

GREY TIDE AGAINST GREEN MARSH -  
SEA DEFENCES IN EAST ANGLIA  
SYNOPSIS OF PROCEEDINGS OF CONFERENCE  
HELD AT SNAPE on 1st NOVEMBER 1991

ENVIRONMENT AGENCY



132158

SEA DEFENCE CONFERENCE - 1st NOVEMBER 1991

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GREY TIDE AGAINST GREEN MARSH - SEA DEFENCES IN EAST ANGLIA

CONFERENCE AT THE CONCERT HALL, SNAPE, SUFFOLK

1st NOVEMBER 1991

GUEST OF HONOUR - THE RT. HON. JOHN GUMMER, M.P., MINISTER OF AGRICULTURE

P R O G R A M M E

- 09.30 Assembly and Coffee
- 10.00 WELCOME by Clive Mason - Regional Manager (Flood Defence and Operations), NRA
- 10.05 INTRODUCTION by John Martin, CBE - Chairman, Anglian Regional Flood Defence Committee
- 10.15 PAST LOSSES AND PRESENT SOLUTIONS - Ian Hart, Operations Manager (Eastern), NRA
- 10.40 NRA's GENERAL STRATEGY - Current and Future - Mike Child, Engineering Manager, NRA
- 11.05 SALTWATER FLOODING IN BROADLAND - A Threat to Agriculture and the Environment - John Ash, District Engineer (Norfolk), NRA and Jane Madgwick, Assistant Broads Officer (Conservation), Broads Authority
- 11.30 BARRIERS, FOR AND AGAINST - The Value and Limitations of Barriers as a Means of Estuarial Defence - Stephen Worrall, District Engineer (North Essex), NRA
- 11.55 ADDRESS by Lord Crickhowell - Chairman of NRA
- 12.00 Questions
- 12.15 Lunch
- 13.45 THE IMPORTANCE OF SALTINGS IN COASTAL DEFENCES - Dr. A. Brampton, Hydraulics Research
- 14.15 COASTAL PROCESSES AFFECTING COHESIVE SEDIMENT COASTLINES - Dr. J. Pethick, Hull University
- 14.45 ENVIRONMENTAL CONSIDERATIONS AND PRIORITIES IN RELATION TO ESSEX RURAL SEAWALLS - Mr. A. St. Joseph, Wetlands Advisory Service Ltd.
- 15.15 COASTAL MANAGEMENT FOR THE 21st CENTURY - Professor T. O'Riordan, University of East Anglia
- 15.45 Questions
- 16.00 CLOSING ADDRESS - The Rt. Hon. John S. Gummer, M.P., Minister of Agriculture
- 16.15 Tea and Disperse

SEA DEFENCE CONFERENCE - 1st NOVEMBER 1991

D E L E G A T E S

<u>Organisation</u>	<u>Name</u>
Anglian Regional Flood Defence Committee	Dr. M. George Mr. C.G. Groome Mr. D.C. Hoyes
Association of Drainage Authorities	Mr. K.A. Buckley (Secretary, East Anglian Coastal Branch)
Broads Authority	Mr. M.C. Broom (Chairman, Navigation Committee)  Mrs. S. Ashford (Vice-Chairman, Planning Committee)  Mr. M. Aitken-Clark (Principal Adviser & Chief Executive)  Mr. R.T. Bramley  Mr. P. Ashford (Consultant)
Castle Point District Council	Cllr. Mrs.V.C.Elworthy (Chairman)  Mr. N.P. Thomas (Chief Technical Officer)
Colchester Borough Council	Mr. G. White (Deputy Town Clerk)  Mr. J.W.T. Hutton (Chief Technical Officer)
Council for the Preservation of Rural England	Mrs. E.H. Clothier (Essex Branch) Mr. E. Pearson (Essex Branch) Mrs. A. Bartlett (Essex Branch) Mr. P. Edwards (Suffolk Branch) Ms J. Hannam (Norfolk Branch) Mr. H. Murland (Norfolk Branch) Mr. M. Walton (Norfolk Branch)
Country Landowners' Association	Lord Tollemache (Chairman) Lord Marlesford Mr. M.T. Thomasin-Foster Mr. R. Lane Mr. H.G. Cator Mr. B.A.F. Swayne Mr. B. Blower Mr. J.E.B. Hill Lt. Col. I.K. MacKinnon (Regional Secretary, Norfolk & Suffolk)
Countryside Commission	Mr. T. De Keyzer

English Nature	Mr. R. Rafe Dr. C. Gibson Dr. J. Dagley Mr. I. Black Mr. C.S. Waller Dr. G. Radley Mr. C. Doarks Mr. J. Clitherow
Essex County Council	Cllr. M.S.S. Rose Mr. K.W. Boddie Mr. M.A. Sibson (Emergency Planning Officer)
Essex Land Drainage Consultancy	Mr. T.J. Wilby
Essex Local Flood Defence Committee	Mr. F.S. Thornton (Chairman) Mr. R.A. Brice Cllr. T.E. Dale Mr. R.M. Hamilton Cllr. R.C. Howard Cllr. G.R. Miles Mr. W.H.R. Squier Mr. E.W. Strachan Cllr. J.A.W. Whitehead Mr. P. Moorhouse (former member)
Essex Wildlife Trust	Dr. C.J. Miles
Felixstowe Port Authority	Mr. G.R. Steele (Head of Civil Engineering)
Fisheries Advisory Committee, Eastern Area	Mr. S.E. Alden (Chairman) C.E. Wigg
Guests of Delegates	Mr. R.W. Mann (Farmer)
Great Ouse Local Flood Defence Committee	Mr. J.M. Childs (Chairman) Mr. A.G.F. Richardson
Great Yarmouth Borough Council	Cllr. O. Lloyd Cllr. J. Barnes Mr. M. Dowling (Planning Officer) Mr. D.V. Greasley (Principal Eng.)
Great Yarmouth Port Authority	Mr. M.C.M. Boon (Chief Executive) Captain A. Goodlad (Harbour Master)
Harwich Haven Authority	Captain V.A. Sutton (Chief Executive)  Mr. R.S. Allen (Harbour Engineer)
Internal Drainage Boards	Mr. P.J. Mann (Chairman, Alderton, Hollesley & Bawdsey IDB)
Ipswich Port Authority	Mr. J. Austin (Chairman) Mr. P.D. Measham (Chief Engineer)
Kent & Essex Sea Fisheries Committee	Mr. J. Wiggins

