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WAVE DATA AROUND THE COAST OF ENGLAND AND WALES

A Review of Instrumentally Recorded Information

A H Brampton PhD
P J Hawkes PhD

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Registered Office: Hydraulics Research Limited, Wallingford, Oxfordshire OX10 8BA. Telephone: 0491 35381. Telex: 848552

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ABSTRACT

This brief report summarises the present position regarding the availability and quality of instrumentally recorded wave data around the coasts of England and Wales. The main emphasis is on data which can be used in the design of sea defence or coast protection works, including beach improvement schemes. Attention is drawn to areas where more information is required.

For further information on this report, please contact Dr A H Brampton or Dr P J Hawkes, Coastal Processes Section, Maritime Engineering Department.

CONTENTS

1 INTRODUCTION

In recent years there has been a greatly increased awareness amongst coastal engineers of the need for good information on wave conditions close to the shoreline. Because the severity of the wave climate varies greatly around the coastline of England and Wales, different methods of protecting the coast are appropriate in different areas. For example, flood banks in the Thames Estuary can be satisfactorily protected by very light armouring or even by encouraging the growth of salt marshes. This type of defence would be quite impracticable on open coasts in, say, Cornwall or Northumberland.

Generally speaking, the north-west European continental shelf is very well served with data, and it has one of the highest concentrations of wave recorder sites anywhere in the world. Nevertheless, no national policy has ever been established to organise the collection of wave data around the coast of the United Kingdom, and the vast majority of information available stems from specific projects and site investigations. Apart from the consequently rather erratic distribution of recording sites, this data is subject to various degrees of confidentiality, limiting its value. The only significant exceptions to this general rule are the various recording instruments deployed by the Institute of Oceanographic Sciences (formerly the National Institute of Oceanography). Particular mention should be made here of Mr Lawrence Draper whose far-sighted enthusiasm, especially in establishing recording devices on lightships, resulted in a fundamental data set which forms the basis for our present knowledge of the wave climate of the United Kingdom's coast.

The purpose of this report is to review the data available to assist engineers in the design of sea defences and coastal protection works. Firstly, in Chapter 2, the requirements for a suitable wave data set are discussed. This is followed, in Chapter 3, by a detailed review of the wave records which have been collected around the UK coast, identifying the most useful and representative data sets. Finally, in Chapter 4, recommendations are made for future wave recording sites, bearing in mind not only the need for widespread and roughly uniform coverage of the coast, but also the likely need for such data in the future for the design of coastal defences.

It should be pointed out that in this study only instrumentally recorded data has been considered. There is no doubt that visually observed wave information, usually from vessels or lightships, can be very valuable particularly in the open sea. Although any individual observation may be inaccurate, the large mass of data collected over many years usually provides ample compensation. The additional information on wave direction can also be valuable. Around the coast of the United Kingdom, however, there are considerable difficulties in using such data for coastal engineering purposes. This is because ships observations are usually grouped in sea areas too large to provide sufficient information to be representative. For the very varied exposure of the coasts around England and Wales, these areas are too large to be applied with any confidence at any particular location.

It is also worth mentioning that considerable advances have been made in numerical modelling of wave generation and propagation. As a good example, the Fine Mesh Wave Model developed and run by the Meteorological Office provides predictions of wave conditions on an approximately 25km grid around the United Kingdom coast. The most accurate predictions are stored and can be accessed and analysed to provide a synthetic wave climate, with spectral and directional information. This source of data should not be overlooked, especially for open coasts where there is no suitable recorded wave data.

2 THE SUITABILITY OF WAVE DATA SETS

When considering a particular project, the engineer will need to examine the available wave data and decide on its suitability. This decision will be guided by a variety of factors, and this chapter outlines some of the important criteria.

Firstly the location, and the type of instrument used to record the data, need to be considered. As mentioned in the introduction, some of the earlier data was collected using wave recorders on lightships. Whilst the instruments are entirely satisfactory, their locations may not be ideal for coastal studies. For example, some of the lightships were located well offshore and the conditions recorded would need considerable modification to provide realistic conditions closer to the coast. Many of these recorders were deliberately sited close to major sea bed features and hence waves recorded at the vessel might be atypical of the general area.

