately spaced at greater intervals.

ii) Selection of sampling sites:

Wherever practicable, a monitoring point should be established at locations where the maximum number of the designated target species can be obtained from the same site. Target species not present at the principal location should be collected from the nearest appropriate habitat within the 150km section. In regions of fairly uniform coastal topography where a number of suitable sites exist it is strongly recommended that an initial, more intensive, screening survey be undertaken to assist in the identification of the most appropriate monitoring point. Point source discharges should be avoided if possible.

iii) Selection of target species:

As an absolute minimum, one species accumulating from the dissolved phase plus one species accumulating from the particulate/dissolved phase (see Table I), together with fish (for hydrocarbon contamination) must be collected from each monitoring point/sector. It is also highly desirable that the second species listed for each category is also collected and analysed.

It is likely that in certain sectors some species will be absent or not present in sufficient numbers (or not compatible with the specified size criteria), and there is every possibility that a species collected on one occasion will be absent on a future occasion or occasions. The second species therefore represents a 'back-up' for the main species. Furthermore, since levels of p.c. in one species are not comparable with levels in other species, even for the same

environmental 'compartment', the apparent duplication is necessary to maximise spatial and temporal comparison. Such a 'safety-net' procedure could be reviewed after the early years of monitoring data have been collated and appraised.

iv) Frequency:

Samples should be collected annually at the appropriate time of year (see Table II). Where a range of collection times is given it is recommended that the month selected for sampling in the first survey is established as the collection time for subsequent sampling.

v) Intercomparability Exercises:

It is strongly recommended that intercomparability exercises are undertaken by all contributing laboratories to ensure compatibility of methods and results. This will be especially vital during the first few years of the programme.

8. GENERAL CONSIDERATIONS

The information and guidelines set out in the preceding sections are based on the best data currently available and are therefore subject to modification in the light of continuing research.

There is certainly scope for the introduction of "new" monitoring species, and early returns may demonstrate the need for adopting a programme of transplanting target species to overcome regional variations.

Local investigations -

The programme proposed in Section 7 is intended to fulfill the requirements of a national programme, which should be viewed as the minimum commitment for each Region. Local problems, especially areas receiving appreciable quantities of domestic and/or industrial waste will require more comprehensive investigation. The criteria established here should be incorporated into regional programmes and every attempt should be made to ensure that localised investigations are compatible with national monitoring to facilitate comparison of data. Local programmes will require much greater geographical coverage, and indeed the identification of point source discharges may require sampling intervals of only a few km. (9), although the annual sampling frequency should be adequate for monitoring purposes.

Existing Regional Programmes -

It is appreciated that in some regions relatively comprehensive bioaccumulation programmes already exist and in some cases these have been continuing for a number of years. It is recommended that insofar as possible these programmes be incorporated into the broader framework.

They should therefore be continued at least for a sufficiently long period of time to allow calibration of existing data with that generated for the national programme, in cases where different species have been used, or sampling has been carried out at times of the year other than those listed here. (Data submitted for the national programme must comply with the specifications in this document to ensure the validity of comparisons).

9. LITERATURE CITED

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11. Yorkshire Water Authority. 1984. Collection and preparation of Nereis (Ragworm) for bioaccumulation studies in the Humber Estuary (North bank). Unpublished internal document ref: MG/BHF MDF/037/006, 29/3/84.
Yorkshire Water, North & East Division, 32/34 Monkgate, York, YO3 7RH.

10. OTHER REFERENCE MATERIAL

The following documents are not referred to in the text, but have been used in the preparation of this paper.

a) Investigations into the methodology of bioaccumulation studies. Unpublished report: Welsh Water Authority, Directorate of Scientific Services, Tidal Water Section, Tremains House, Coychurch Road, Bridgend. Tidal Waters Report No. TW 82/4.

b) The concentration of metals, organochlorine pesticide and PCB residues in marine fish and shellfish.
MAFF Directorate of Fisheries Research; Aquatic Environment Monitoring Report NO.16. 1987.

11. RESEARCH AND DEVELOPMENT

During the preparation of this document there was a secondary brief to identify areas requiring research and development. One major facet where knowledge and understanding seems to be distinctly limited is the accumulation of organic chemicals. Certainly in comparison to the reasonably thoroughly researched issue of heavy metal bioaccumulation there is scope for substantial improvement in the scientific assessment of the reliability of most species to act as monitors for the various organic compounds which are of increasing interest in environmental regulation.