King's Lynn Consortium of IDBs	Mr. B. Hornigold Mr. L.V. Wright (Clerk to IDBs)
King's Lynn & West Norfolk Borough Council	Cllr. Mrs. E. Kemp (Mayor) Cllr. J.B. Howling Mr. S.J. Beales (Community Services Manager)
Land Agents, Estate Agents & Valuers	Mr. M. Horton (Messrs. Savills) Mr. H. Wykes-Sneyd ) Strutt & Mr. S. Wallis ) Parker
Lincolnshire Local Flood Defence Committee	Mr. W.E. Grant (Chairman) Cllr. J.A. Fisher Cllr. Mrs. M.R. Giles Cllr. D.G. Mawby Mr. R.H. Tunnard
Ministry of Agriculture, Fisheries & Food	Mr. D.A. Boreham (Regional Director)
	Mr. A. Ibbotson (Acting Regional Engineer)
	Mrs. R. Edwards (Fisheries Laboratory)
Maldon District Council	Mr. E.A.P. Plumridge (Chief Executive)
Mascall, Arthur (Consultant)	Mr. A. Mascall
National Farmers' Union	Mr. W. Brigham (Norfolk Chairman) Mr. D.L. Ritchie (Norfolk Branch) Mr. J. Paul (Suffolk Chairman) Mr. P.A. Evans (Essex Chairman) Mr. P. Fane (Senior Policy Adviser)
National Rivers Authority	Lord Crickhowell (Chairman of NRA)
	Mr. J.H.M. Norris (NRA Board Member)
	Mr. P.A. Brandt (NRA Board Member & Chairman of Anglian Regional Advisory Board)
	Mr. R. Hyde (Regional General Manager)
	Mr. R. Linfield (Regional Manager Fisheries, Recreation, Conservation & Navigation)
	Mr. G. Beel (Operations Manager, Central)
	Mr. B. Utteridge (Operations Manager, Northern)

NRA (contd.)

Mr. J. Robinson  
(Planning Engineer)

Mr. B.F. Elsdon  
(Planning Engineer)

Mr. S.J. Hayman  
(Operations Engineer, Eastern)

Mr. P. Barham (Fisheries &  
Conservation Officer)

Mr. J. Hesp (Projects Manager)

Mr. N.B. Woonton (District  
Engineer, King's Lynn)

Mr. C.W. Beazley  
(District Engineer, Suffolk)

Mr. C.T. Ramsden (District  
Engineer, South Essex)

Mr. T.P. Miller (Assistant  
District Engineer, South Essex)

Mr. S.D. Jeavons (Assistant  
District Engineer, Norfolk)

Mr. D. Taylor  
(Principal Quality Officer)

Mr. R. Runcie (Senior Engineer)

Mr. A.M. Dixon (Senior Engineer)

Mr. M.G. Jones  
(Principal Committee Clerk)

Miss D. Prigmore  
(Assistant Conservation Officer)

Mr. P.Ward (Works Superintendent)

Mr. C.W. Roberts (former staff)

Mr. C.A. Boar (Finance Director)  
Mr. J. Wright (Principal Planner)

Norfolk County Council

Norfolk & Suffolk Local Flood  
Defence Committee

Mr. H.A. Duffield (Chairman)  
Mr. D.C. Adams (Vice-Chairman)  
Sir Peter Batho, Bt.  
Mr. P.D. Blaxell  
Mr. N.G. Chapman  
Mr. J.B. Gardiner  
Sir Edward Greenwell, Bt.  
Mr. J. Haylock  
Mr. M. Holmes  
Mr. R.D. Phelan

North Norfolk District Council	Cllr. B. Alton Mr. D.G. Evans (Chief Planner) Mr. M. Terry (Asst. Chief Planner) Mr. P. Lawton (Technical Officer) Mr. B. Farrow (Coastal Engineer)
Parliamentary Candidate (Prospective)	Mr. J. Whittingdale (South Colchester & Maldon)
Posford Duvivier Environmental	Miss A. Reynolds
Reading University (Postgraduate Research Institute for Sedimentology)	Dr. K. Pye
Rochford District Council	Cllr. Mrs. E. Hart (Chairman)  Mr. P. Hughes (Chief Executive Designate)  Mr. S. Peen (Assistant Chief Executive)
Royal Society for the Protection of Birds	Dr. R. Buisson Mr. R. Land Mr. S. Babbs
Southend-on-Sea Borough Council	Mr. D. Moulson (Chief Executive) Mr. P.M. Longden (Director of Development)
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Sudbury Upper School	Mr. N.H. Fraser
Suffolk Coastal District Council	Cllr. C.W. Webb Mr. B. Saunders (Chief Engineer) Mr. R. Stoddard (Coast Protection Engineer)
Suffolk County Council	Cllr. C.W.M. Penn (Leader)  Mr. E.E. Barritt (Chief Planning Officer)  Mr. J.T. Hindle (Principal Asst. Planning Officer)  Mr. J. Grand (First Assistant County Treasurer)  Mrs. M. Gough (R & D Officer)
Suffolk Wildlife Trust	Dr. C. Beardall (Conservation Manager)
Tendring District Council	Mr. R. Coulter (Director, Envir- onmental & Technical Services)



Tendring District Council (contd.)