Pressure sensing wave recorders were also used at an early stage in gathering data, and have continued to be used to the present day. Where such instruments have been deployed in sufficiently deep water, they can produce very useful information. However, some of the sites lie in very shallow water, often in the inter-tidal zone. In such cases the data obtained may be seriously affected by shallow water effects such as wave breaking on the beach or over offshore banks. As a consequence it may be difficult, if not impossible, to deduce the wave conditions in deeper water which gave rise to those actually measured.

The advent of the wave-rider buoy, which has been in routine use for over 15 years, was a major advance and most of the results from such instruments around our shores are directly useful for coastal defence design. Because they cannot be safely moored in areas where waves break, the records obtained are rarely badly affected by shallow water effects, although some sites are on the landward side of offshore banks.

In addition to the equipment which has been used to record waves, however, there are a variety of other factors which need to be considered when deciding whether a data set is useful for a particular purpose. The usual starting point for an investigation of wave conditions at some point close to a coast is to define the "offshore" wave climate. The word "offshore" here is used deliberately. In the relatively shallow seas around the coast of England and Wales it is usually impossible to find a sensible boundary close to the coast in truly deep water (ie where the depth is great enough that no wave refraction effects will occur even for the longest wave periods considered). As a consequence, a more modest depth is usually chosen, the value often being based on the distance offshore (compared to the fetch length) as well as on the expected wave periods (and hence wave lengths). On the coasts of south-east England, the offshore depth used may be perhaps 20-30m, whilst in the north-east or south-west this may increase to around 50m.

Having chosen an offshore location at which to predict wave conditions, the engineer would seek a recording site nearby and in a similar water depth. It will be unusual for a recording site to be found which satisfies these requirements so well that no further adjustment to the data is necessary. This is principally because of the irregular shape of the seas surrounding the United Kingdom. However, computer models, for example of wave generation by winds, can often be used to adjust wave measurements made at one (offshore) site to give corresponding conditions at another. However, such modelling techniques become less accurate if the wave recording site is not representative of the general area in which it is placed. As an example, on a relatively straight coastline a wave refraction model can be used to calculate wave conditions at, say, the 20m contour based on a set of wave records at the 5m contour. These derived offshore conditions could then be used to calibrate a model of wave generation which in turn could be used to derive corresponding offshore conditions further along the coast.

This procedure becomes very much less accurate if the wave measurements have been made in very shallow water or in areas of complicated bathymetry. It is also important that the wave recording site should be close to and similarly exposed to the site of interest. As a trivial example, wave records offshore from the southern end of Chesil Beach will not be of any great value in predicting conditions offshore from Weymouth Harbour, even though the two sites are only a few kilometres apart.

As well as the location of the wave recorder, due account has also to be taken of the period over which the data has been collected. Admittedly the weather conditions in this country are markedly less seasonal than in other parts of the world. Even so, at least one complete winter and preferably a complete year of records are required to give an indication of severe events. If extreme wave heights are to be estimated (ie with return periods of several years or more) either a longer recording period is required, or recourse must again be made to mathematical techniques to link the wave measurements with wind data. This latter method of analysis allows a relatively short period of data to be set into a longer timescale, and significantly improves the reliability of extreme wave height predictions.

It is worth making the point here that the older wind and wave records are often much less easy to adjust in this manner than more recent sets. Much of the wind data collected from anemometers around our coast since about 1970 has been placed on magnetic tapes at the Meteorological Office and can therefore be rapidly accessed and used in computer models. Although it is possible to put a year's wind data into similar format for earlier years, to compare with wave data from a particular site, it will considerably increase the effort required.

Also, older records were generally not analysed to provide wave spectra and if such information is required, say, for laboratory tests it may not be possible even to recover the original data. This is sometimes a problem with records from pressure sensing equipment; the original data is lost and semi-empirical and approximate techniques have been used to produce just a wave height and period. It is therefore always sensible to read any reports which describe the data and its analysis before deciding on the subsequent use of the records.

At present, very few sets of instumentally measured wave data include wave direction. However, recorders capable of giving information on wave direction are just becoming available for routine applications. The proportion of wave records including measurement of direction can be expected to improve dramatically over the next decade.