It is also apparent that all species so far examined have certain limitations in their usefulness. One potentially versatile group of organisms are the ubiquitous barnacles which occur almost everywhere that any solid substratum exists. Several authorities refer to the promising possibility of using these animals as monitoring organisms, but as yet the potential and limitations of even the most common species have not been adequately researched. In the search for a new and widely applicable target species the barnacle appears to offer a capability which merits further research.

APPENDIX 3

DRAFT NRA BASELINE ESTUARY AND COASTAL WATERS MONITORING PROGRAMME

NRA BASE LINE ESTUARY AND COASTAL WATERS MONITORING PROGRAMME

1. Background

This programme is a first step in the process of producing a national standard monitoring protocol for estuaries which will ultimately seek to rationalise existing monitoring programmes undertaken by the various NRA regions. It incorporates recommendations by Marine Pollution Monitoring Management Group arising out of their review of the UK marine monitoring programme. It also forms part of the Monitoring Master Plan of the North Sea Task Force (NSTF); it is the ultimate intention that NRA will be responsible for monitoring NSTF sampling locations in major estuaries and out to three miles. The opportunity has been taken to bring these requirements together and institute a common programme which will meet the needs of the North Sea Task Force and go some way towards establishing a baseline programme for major estuaries which fall within the responsibilities of the NRA. The present proposals will need to be modified subsequently in the light of future NRA requirements, particularly in terms of frequency and intensity of sampling. The present, very low sampling frequency is largely determined by the needs of the North Sea Task Force. This programme is not a substitute for more intensive programmes (such as those on the Humber and Mersey) which are necessary to meet local requirements but represents a minimum scheme which must be achieved.

2. Objectives

a) To provide baseline information on the quality of coastal waters and major estuaries in England and Wales and to develop standard sites which can be used for trend analysis*.

b) To provide data which can be used to make quantitative comparisons between major estuaries.

c) To fulfil monitoring obligations arising out of North Sea Task Force (North Sea Task Force Monitoring Plan JMG 15/8/2-E, Jan 1990).

d) To fulfil monitoring obligations arising from Joint Monitoring Programme of the Oslo and Paris Commissions.

*NOTE (i) This programme is not a substitute for the more intensive sampling programmes presently underway in some estuaries. Standardisation of the techniques adopted in these surveys will be necessary at a later date.

(ii) The range of determinands included in the programme may need to be changed subsequently to reflect future national and international concerns.

3. Sampling Sites

3.1 Estuarine Sites

Tyne	Southampton Water
Tees	Tamar
Wear	Severn
Humber	Dee
Wash	Mersey
Thames	

Three sites per estuary need to be selected, representative of salinity regimes 0-10, 10-20, 20-30 ppt. Sites should be located within the main channel for water quality monitoring. It may be necessary to go outside the main channel for biological and sediment sampling in order to obtain a representative sample because of local factors such as dredging operations and also for reasons of practicality and ease of access. Once a sampling site has been chosen, all future sampling should be at the same sampling location under the same tidal conditions.

3.2 Intermediate (Coastal Waters) Sites

11 sites (see attached diagram) located at the edge of the estuary plume (i.e. limit of estuarine influence) with one exception in Cardigan Bay. Exact location to be agreed in discussion with MAFF. Where possible these sites should be identical to existing JMP sites.

4. Physico-chemical determinands

4.1 Routine

Determinand	Matrices to be analysed	Component of NRA Programme	Some Matrices form a Component of NSTF Programme
Salinity	2^m	/	/
Temperature	2^m(insitu)	/	/
Oxygen	2^m(insitu)	/	/
NH_4-N	1^m	/	/
NO_3	1^m	/	/
NO_2-N	1^m	/	/
Orthophosphate-P	1^m	/	/
SiO_2-Si	1^m	/	/
Total P	1^m	/	/
Total N	1^m	/	/
Suspended Solids	2^m	/	/
Chlorophyll a	2^m	/	/
Secchi-depth	2^m(insitu)	/	/
Cd	$1,3^m,5,6$	/	/
Hg	$1,3^m,5,6$	/	/
Cu	$1,3^m,6$	/	/
Pb	$1,3^m,5,6$	/	/
Zn	$1,3^m,5,6$	/	/
Ni	$1,3^v,6$	/	/
Cr	$1,3^v,6$	/	/
As	$1,3^v,6$	/	/
DDT (ppDDE,ppDDT,ppTDE, opDDE,opDDT)	$2,3^m,5$	/	/
HCBD	2,5	/	
$CHCl_3$	2,5	/	
PCP	2,5	/	
CCl_4	2,5	/	
PCB (on an individual basis cogener numbers 28,52, 101,118,153,138,180)	$2,3^m,5$	/	/
γ - HCH	$2^m,5$	/	/
α - HCH	$2^m,5$	/	/
HCB	$2,3^m,5$	/	/