Mr. A.G. Mowle (Deputy Director,  
Technical Services)

Mr. W. Newman  
(Principal Planning Officer)

Thurrock Borough Council

Cllr. M. Millane (Deputy Mayor)

University of East Anglia  
(School of Environmental Sciences)

Dr. F. Maguire  
Ms S. Bateman  
Mr. P. Doktor  
Ms K. Carpenter  
Miss K. Brown

Waveney District Council

Mr. T. Oakes (Technical Officer)  
Mr. K. Tyrrell (Principal Eng.)  
Mr. P.J. Perkin (Asst. Planner)  
Mr. J. Rowley (Senior Planner)

Welland & Nene Local Flood Defence Committee

Mr. D.J. Riddington (Chairman)  
Mr. J.H.R. Hoyles  
Mr. J.H. Proctor

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WELCOMING ADDRESS

Clive Mason - Regional Manager (Flood Defence & Operations)  
NRA Anglian Region

I should like to welcome you all to this conference: the splendid attendance includes many eminent people. The NRA, as guardian of the water environment, has achieved a great deal during its short existence. Flood defence represents half the business of the NRA and is a vital function in Anglian Region with its long coastline and high ratio of low lying land. The conference is intended to increase awareness of the constant threat and challenge posed by the North Sea, to explain how the NRA is endeavouring to meet the challenge and to emphasise the need for resources to allow progress to be made. The NRA can never relax its efforts to protect people, property and land from the sea. I hope that delegates will leave the conference with a better understanding and a determination to help obtain resources.

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INTRODUCTION

John Martin, CBE - Chairman, Anglian Regional Flood Defence Committee

I endorse the welcome to you all, and it is a particular pleasure and honour to have the presence of Lord Crickhowell, the National Chairman of the NRA. The concern for flood defence in Anglian Region is of special significance at the time of the publication of the consultation paper on the creation of an Environmental Protection Agency. It is important to ensure the NRA's succession as a fully integrated body for the management of the whole water environment and that it is not weakened in any way. The particular concern of this conference is for sea defences. With so many claims on the public purse it is important to demonstrate that money is spent wisely, that the right decisions are taken regarding land use and sensitivity shown to the interests of all those affected by our work. I wish to pay tribute to the financial support from MAFF which has doubled in the last few years in Anglian Region. Sea defence is a local as well as national responsibility and there are examples on the North Norfolk, Essex and Lincolnshire coast of what can be done with the full support of the County Councils. Norfolk and Suffolk County Councils should follow their lead. The NRA's flood defence task is to protect life and property and this has an equal priority to other social and community needs. To delay will be gambling with lives and property and with the future.

Anglian Region is in the forefront of strategic management, looking to the whole environment, working with nature rather than confronting it, seeking the right balance between environmental considerations and engineering feasibility, and finding more cost effective solutions. With growing populations, the pressure on land use in the temperate zones is bound to increase for a whole range of recreation and amenity purposes, but land lost to the sea is lost for ever.

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## PAST LOSSES AND PRESENT SOLUTIONS

Ian Hart - Operations Manager, NRA Anglian Region

In contrast to the majority of presentations to be made, which will concentrate on current work and research, the purpose of this paper is to present a brief review of the history of flooding disasters over the centuries, concentrating on its effects on the physical coastline and the coastal communities. History holds many valuable object lessons which serve to stiffen the resolve to meet the challenges imposed by the North Sea. Countless villages in East Anglia have been lost to the North Sea since the Middle Ages, and the present position is that the most exposed lengths of the east-facing seaboard have been retreating this century at approximately 1 metre per annum. This process is not gradual but by several metres at a time in response to specific events. As well as eroding the coastline, North Sea surge tides can overwhelm vast tracts of land, e.g. in 1953 there were 307 lives lost, 400 houses completely destroyed and 42,000 people forced to flee their homes as their houses were flooded. There have been at least 19 recorded flood disasters since the first surviving record of December 1287. Although not regular events, statistically they amount to a disaster every 37 years.

Since Georgian times, fairly basic defences have been sufficiently successful to encourage the building of tidal embankments, but with the increasingly high tides they are often no longer equal to the task. Man has settled on coastal fringes since the earliest times and, despite a catalogue of flooding tragedies, the coastal communities have survived and prospered due to determination, faith and persistence. Today, with the benefit of modern knowledge and scientific techniques, a comprehensive understanding is being gained of coastal processes and how to control the sea's excesses. We have learned the futility of confronting the sea's energy with embattlement style defences, although there may be little choice where there are established towns.

We have to analyse the benefits and costs of sustaining a sea defence. Nevertheless the modern environmentally sensitive "soft engineering" still demands a lot of money. £200m is needed to be spent in the next 10 years to secure the defences of Norfolk, Suffolk and Essex, which represents roughly £10 per head per annum for each community charge payer in those counties. In Norfolk and Suffolk that yearly bill will have to double shortly to provide sound defences, a reasonably modest sum compared with the competing costs of other services such as education, road building, etc. To delay the 10 year programme of works would be risky and dismissive of the benefit of the works already completed.

There is the argument that natural forces cannot be denied by man's most sophisticated engineering; also that the maintenance of the established line of sea defences could damage the natural environment, and that it may be wiser to allow natural processes free rein in uninhabited rural areas. The danger of this philosophy is that, economically, coastal erosion is an irreversible process. Secondly, sea defences protect the entire coastal margin, mankind's as well as nature's habitat, and coastal fringes represent a critically important reservoir and refuge for the natural environment. At present there is insufficient knowledge of coastal processes to be able to manage natural defences such as sand dunes to provide a secure sea defence.

Whilst the value of any investment will eventually and inevitably be extinguished, wise investment is still worthwhile to protect both mankind and all sorts of other communities and their respective habitats. Some recent flooding events could have been a repetition of the tragedies of earlier years, had it not been for the existence of improved sea defences.