Finally, since so much of the wave data around our coasts has been collected by commercial organisations, a considerable amount is subject to some degree of confidentiality. Whether or not data, or a report on that data, will be released often depends on the purpose for which it is required. For this report we have assumed that data collected by public organisations (eg local district councils, and water authorities) would be made available for coastal defence designs. For data collected by commercial organisations, it has been assumed that it is not likely to be available, unless we have firm knowledge to the contrary.

3 REVIEW OF WAVE DATA SETS

This chapter briefly describes the way that the wave information has been collated in this study. The locations of the known recording sites, past and present, are shown in Figures 1-3 which respectively cover the south-west, south-east and north coasts of England and Wales. Also shown are those locations where wave recordings are known to be imminent.

A more detailed description of the data sets from these sites is given in the three corresponding appendices to the report. A large proportion of the information in those appendices has been reproduced with the permission of the Marine Information and Advisory Service from their wave data catalogue. Other information has been collected from organisations such as the Central Electricity Generating Board, consulting engineers, harbour authorities and our own files. Whenever possible the following information has been presented:

(a) site name,

(b) the MIAS reference number (from their data catalogue),

(c) the site location (longitude and latitude),

(d) the type of instrument used,

(e) the water depth at the recording site (mid-tide),

(f) the period during which the instrument was on site,

(g) the organisation which owns the data (usually the body which arranged and paid for its collection),

(h) the organisation which deployed the recorder and collected the data,

(i) finally, supplementary notes covering the data quality, quantity, and any other information considered relevant.

Of the many types of recorder that have been deployed three main categories can be identified, as follows:

1. offshore wave-rider buoys that telemeter the data to an onshore receiver,
2. ship-borne (or platform mounted) wave recorders, and
3. pressure recorders usually close inshore, which are either connected to the shore by cable or are self-contained with a cassette recorder inside.

The data in this report is thus designated either from a surface wave recorder, ship-borne wave recorder or a pressure gauge and is further sub-divided by stating whether the data is collected by the Institute of Oceanographical Sciences, Hydraulics Research, British Maritime Technology or some other organisation.

As mentioned previously, the availability of data, or its analysis, is always difficult to anticipate. Many organisations will judge each request for reports (if they exist), or for wave data, on the merits of the intended application.

In view of these difficulties, no attempt has been made in the appendices to comment on data availability or the existence of reports. Generally speaking, data collected by public bodies, and held by MIAS, will be available at a modest fee. Further information on particular data sets can usually be obtained most readily from the MIAS wave data catalogue or the organisation which collected it.

The appendices do contain information on the period over which data has been collected, and this can be particularly important if extreme wave conditions have to be calculated.

Finally, in almost all cases information on significant wave heights and mean periods will be available from each site. If, for example, only maximum wave heights have been recorded, or if extra information such as wave direction is available then this is noted. Attention is also drawn to particular limitations of data sets, for example, recording at high water only (eg Heacham) or when the instrument was principally installed to record long waves (eg Shoreham).

4 RECOMMENDATIONS FOR NEW WAVE RECORDING SITES

An important aim of this report was to suggest a selection of sites, not adequately covered by existing data, at which wave data is likely to be needed by coastal engineers in the near future. As with the remainder of this report, attention is focussed on the coastlines of England and Wales.

A variety of factors have been considered in the compilation of a list of recommended sites. For example, accurate wave data is obviously more important in front of built-up coastal areas, low lying land, or rapidly eroding soft cliff areas than it is offshore from hard rocky cliffs.

There is also a need for a greater density of wave recording sites in areas such as East Anglia or the south-east corner of England, than on, say, the north-east coast. This is because there is a greater variation in wave climate in the former areas, due to both the rapidly varying fetch lengths, and to the complicated and often extensive shallow water areas.

In view of all this, seven proposed locations for wave recording have been marked on Figures 1-3. It is suggested that a wave-rider buoy should be deployed at each site for at least one year, and the approximate priority for each recording exercise is indicated by the order of their listing.