Dieldrin	$2,3^{v},5$	/	/
Aldrin	$2,3^{v},5$	/	/
Endrin	$2,3^{v},5$	/	/

4.2 One-off Survey

Determinand	Matrices to be analysed	Component of NRA Programme	Some Matrices form a Component of NSTF Programm
Polynuclear aromatic hydrocarbons (Benx[a]anthracene, Benzo[a]pyrene, Benzo[b]fluorathene, Benzo[e]pyrene, Benzo[ghi]perylene, Chrysene, Fluoranthene, Ineno[1,2,3-cd]pyrene, Phenanthrene, Pyrene)	$2,3^{v},5$	/	/
Polybrominated biphenyls (flame retardants)	2,5 (NSTF matrix to be specified	/	/
Dioxins	$2,3^{v},5$	/	/
Atrazine	$2^{v},5$	/	/
Simazine	$2^{v},5$	/	/
Toxaphene	$2,3^{v},5$	/	/
Chlordane (Cis-Chlordane, Trans-nonachlor, Trans-chlordane, Oxychlordane)	$2,3^{v},5$	/	/
Methyl mercury	4^{v}		/
TBT	$3^{v},4^{v}$		/

4.3 Matrices to be analysed

Code used in 4.1 and 4.2:-

1 - filtered water sample
2 - unfiltered water sample
3 - surficial sediment, size fraction to be defined by NSTF
4 - shellfish tissue as defined by NSTF
5 - bioaccumulation organism consistent with recommendations of proposed NRA bioaccumulation protocol; preferably molluscs for organics and molluscs and seaweed for metals from estuarine sites
6 - surficial sediments, <63 μm size fraction to be analysed; analysis of sediments must include measurement of particle size distribution/composition to aid normalisation.

m - mandatory determinand within NSTF programme; matrix and sample preparation/analysis must be consistent with the requirements of NSTF. Data must be collected for NSTF programme during 1990/91.

v - voluntary determinand within NSTF programme; matrix and sample preparation/analysis must be consistent with the requirements

of NSTF. An attempt should be made wherever possible to recover data for NSTF programme during 1990/91.

5. Microbiological Determinands

E.Coli
Total coliforms
Faecal streptococci

NB these determinands will only be recovered from estuarine sampling sites, not intermediate sites and not part of the NSTF programme.

6. Biological Sampling

6.1 Benthic sampling; organisms will need to be identified to species level. A separate sample at the same location will be required for granulometric analysis, determination of redox potential (Eh) at 1 cm intervals to a depth of 10 cm at least and for elemental analysis of carbon and nitrogen to provide an estimate of organic enrichment (the presence of coal should be identified where appropriate). Estuarine samples should be recovered from areas of the estuary broadly consistent with the salinity regimes specified in Section 3.1 and should be representative of each of the different substrate types present in the estuary and should also be recovered from the intermediate site. These analyses are a mandatory component of the NSTF programme as well as part of the NRA programme; data must be collected for NSTF programme during 1990/91 using approved NSTF methods.

6.2 Oyster embryo biossay. This analysis will almost certainly need to be contracted out by the NRA on a nationwide basis. These analyses are a mandatory component of the NSTF programme as well as part of the NARA programme; data must be collected for NSTF programme during 1990/91 and analysis undertaken in line with NSTF requirements. The bioassay should be undertaken on water samples recovered from the three estuarine sites and the intermediate site.

7. Optional Determinands ††

7.1 Mussel scope for growth. Sampling protocol to be defined following discussions with WRc but only likely to be undertaken on estuary samples.

7.2 Fish population assessment (only within estuary).

7.3 Fish pathology on samples recovered from 7.2.

†† NOTE These optional determinands are only likely to be included where they are already present in existing programmes and for which there is sound local justification for their presence. They are not part of the NSTF programme.

8. Sampling Frequency

8.1 Estuarine Sites

8.1.1 Physicochemical determinands

Routine determinands four times per year corresponding to seasons for water column sampling; once per year for sediment/bioaccumulation sampling as specified in the NRA bioaccumulation sampling protocol.

8.1.2 Microbiological determinands.

Four times per year corresponding to seasons.

8.1.3 Benthic sampling

Once per year November - February inclusive.