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## NRA's GENERAL STRATEGY - CURRENT AND FUTURE

Mike Child - Engineering Manager, NRA Anglian Region

Strategy by definition is the art of battle against the forces of nature - as much today as in the past and in the generations ahead. There can be no final solutions, as the course of nature cannot be changed and the sea will continue to batter the coast. It is necessary to be in a continual state of readiness to react when the inevitable major North Sea surge happens. A sound strategy will help survive the battle with nature. A strategic approach has the benefit of a long term coastal overview on an integrated basis, and avoids the piecemeal approach. The strategy relies on a battle plan - information, options, resources and flexibility.

Information is needed about coastal processes, the condition and age of the defences, environmental and conservation needs, etc. Anglian Region has developed one of the most comprehensive databases, covering every aspect to be taken into account for coastal management and the design of defences. Coastline monitoring is very important to ensure that this information is continually updated. Options have to achieve targets and standards of defences, achieve technical soundness with value for money and minimum environmental impact, and take account of conflict of interests. There are several options in the armoury to be considered - armoured seawall embankments, groynes, barriers, "soft engineering" such as beach recharge, saltings regeneration and wavebreaks. The "do nothing" option always has to be considered - nature would take its course and there are places where there could be advantages in setting back the defence line: this has to be kept in context, taking into account the risks and long term costs. Resources of manpower and cash, both now and in the future, are required to implement the preferred options. The aim, which we are now achieving, is to plan and develop in good time to allow public consultation. Flexibility is essential to meet changing resources allocation, to accommodate changing coastal pressures and to meet the uncertainties of global warming and sea level change. It is the consensus scientific view that sea levels are rising, although there is no proof. Therefore our plans build in a sea level rise of 7mm per annum. There is no decision to improve all defences, and a move to soft engineering will increase flexibility. Working with nature will give a far better chance to cope with rising sea levels.

Our objectives are to protect people and property (i.e. houses, industry, infrastructure and land: land includes agricultural, developed land, SSSIs, etc.), ensure value for money, maximise benefits and minimise environmental impacts. All these are a permissive responsibility, i.e. we can do the work provided it is justified and we can afford it.

50% of the Region is within the Essex, Norfolk and Suffolk areas, with a variety of coastline. One fifth of the Region is below flood risk level with  $\frac{1}{2}$  million people at risk and £1 billion of property and land. There are 1000km of coastal and tidal defences. 70% of our beaches are getting steeper.

There has been an increase in public environmental awareness. We have entered a new era of coastal zone management and will continue to bring all its aspects into the public arena: it is easy to forget the power of nature and of flood. Drowning was a reality in 1953 and is the reason why we need sound defences and a sound strategy for now and the future.

[At the conclusion of his talk Mike Child gave a graphic account of some of his boyhood memories of the 1953 flood, which he had experienced at first hand.]

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## SALTWATER FLOODING IN BROADLAND - A THREAT TO AGRICULTURE AND THE ENVIRONMENT

John Ash - District Engineer (Norfolk), NRA Anglian Region and  
Jane Madgwick - Assistant Broads Officer (Conservation), Broads Authority

The Norfolk and Suffolk Broads is an area where the constant threat from flooding by the sea has become a reality on numerous occasions over the centuries, with varying degrees of severity. Even without global warming and sea level rise most of the Broads would be affected by saltwater flooding and the consequences for the natural life of the Broads as a whole and the people would be very widespread and complex. Most at risk are the drained marshlands in the lower reaches of the rivers. Further up river valleys peat lands and their rich wildlife would be affected. Fish kills are becoming more regular as a result of saltwater intrusion and the effect is being seen further up the rivers. The Broads Authority devotes much of its budget to restoring freshwater life in the waterways, and in places one tidal surge could devastate the investment. Locations not protected by flood walls, e.g. boatyards, will find operations difficult in times of increased storminess and surges. Pleasure boating is an historical feature of the Broads, but will become very hazardous in the lower reaches if nothing is done. The whole tourist industry could be under threat.

During the Iron Age large areas of Norfolk were open to the sea. Today's landscape, except for the Broads, was formed between the Roman occupation and about 1000 AD. The 13th Century saw the origins of the Broadland flood walls, constructed to permit cultivation of areas adjoining the rivers that flooded more regularly as sea level started to rise. The land was drained initially by gravity sluices through the flood walls. As agriculture intensified, wind energy was used throughout the year, especially during high tide levels. The advent of steam power and latterly diesel and electric pumps allowed agriculture to intensify and produced marshes which supported a freshwater habitat.

The risk of flooding still exists today, not only on high spring tides, but also on those tides where the tide stays in throughout the whole tidal cycle, pushing water into the Broadland river system, giving high levels in the middle reaches. Flooding of protected land is caused by failure of the flood defence wall. This can be by overtopping leading to scouring the back of the bank, with progressive collapse. Some walls fail as a result of poor material and foundations or are subject to wave erosion or seepage at their base. Over the last two years cracking due to the drought has been experienced, the saltwater flooding is having a serious effect on marshes, dry from lack of rainfall. High salt levels have been found at considerable distances inland, either from seepage or possibly from salt moving within groundwater. Water has had to be transported into some areas for livestock to drink.

The marshes between the Rivers Yare and Bure to the west of Great Yarmouth are known as the Halvergate Triangle, an area of some 4,000 ha protected by 30km of flood wall. The main benefits of protecting this part of the Broads will be to farming and conservation. This traditional summer grazing area decreased in viability in the late 1970s and European incentives assisted arable conversion, with grants for improvement to access and drainage systems, which slice through the fabric of the Halvergate Marshes. National public outcry resulted in payments to farmers to maintain a grazing regime, and some land reverted to grassland. Now only about a quarter of the land is under arable cultivation. The area was designated an Environmentally Sensitive Area in 1987, which provided security for its management as a grassland. This involves the conservation and maintenance of a vast network of ditches, from freshwater to brackish, harbouring a great range of types of aquatic communities. Considerable efforts have also been made to return higher water levels, bringing much benefit to wading birds and wildfowl. This enormous range of wildlife on one marsh system depends on

adequate flood protection for the whole area. The riverside banks are protected by reed margins. If these reed rands and banks were to break up, mud flats would form and the freshwater would be lost.