1. Off Trusthorpe, Lincolnshire

   There is apparently no substantial period of wave data for the 60km of Lincolnshire coast between the Humber and the Wash. Presently beach levels along this frontage are giving rise to considerable concern. Several substantial lengths of sea wall may require expensive rehabilitation in the near future, and adequate wave information would be both valuable and timely.

2. Off Aberystwyth, Cardigan Bay

   There is presently only one set of offshore wave data for the west-facing coast of Wales. The proposed site in the centre of Cardigan Bay, when combined with wind wave modelling and refraction calculations, would be of use throughout most of the inner 100km of Cardigan Bay.

3. Margate, Kent

Although the Thames Estuary is well served with wave data it is mainly offshore or more relevant for the Essex coast than for the north-east facing coast of Kent. This site would provide useful calibration data for about 30km of coast, including the whole of the Isle of Thanet and also further east.

4. Off Blyth, Northumberland

The north-east coast of England is poorly served with wave data. Some coastal problems have been experienced near Blyth in recent years, but data gathered here would be representative of perhaps 50km of coastline.

5. Off Workington, Cumbria

There is presently no measured data representative of the Cumbrian coast and Solway Firth. The proposed position would provide offshore wave conditions for the 50km of English coast north of Whitehaven (plus as much again of Scottish coast).

6. Off Torbay, Devon

There is inshore data in Lyme Bay for specific sites but nothing suitable for general offshore use in an area 50km wide which is subject to cliff erosion.

7. Off Bude, Cornwall

This would provide offshore data for about 60km of coast in north-east Cornwall.

It is also realised that by no means all of the wave data collected around the coastline is included in Chapter 3. This is because MIAS is not always made aware of the existence of this data. It would be extremely useful if, when data collection funded by central government takes place, a pre-condition would be that MIAS was informed of its whereabouts and the type of information collected.

5 CONCLUSIONS

Opportunistic data gathering has generally served well in the past, but as might be expected, coverage is patchy and some data is confidential. There is a need to improve the situation with extra wave recording so as to fill in those gaps around the coast of England and Wales, where there is at present no representative instrumentally measured wave data. This report has identified seven locations where such recording may be carried out.

Mathematical models are now good enough to enhance any available data, in terms of its extension to more points in the vicinity, its transfer offshore/inshore, and to increase the record length. Nevertheless, there is still considerable scope for more data at many points around our coast. Such data will not only reduce the extent to which mathematical models have to extrapolate results from other sites, but also to help those models by providing calibration data.

The authors also feel that there should be a permanent review body, equivalent to the Tide Gauge Committee, to monitor wave recording and report regularly to

MAFF. Finally, the present report has considered wave data around England and Wales; it would be worthwhile to undertake further studies in due course for data availability around Scotland and Ireland.

6 ACKNOWLEDGEMENTS

We would like to gratefully acknowledge the substantial contribution made to this project by the Marine Information and Advisory Service, and by Mr Lawrence Draper in particular. Also, we would like to thank Mr Peter Moulding of the Central Electricity Generating Board, Barnwood, Gloucestershire, and Mr R A Sproson of Marex Technology Limited, for providing useful information.

FIGURES.