NOTE Ideally sampling at all sites within a single estuary should be undertaken on the same day on each occasion although this is not essential if there are sound practical reasons for not doing so.

8.1.4 Oyster Embryo Bioassay

Once per year November - February inclusive.

8.2 Intermediate Sites

8.2.1 Physicochemical determinands.

Routine determinands once per year November - February inclusive.

8.2.2 Benthic sampling

Once per year November - February inclusive.

8.2.3 Oyster Embryo Bioassay

Once per year November - February inclusive.

9. Tidal State

Estuarine water samples should be recovered at or around highwater preferably on or around neap tides, unless worst case conditions expected at other times due to local circumstances or there are sound practical reasons for sampling at other times. Neap tides are also preferred for intermediate sites.

10. Depth in Water Column

Water samples should be recovered at about 1m below the surface. Where significant stratification occurs it may be more appropriate to specify other depths to obtain a representative sample.

11. Bioaccumulation Sample Collection

For those determinands which form part of NSTF programme, first choice bioaccumulation shellfish species is *mytilus edulis*; number 50±10%, size 2-6cm with a mean of 4-6cm, analysing whole soft tissue. Second choice in NSTF programme is *Crassostrea gigas*; number 10±10%, size

9-14cm (2 years of age), analysing whole soft tissue. Otherwise, sampling, treatment and preservation must be consistent with guidance given in the Bioaccumulation protocol. Samples will almost certainly be collected from the margins of the estuary at locations largely dictated by the distribution of suitable organisms.

12. Analytical Methods

12.1 NSTF analysis

These physicochemical and biological samples must be analysed using approved methods identified in Annex 2 (attached) of 15th Meeting of the Joint Monitoring Group 23-26 January 1990; these methods should be discussed and agreed with MAFF or other representatives of the North Sea Task force in their bilateral discussions with individual regions on their contribution to the North Sea programme. These methodologies are mandatory and must be adhered to. In some instances this may necessitate analyses being subcontracted out - possible examples include the oyster larvae bioassay, dioxins and other organics included in the one-off survey list and the NSTF requirement for HF digestion of sediments for trace metal analyses. These analytical suites should be identified and a co-ordinated NRA decision taken as to an appropriate course of action.

12.2 NRA analysis

An agreed set of sampling, preservation and analytical methods must be identified as a matter or urgency and must be used by all regions to ensure comparability of data. In some instances the same analytical procedures as adopted by NSTF should be used to ensure inter-national consistency and avoid unnecessary and wasteful duplication - examples include the analysis of benthic samples, nutrients, salinity etc. However in the case of sediments it is likely that the NRA will wish to use a selective acidic lead on the <63 μm fraction of sediments rather than the total digestion preferred by NSTF, so there will be an element of duplication in sediment analysis at some sites.

12.3 Quality Assurance

It is essential that NRA data collected in this programme is comparable between regions and is acceptable at an inter-national level. This requires adherence to approved techniques and participation in the NSTF QA programmes for the various determinands. The NRA is already involved in a major international QA workshop for some chemical determinands - Anglian Region Laboratory is the first tier NRA laboratory.

13. Organisational Responsibility for sampling sites

13.1 Estuarine Sites

National Rivers Authority.

13.2 Intermediate Sites

For the purposes of the North Sea Task Force, responsibility for individual sites should be agreed between NRA and MAFF having regard particularly to the availability of suitable sampling vessels and associated safety considerations. Whenever possible the NRA should assume responsibility particularly in the longer term. Location is to be agreed in discussion with MAFF.

14. Duration of Programme

14.1 NRA baseline programme

Ongoing with a review and update of determinand suite every five years.