The flood walls protect the Halvergate Marshes to approximately a 1:5 year standard. To maintain that standard will cost £4m over the next 10 years plus an annual maintenance cost of £15,000. To raise the defences to a 1:50 year standard will cost an additional £5m/£6m with annual maintenance costs of £50,000/£60,000.

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BARRIERS, FOR AND AGAINST - THE VALUE AND LIMITATIONS OF BARRIERS  
AS A MEANS OF ESTUARIAL DEFENCE

Stephen Worrall - District Engineer (North Essex), NRA Anglian Region

By definition the word "Barrier" is threatening and emotive and one that is instinctively disliked. However, threatening though the word may sound, it is less distressing than the words "flood", "devastation" and "bereavement": those words can be pushed to the back of the mind when a barrier exists between you and the sea. There is confusion in some people's minds between the words "barrier" and "barrage". A barrier is essentially a surge protection device. It is open for the majority of the time, allowing the tide to go in and out, only being closed on a surge tide. A barrage, on the other hand, is a form of dam which impounds the water. Today's talk will only be concerned with barriers.

It is a popular misconception that barriers are large steel and concrete structures, an eyesore with a devastating effect on the landscape. Although some barriers can fit into that category, the NRA, with its duty to protect, enhance and improve the water environment, does not build that sort of barrier.

The construction of a barrier is not the answer to all problems, but there are situations where it is the right solution, considering all possible options. Appropriate situations are mostly capital funded solutions to an urban area at risk from flooding. The production of feasible engineering options is the starting point in finding the appropriate solution. Next is assessment of the environmental impact, which could preclude any option, regardless of cost. Economics is the third consideration, and cost effectiveness has to be optimised.

Looking at this (illustrated) typical, but fictional, estuary, we have to approach the problem by looking at all the factors to be taken into account and the effect on them of the various options to be considered - "Do Nothing" (an option which always has to be considered); sustain or alternatively raise and strengthen existing seawalls; build new seawalls and counterwalls; foreshore recharge; build a tidal barrier; fill and raise low lying areas; employ a barrage to dam the estuary, etc. Many of these options would not be appropriate but, for this example, consideration of seawall raising and a barrier will be sufficient.

Seawalls have their advantages and disadvantages - there is an existing structure and raising and strengthening often suffices; they are usually the cheaper option (but long frontages are expensive); counterwalls can reduce their length, but require new works inland; they are often the only option. On the other hand many are in SSSIs and works could have a detrimental effect on wildlife habitat; sometimes they cannot be improved; harbours are often left with no defence; A new seawall can itself be a "barrier" to access and to vision as well as tide.

Barriers also have advantages and disadvantages - they protect everything behind them; they reduce the length of sea defence with resultant cost saving on both construction and maintenance; they leave the frontage access and seawall SSSIs undisturbed; careful design and siting can reflect existing harbour structures, reduce silting and scouring, and ease passage for shipping; they can be linked by new embankments to the old seawall; they need not be obtrusive, as the whole structure can be no higher than maximum surge level. However, they can sometimes look unattractive and affect navigation, and in many situations they are not an option. The estuarine regime requires careful study both before and after the building of a barrier.

In conclusion, each case is unique and the solution has to satisfy engineering, environmental and economical requirements. Whether the solution is to build a seawall or a barrier, the NRA will seek out the appropriate solution.

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ADDRESS BY THE CHAIRMAN OF NATIONAL RIVERS AUTHORITY

Lord Crickhowell

The hazards we have been hearing about today are a stark reminder of the Towyn disaster: since my last visit to Aldeburgh there has been a breach. At the press conference announcing the formation of the NRA I said that after the protection of life and property our first priority was tackling the problem of pollution, with which I closely linked the better management of the system - but I said "after the protection of life and property from flood": that must always be the first priority of NRA and Government, central and local. The NRA does a task that will always involve partnership with central and local government. This particularly involves the Flood Defence Committees who have always played such a central role and used local expertise which is vital if the job is to be done properly. So I am delighted that so many of you representing different parts of the partnership are here today.

What is said today will indicate our serious anxieties of what can happen, and emphasises the scale of the problem. The real fear is that 5 years ahead you will find a very significant proportion of the most important projects still unfinished, and the risks will still be too great. The partnership involves people and money.

Because of the complex network of inter-relationships with which we have to deal, drought and water resources, flood defence, pollution control and environment, you cannot, in the view of the NRA, separate these and break them up. That is why we have so strongly expressed the view that, if the Government proceeds with its scheme for an Environmental Protection Agency, it is absolutely crucial that we do not break up the existing responsibilities of the NRA but that they are incorporated within that greater organisation. We are encouraged by the unanimous support received from the major organisations, and that the Government has given adequate time for proper consultation. So we may finish as a wider environmental agency, but whatever its responsibilities, its foremost priority will be and must be the protection of life and property against flood.

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## THE IMPORTANCE OF SALTINGS IN COASTAL DEFENCES

Dr. Alan Brampton - Hydraulics Research Ltd.

Saltings and saltmarshes are widespread around England and Wales, protecting about 2,000km of coast, particularly in this area. They are usually found in estuaries where they are partly sheltered by land mass with a supply of mud and nutrients, the majority fronting agricultural land which itself has sometimes been reclaimed from saltings. As a result there is often little attention paid to them compared with eroding beaches and cliffs, and much less interest than their 20% coverage merits. Management of saltmarshes for coastal defence has the dual constraints of ecological sensitivity and modest expenditure because of the limited benefits.