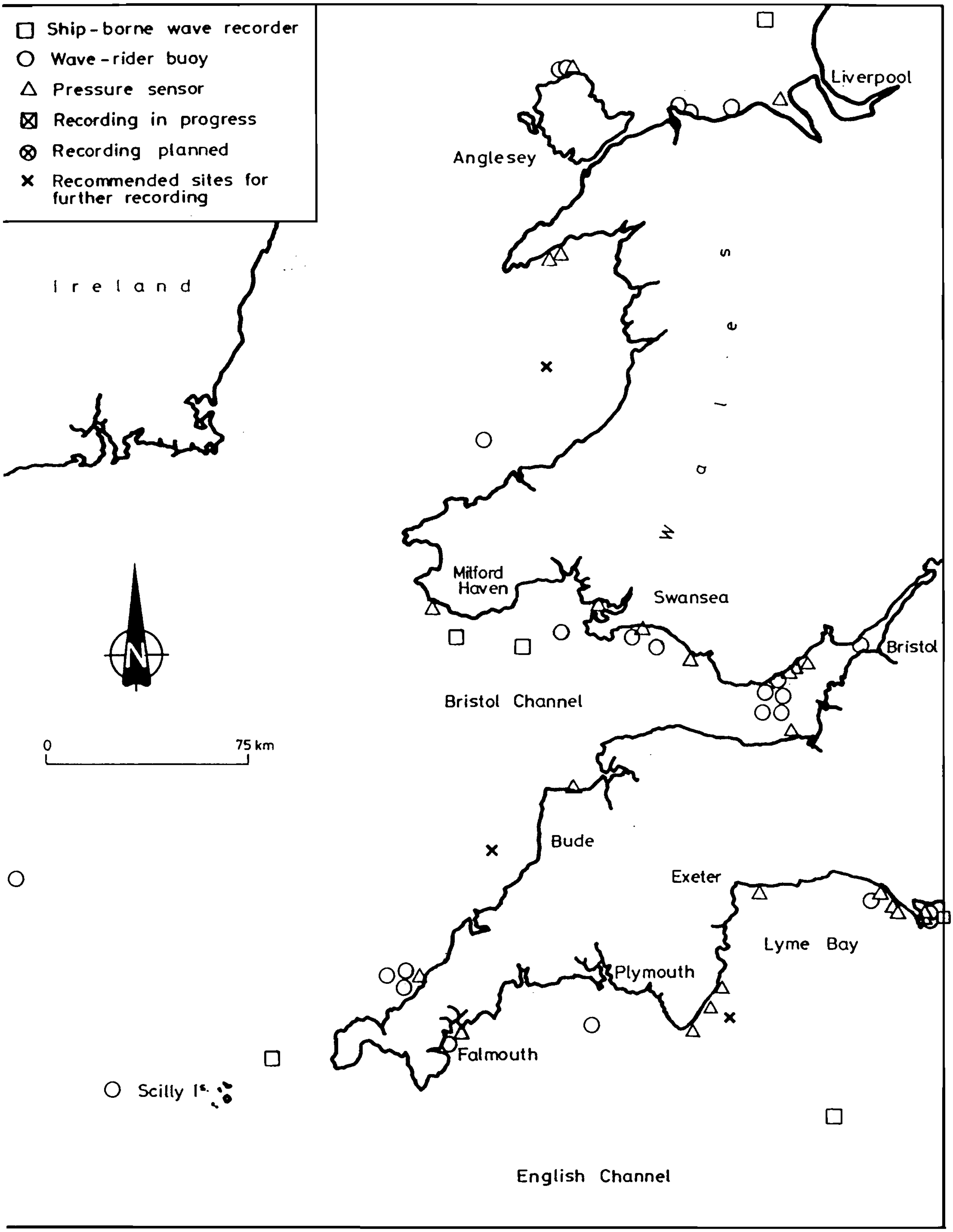

Fig 1 South and West

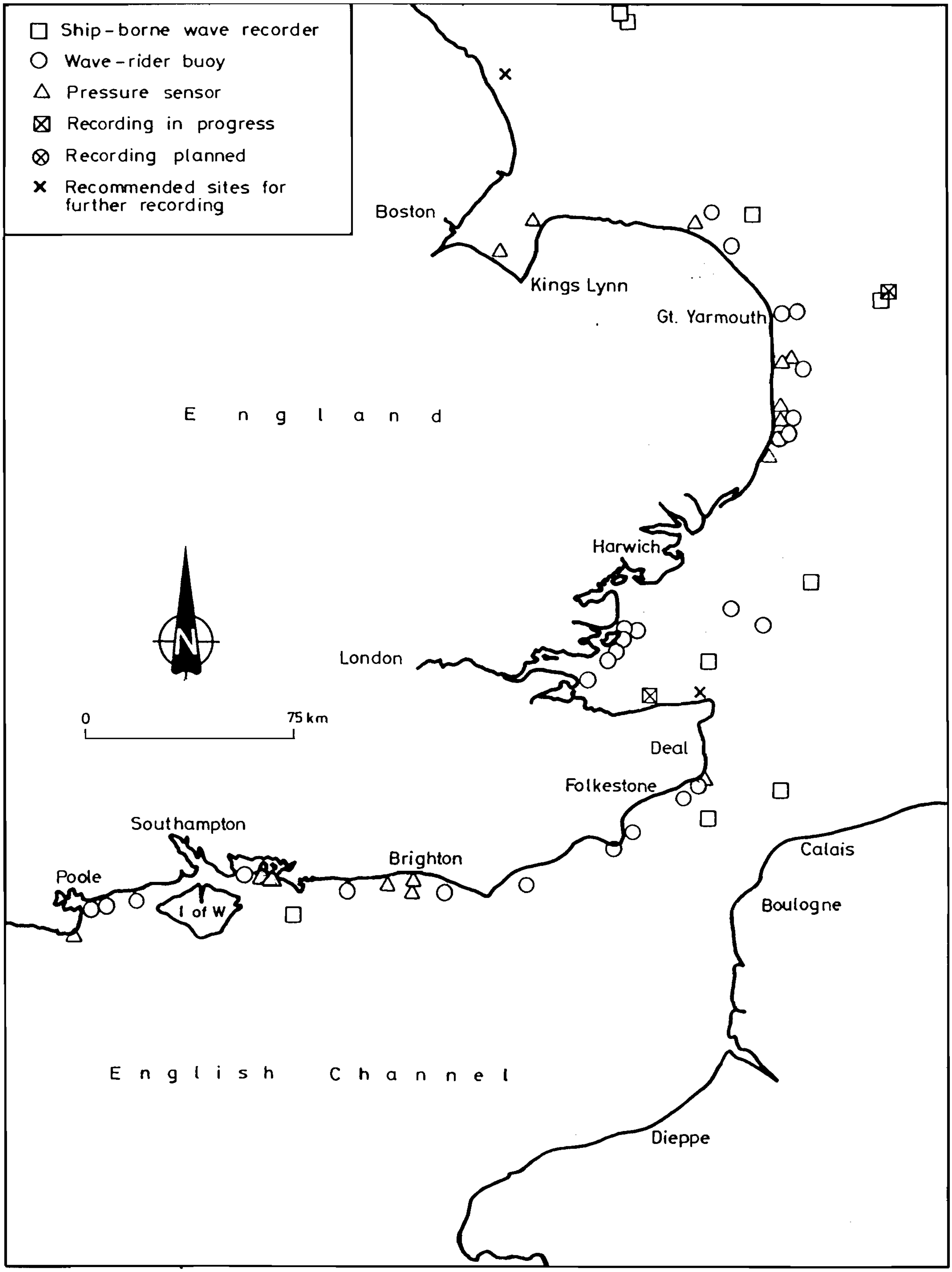

Fig 2 South and East

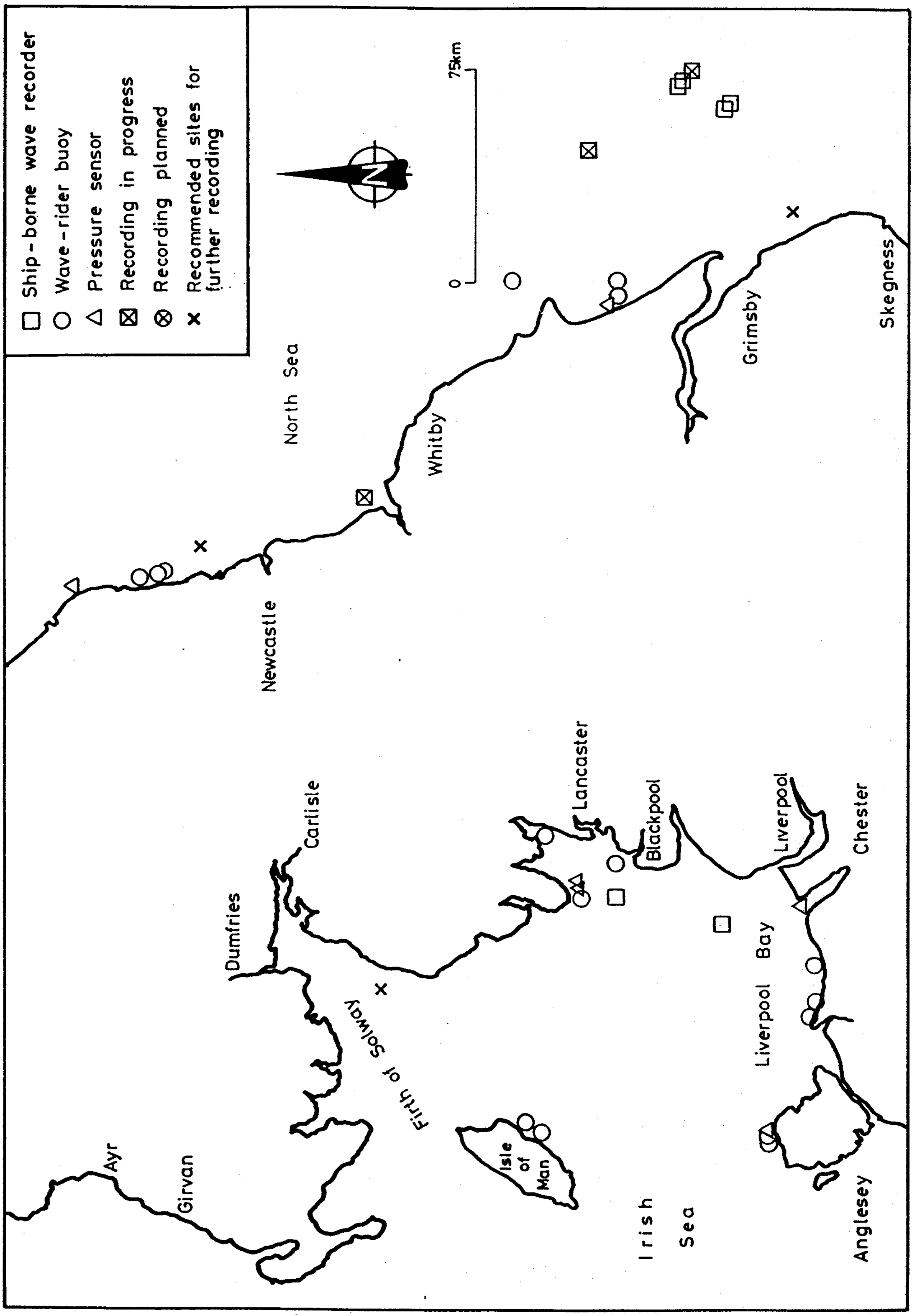
Ship-borne wave recorder
Wave-rider buoy
Pressure sensor
Recording in progress
Recording planned
Recommended sites for further recording
N
0
75km
North Sea
Whitby
Newcastle
Grimsby
Skegness
Carlisle
Dumfries
Lancaster
Blackpool
Liverpool
Chester
Firth of Solway
Liverpool Bay
Ayr
Girvan
Isle of Man
Irish Sea
Anglesey

Fig 3 North

APPENDICES

Key to abbreviations used in Appendices

KEY TO ABBREVIATIONS USED IN APPENDICES

Instrument Type

wrb	Wave-rider buoy
dwrb	Directional wave-rider buoy
swr	Ship-borne wave recorder
pg	Pressure gauge
flwr	Float long wave recorder
cs	Capacitance sensor
ws	Wave staff (platform mounted)
ir	Infra-red wave height monitor (platform mounted)

Owner/Collector

HRL	Hydraulics Research Limited
IOS	Institute of Oceanographic Sciences
CEGB	Central Electricity Generating Board
BMT	British Maritime Technology
ABP	Associated British Ports
NMI	National Maritime Institute (now BMT)
DoE	Department of the Environment
DEn	Department of Energy
DTp	Department of Transport
BTDB	British Transport Docks Board
UKOOA	United Kingdom Offshore Operators Association
PLA	Port of London Authority