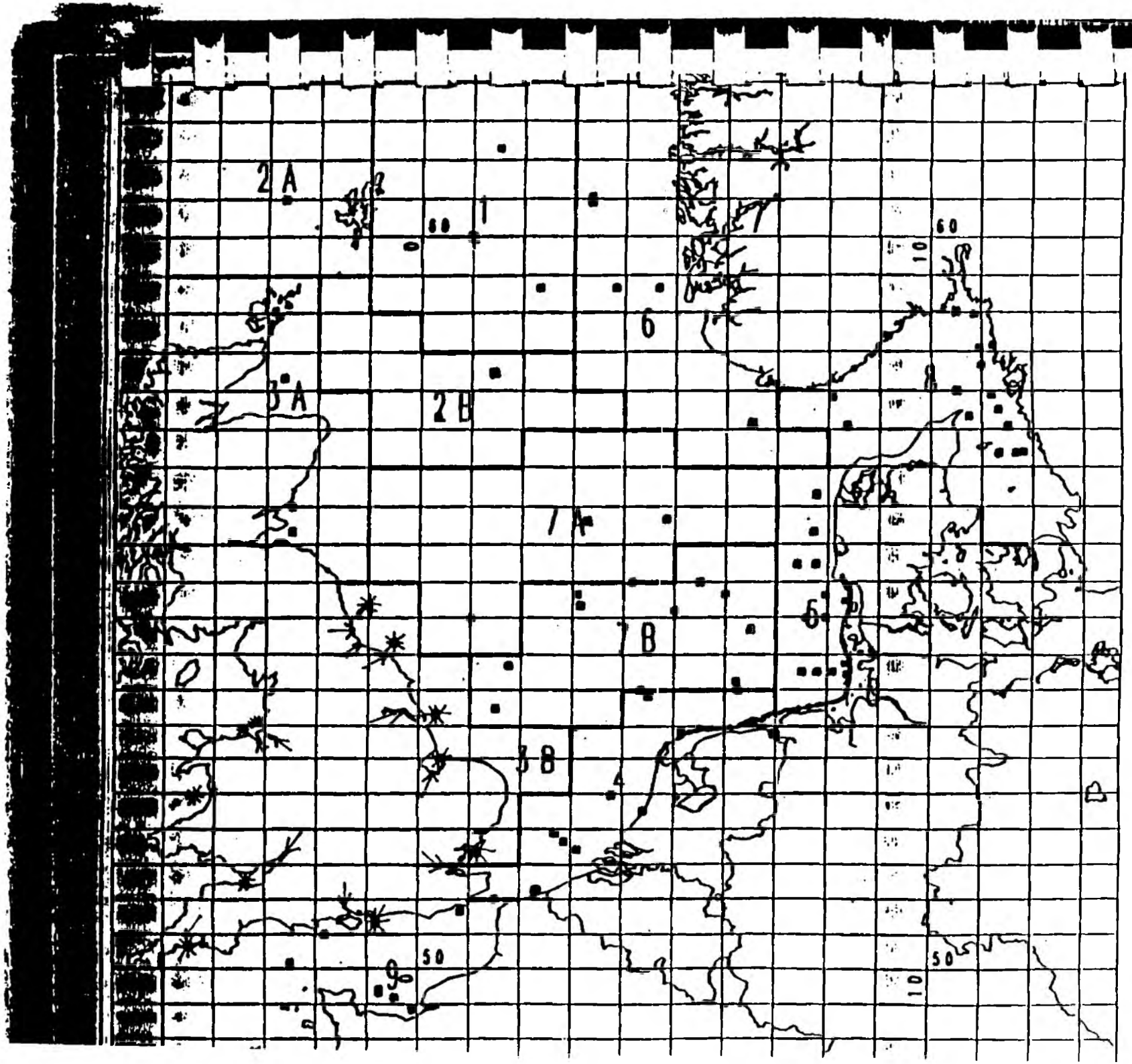
14.2 North Sea Task Force Programme

Commence 1990 and review at end of 1991.

14.3 Joint Monitoring Programme

Ongoing.

PL/EAM/M2jmm
20.03.90.



NORTH SEA TASK FORC

MONITORING MASTER PLAN (90/9

Location of main monitoring stati

according to the NSTF Sub-Regio

LEGEND :

■ N S T F - station

DATA PROCESSING & CARTOGRAPHY :
CORINE - CEC, DG XI/A/6 12/85

* Provisional NCA network sites, to be agreed with NCA's/Estuarine sites.

LIST OF SELECTED REFERENCES OF THE MOST RECENT GUIDELINES FOR THE CONDUCT OF THE JOINT MONITORING PROGRAMME

General

1. Monitoring Strategies. Report of the ICES Advisory Committee on Marine Pollution, 1988, (Section 4), Coop. Res. Rep. No. 160.

2. Advice on the most appropriate matrices for use in monitoring for the purposes of assessing risk to human health, assessing spatial distribution and assessing temporal trends. Report of the ICES advisory Committee on Marine Pollution, 1989 (Section 6), Coop. Res. Rep. No. 167.

Seawater

3. Guidelines for the sampling and analysis of trace metals in seawater under the Joint Monitoring Programme. Tenth annual Report on the Activities of the Paris Commission (1989), Annex 24.

4. Trace metals in seawater. Sampling and storage methods. ICES Techniques in Marine Environmental sciences, No. 2, 1987.

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Sediments and Suspended Particulate Matter

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