With their deposits of fine grained material, saltmarshes have little strength to resist erosion from waves, especially on open coasts, and depend on natural regeneration to remain healthy. In the north or west of the country they are generally likely to be more healthy than in the south and east where they are eroding, particularly in Essex and Hampshire, in some places at the rate of 2m per annum. Even in areas where erosion is prevalent it is often found to be patchy, possibly due to sea level rise, climatic change, pollution or reduction in mud supply, but there are no firm conclusions as yet. The problems are not recent and erosion of beaches was observed long before aggregate dredging began.

The erosion of saltmarshes and muddy foreshore, apart from being a loss to the ecology of the area, increases the danger of flooding or erosion of the land behind, especially on open coast saltmarshes as opposed to those well inside an estuary. It is important to ensure that those required to withstand both high tides and wave action remain healthy, as they protect earth embankments and have to be considered a component of coastal defences. Like a beach, the saltmarsh alters its shape, responding to waves and tides, with periods of erosion and regeneration over the years. From a flood defence viewpoint their main value is in resisting the occasional severe event, where they help break waves and partially absorb the energy. Therefore, in sea defence terms, the hydraulic performance of saltings can be examined and measured, using laboratory models and numerical analysis. If salting width decreases, its efficiency diminishes and the wave height at the seawall and the amount of overtopping increases. As the erosion progresses towards the seawall, the wall height has to be raised enormously. This information can be used by the designer to put a value on saltmarshes; it can be shown that several thousand pounds per metre are saved on walls protected by saltmarshes. Against a background of very substantial benefit, the coastal manager considers his options - to accept loss of saltmarsh and raise and strengthen walls; or to place new embankments further inland; or (most attractive although the most difficult) to regenerate the saltmarshes.

The problem of saltings as a flood defence component is that there is no standard technology for managing a saltmarsh coast, nor is there any easy way to measure them as a coastal engineering structure: they are not easily accessible and difficult to monitor. Aerial photography has been tried without great success. Unless this very basic problem is solved we cannot obtain vital information on the erosion/accretion cycle. Without monitoring the manager cannot make good estimates of when and where intervention will be required, nor can the success of intervention works be judged. Even if we had good monitoring methods and understood better why saltmarshes are eroding, the problem is that until five years ago all the regeneration schemes in the UK were experimental and, but for the efforts of the NRA in Essex in particular, there would probably be no methods at all today. Essex has developed methods, using groynes, polders and offshore breakwaters, with some success. Looking further afield, other possibilities include placing a low stone cill around the saltmarsh; the use of artificial seaweed; nourishment with imported mud; and even ploughing the saltmarsh.



A lot more monitoring, research and experience is needed quickly, because the rate of saltings loss in some areas could get rapidly worse with the threat of global warming and sea level rise. It is important to maintain cross disciplinary contacts to help develop effective, appropriate and sympathetic management of saltings with a view to keeping the costs low and ecological damage to the minimum. Only that way will we keep the sea within the limits we choose rather than those it has developed by itself.

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### COASTAL PROCESSES AFFECTING COHESIVE SEDIMENT COASTLINES

Dr. John Pethick, Director of the Institute of  
Estuarine and Coastal Studies, Hull University

There is an important distinction between cohesive muddy coastlines and soft shorelines comprising shingle or sand. Saltmarshes are not an entity in themselves but exist with the mudflats to make the whole inter-tidal profile. Although we do not know enough to produce a textbook for coastal managers, we are beginning to understand the general processes. The function of the coast is energy absorption and it responds in various morphological ways. Whereas a narrow shingle or sandy beach can rapidly absorb the kinetic energy of even a big storm because of the oscillation of millions of grains, this is not true of cohesive sediment shores because particles stick together. Therefore energy is not absorbed as quickly, i.e. not in the same space. Therefore inter-tidal profiles in mud have to be longer than sand or shingle, and absorb energy by friction.

A mudflat is an intricate piece of geomorphology: it absorbs most of the small wave energy, which during an average year is all dissipated by the time the wave reaches the top of the mudflat. Mud is deposited, providing a very calm environment in which saltings can grow and develop vegetation cover. When a larger wave comes in, not all its energy is absorbed by the mudflat and the salting absorbs the remainder. During big storms, say 1:5 years, the saltmarsh itself cannot withstand the wave energy: the edge becomes eroded and retreats. It then has 5 years to recover and grow forward. When the edge erodes some sediment is thrown on top of the saltmarsh and accretes slightly but most of it is deposited on the lower mudflat, which flattens: its slope decreases and its length increases if the tidal range is the same. A saltmarsh under natural conditions will migrate onshore but the whole profile stays the same size because of accretion.

In Essex there is isostatic sea level rise between 3mm/5mm per annum. As floods and wave events become more frequent the saltmarsh does not get 5 years to recover. Continuous erosion replaces the normal process of erosion/advance. The management problem posed by the present shoreline is that the saltmarsh's normal landward progress is stopped by the inshore embankments. Therefore, because of more frequent energy resulting from sea level rise, the Essex saltings erode and the embankments are undercut.

Channels are the other response of the coast to energy. They may range in size from large estuaries to tiny channels a few centimetres across but about a metre deep. The amplitude of the tide decreases as it moves up the narrowing channel from its mouth because of the frictional drag. There are a multitude of very small channels in mudflats and saltings, decreasing in size to fingertip ends: they are a stable form to dissipate tidal energy, neither extending nor eroding. When a creek is cut off by a seawall the tidal energy cannot be dissipated in the

existing system and saltmarsh erosion will occur. Meanders are also a tidal dissipation device. The coastline naturally adjusts to sea level rise in channels of a creek system: balloon ends form at the head of the fingertip to absorb any remaining energy. If that wave has a slight list, it starts to turn, eventually forming concentric rings as more tidal energy is pushed into the marsh. This demonstrates how sea level rise is extending creek lengths and compressing the mechanism into a very small complex.

To summarise, a cohesive foreshore cannot be made smaller without reducing the efficiency of energy absorption. Too much foreshore has been taken by building seawalls and turning marsh into agricultural land. As a result waves reach the unprotected embankment which starts to erode. A wide salting is needed and this could be achieved by converting the first field into a salting and building another seawall behind it. A small experiment to put this into practice has recently been undertaken by the National Trust and NRA at Northey Island in the Blackwater. Set-back is not abandonment: it should be called coastal regeneration. Cost benefit could be shown in terms of saving on the specification for the inner seawall, because of the salting fronting it, and in some cases because of the protection to an existing investment nearby which would result. There are obviously locations where nature cannot be allowed to develop its own processes, and the protection of life and property must always be the first consideration. However, in the right place coastal regeneration can be a beneficial solution.

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ENVIRONMENTAL CONSIDERATIONS AND PRIORITIES  
IN RELATION TO ESSEX RURAL SEAWALLS

Andrew St. Joseph - Wetlands Advisory Service Ltd.

Any consideration of environmental values of the rural parts of the Essex coast is an exercise in documenting existing values and considering future land use. In habitat terms there are 4,500 ha of saltmarsh, 19,000 ha of mudflat, then 300km of seawall and 20,000 ha of floodable land in about 100 farm ownerships. Of that habitat the saltmarsh is far the most significant in nature conservation terms: nationally it is rarer than ancient woodland and Essex contains over half the East Anglian total. In wildlife terms the most visible components are the wildfowl and waders. Essex is among the top 5 coastal wetlands in the country, but losses through erosion are considerable and virtually none of the saltmarsh is now high enough to support populations of nesting waders. There is also a very poor freshwater habitat component, with brackish lagoons and reedbed being equally absent. Seawalls are also important in recreational terms, the coastal footpaths attracting people in increasing numbers.

The capital and maintenance budget totalling over £2m per annum for the Essex rural walls is a major influence on coastal land use. Whilst NRA is facing significantly increasing costs, agricultural over-production remains a problem and income and profitability have declined. This has led to a situation where the cost of the defence exceeds the commercial agricultural land value or income from grazing and shooting rents. The cost/benefit in retaining rough grazing is much less favourable at present than for arable land. Set-aside management agreements in SSSIs provide a far better cost/benefit figure. Whether protecting an SSSI or arable land, maintenance of rural seawalls will become very expensive indeed as the protecting saltmarsh decays.

If a seawall is overtopped before it can be raised, abandonment is a possible alternative, but it favours environmental interests only to a small extent. In recreational terms, the amenity of the coastal footpath would be lost: they are already impassable in some places. Marshes need management to reach their full potential and abandonment is a wasted opportunity. This quandary is not new to coastal engineers: after the 1953 floods, when further raising was impracticable, they were considering designing the earth walls of Essex for overtopping in some places. This technique has been used the other side of the North Sea in areas where erosion is a serious problem. Low walls, with a wider profile and revetted faces, protect the saltmarsh edge and combine with very large wooden sluices to provide a high level saltmarsh. The land is suitable for ESA style farming and landowners receive about £40/£50 per acre of which 95% is EEC funded. Maintenance costs would be significantly lower than those of the existing rural walls of Essex, with the bonus of high densities of nesting waders and grazing wildfowl in winter. The risk of flooding is greater than on the UK coast and inundations are significant, but the large sluices quickly evacuate the bulk of the water. Elsewhere in the Netherlands there are very large seawalls, but even then nature conservation is a recognised land use, and huge areas of reclaimed land have been returned to coastal marsh, attracting vast numbers of birds and waterfowl. These examples, from a country with land use pressures at least as great as those of the UK, demonstrate what can be done with a more integrated land use planning system. If such a system were to be adopted, gradually, in the UK, it would have to fit in with current land use, be economically worth while to the farmer and be seen to have the security of a long term strategy.

The sea defence budget supports coastal protection and crop production on little over 100 farms at a cost of up to 20 times the annual crop profits. Furthermore, current predictions estimate up to 4 million hectares surplus to the nation's food producing requirements in the next 20 years. In the light of these facts, perhaps managed wetlands could be a reasonable option to assess, either as Less Favoured Areas or ESAs. There are already landowners on the Essex coast who are paid up to £40,000 annually to manage coastal land for nature conservation. From an environmental point of view this needs to be extended. It would appear that there are savings to be made and that land losses are not necessarily inevitable.

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### COASTAL MANAGEMENT FOR THE 21st CENTURY

Professor Timothy O'Riordan - Centre for Social & Economic Research  
on the Global Environment, University of East Anglia

If, with climatic change, some of our coastal regions are still to exist in 100 years time, we face a period of substantial commitment. The current arrangements for financing and managing coastal protection are working against its best interests, with one financing partner pitted against the other for the benefit of neither, and in the process making the local authorities innocent and resentful scapegoats. The opportunity for a long term spending programme in planned stages is being reduced, which is contrary to the economics of ecological engineering.

Tidal flood defences and coastal protection involve three inter-connected components:- hard engineering structures (barriers and seawalls); soft engineering (saltings, reconstituted dunes and beaches, and offshore bars); and coastal surgery (deliberate cliff erosion or salting accretion to allow sediment to feed offshore and onshore areas, i.e. specific management of the coastal geomorphological system). If such natural processes are regarded as part of a

legitimate investment in coastal defence, then landowner compensation should form part of that cost. Ecological, environmental and recreational advantages become part of a major flood defence operation and can be included in the cost/benefit analysis to justify expenditure.

A major impediment to the achievement of this new approach is the lack of unified coastal planning controls. A coastal management zone should cover an area of at least 1km offshore to 1km inshore, with extensive onshore and offshore planning controls. There is effectively no planning control on activities below low water mark and no requirement for mandatory Environmental Impact Assessments in areas which can be a vital component of a flood protection strategy.

There are also serious financing impediments to operating these ideas. First, the NRA has no statutory borrowing powers. It must be permitted to borrow to pursue an accountable long term flood management investment strategy. This should be in the region of 40 years, with correspondingly lower discount rates. Secondly, there are no clear rules governing the determination of MAFF grant rate for both tidal defences and coastal protection, making financial planning impossible for the authorities in the absence of a known commitment. Thirdly, local authority funding is governed by the limits imposed by Standard Spending Assessments and the risk of "capping". Therefore the current exigencies of Treasury control over local authority expenditure from year to year dictate the funding available for sea defence. The same restrictions apply to the maritime district councils, who face similar problems financing coastal protection. Although the outlay is eventually refunded through the Rate Support Grant, there are long term implications for flood management, with an ever growing shortfall on expenditure requirements.

Whilst there can be no definitive conclusions at present because of two imminent major changes - the proposed new council tax to replace the community charge and local authority reorganisation - this is the appropriate time to consider how a new regime might be established around certain principles. The NRA must have borrowing powers. Accountability and value for money are essential. The local authorities should be involved in the financing structure of long term coastal management, disassociated from Treasury spending rules which were not designed to deal with the needs of flood defence. Also some form of independent flood protection audit commission could be established to examine mostly non conventional proposals and bring these different approaches to environmental cost/ benefit accounting into the public domain and increase public awareness. The basis of central government financing should be changed to interconnect MAFF and DOE more sensibly and effectively across the two perspectives of flood defence and environmental protection, which are part of the strategic whole. There should be a move towards regionally based coastal management authorities, interlinking local authorities with public agencies such as the NRA and a large number of other interested local organisations: a body not unlike the Broads Authority in its earlier form. It should have delegated to it an extension of planning powers offshore and inshore, linking sediment management and land use with the various flood protection options. Its remit should be interlocked with the financing. Compensation and investment need to be part of the same budget. This administrative structure, primarily based on the NRA, would require the NRA to stay intact and expand its role. Any proposal to split up its functions would be counter-productive to long term coastal management. The whole UK coast should be regarded as a new resource and a major element of a land use strategy, which would include the relationship between the agencies for pollution control and land use planning.

The additional cost of all these proposals could be met from a carbon tax - a tax on global warming, which is one of the major causes of the need to defend the coast. Therefore the polluter pays and the future need not be feared.

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## CLOSING ADDRESS

### The Right Hon. John S. Gummer, M.P. - Minister of Agriculture

One of the most exciting things of the past few years has been the degree to which we have changed our methods of approach, an attitude in which research and development has played a much greater part. We have learned much more from how nature defends itself from the sea and sought much less the expensive confrontation of the past.

The cost and extent of the protection now demanded is such that it is vital to proceed in as environmentally friendly a way as possible. The Ministry's increasing understanding of those responsibilities is demonstrated firstly by the acceptance of a sum in the cost/benefit assessment for value to the environment, which was pioneered on the Aldeburgh Scheme; and secondly by the establishment of regular meetings with interested environmental groups to consider the overall impact, in addition to consultations on individual proposals.

I applaud the strategic approach currently being adopted, with our encouragement, by the authorities. It is essential that we take a broad overview of the problems faced and the strategic options open to us. This provides a better opportunity to gauge the effects of physical factors, coastal processes and global warming, and to assess the environmental consequences of certain courses of action, both locally and nationally. As Minister of State I first built into our projections a figure of extra height in case of global warming - a decision made long before government and the scientific community had accepted the full extent of the dangers. I was therefore pleased to provide nearly £1m in grant towards the Anglian Sea Defence Management Study, which will benefit the planning and design of the Region's coastal defences, foster long-term solutions and encourage development of more environmentally acceptable and appropriate responses to sea defence problems. It will be vitally important for the database to be kept up to date and made available to all. In time I hope it will be possible for other stretches of the coastline to be similarly examined.

The furthering of strategic planning was also behind my encouragement of increased liaison between authorities and the establishment of closer links with the NRA and the Association of District Councils, leading to the setting up of Coastal Groups, now linked through the Coastal Defence Forum, covering much of the coast of England and Wales. Coastal defence is a partnership involving a whole range of different people, overseen by the Ministry and largely carried out by the NRA. This should continue and as many people as possible must be involved in the decisions we make and the environment must have a role. I do not believe we would be better off if we had some Super-Body to integrate and co-ordinate this. It would end up by being another layer of bureaucracy. The NRA have not been slow to react to the message and are developing a general strategy based on their comprehensive study of sea defences in England and Wales and the expected sea level rise due to climatic change. I hope, when we come to discuss the proposals put forward in the government's consultation document on the future of the Environmental Protection Agency, for the same kind of informed and willing criticism which I would expect from this industry.

Government, the authorities and local communities all have a responsibility in providing the necessary resources. This Government has increased the national provision for flood defence on four occasions in recent years; between 1989/90 and 1993/94 the provisions will more than double. In Anglian Region the NRA attracts a grant for sea defence works ranging from 55% to 75%. [see footnote] Grant has also been made available for specialist studies, preliminary scheme investigations and the preparation of Environmental Statements. We have also recognised the different nature of the local authorities' contribution by

introducing special arrangements for flood defence levies via the Revenue Support Grant system. There has been some confusion locally about the way this system operates but it is essential that councils recognise the effectiveness of the RSG arrangements and agree to provide their component of the funding. The Government is playing its part and it is up to others to rise to the challenge. Local communities have a special benefit from what happens and cannot be excluded from either the planning or the paying stage.

The debates will continue and we should build on the very considerable progress we have made, by working in partnership and above all by looking at new problems through new eyes. By working together the people of Britain and East Anglia will be well served by those who fight the battle on their behalf and as their partners against that old and cunning enemy, the sea.

**Footnote:** The Chancellor's Autumn Statement announced a further increase in grant provision in 1994/95 and a rationalisation of grant rates: from April 1992 Anglian Region will attract grant for sea defence works at rates ranging from 55% to 85%.

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