Appendix 1: Wave data sets for the West Coast

LOCATION	MIAS REF	LAT (N)	LONG	INSTRUMENT	MEAN WATER DEPTH	PERIOD OF DATA RECORDING FROM	TO	OWNER	COLLECTOR	NOTES
Port Talbot	137	51°34'	3°48'W	flwr	8m	Oct 62	Jul 66		HRL	
Port Talbot	442	51°34'	3°48'W	pg	12m	16.5.75	30.11.77	IOS	IOS	
Scarweather	443	51°27'	3°55'W	wrb	27m	30.7.74	31.12.77	IOS	IOS	
Helwick	179	51°30'30"	4°25'30"W	swr	28m	Aug 60	Jul 61	IOS	IOS	
Milford Haven	138	51°42'	5°05'W	pg	20m	Nov 59	Aug 60	Esso Petroleum	Esso Petroleum	
Saint Gowan	139	51°30'30"	4°59'48"W	swr	55m	Aug 74	31.12.83	IOS	IOS	
Off Cardigan	170	52°12'	4°50'W	wrb	40m	1.1.73	31.12.73	IOS	IOS	
Hells Mouth	36	52°47'42"	4°32'36"W	pg	3m	8.11.75	23.7.77	Univ Coll of North Wales	Univ Coll of North Wales	
Hells Mouth	37	52°47'42"	4°32'36"W	pg	3m	12.7.78	Sept 86	Univ Coll of North Wales	Univ Coll of North Wales	
Wylfa, Anglesey	146	53°25'	4°27'W	pg	5m	Dec 61	Nov 65	CEGB/IOS	James Williamson and Partners	
Hilbre Island	144	53°23'	3°14'W	pg	3.5m	Jan 69	May 70		Binnie & Partners	
Mersey Bar	173	53°32'	3°20'54"W	swr	17.5m	12.9.65	12.9.66	IOS	IOS	
Morecambe Bay	174	53°52'30"	3°30'W	swr	22m	13.11.56	20.1.59	IOS	IOS	
Fleetwood	143	53°57'50"	3°01'02"W	wrb	3.5m	1.10.74	18.3.76	CEGB/IOS	HRL	
Morecambe Bay	145	53°52'24"	3°30'12"W	wrb	22m	1.10.74	18.3.76	CEGB/IOS	HRL	
Heysham	52	54°01'28"	2°56'56'W	wrb	9m	1.7.78	30.6.79	CEGB/IOS	CEGB	
Douglas, IOM	148	54°08'31"	4°27'17"W	wrb	20m	13.6.73	23.4.74	Douglas Harb Bd	Douglas Harb Board	
Douglas, IOM	149	54°08'31"	4°27'17"W	wrb	20m	22.11.74	2.4.75	Douglas Harb Bd	Douglas Harb Board	
Douglas Light	801	54°08'36"	4°27'36"W	wrb	27m	24.6.80	10.6.81	Douglas Harb Bd	Douglas Harb Board	
Cardiff Harbour	1513	51°27.4'	3°10.5'W	pg	0m	8.1.86	28.6.87	Glamorgan County Council	HRL	High water only within harbour
Rhyl	1507	53°25.2	3°30'W	wrb	15m	5.2.85	7.5.86	C H Dobbie & Partners	HRL	
Seven Stones	382	50°03'48"	6°04'24"	swr	60m	31.1.62	31.1.63	IOS	IOS	
Seven Stones	383	50°03'48"	6°04'24"	swr	60m	Feb 63	June 64	IOS	IOS	
Seven Stones	384	50°03'48"	6°04'24"	swr	60m	1.8.64	30.6.65	IOS	IOS	
Seven Stones	385	50°03'48"	6°04'24"	swr	60m	Aug 65	31.12.67	IOS	IOS	
Seven Stones	386	50°03'48"	6°04'24"	swr	60m	1.1.68	31.12.69	IOS	IOS	
Seven Stones	387	50°03'48"	6°04'24"	swr	60m	1.7.71	30.6.74	IOS	IOS	
Seven Stones	388	50°03'48"	6°04'24"	swr	60m	1.4.75	88	IOS	IOS	
Perranporth	161	50°21'	5°09'	pg		Aug 45	Jan 47	IOS	IOS	
Perranporth	135	50°21'	5°10'21"	wrb	8.5m	13.11.75	2.3.86	HRL	HRL	

Appendix 1: (Cont/d)

LOCATION	MIAS REF	LAT (N)	LONG	INSTRUMENT	MEAN WATER DEPTH	PERIOD OF DATA RECORDING FROM	TO	OWNER	COLLECTOR	NOTES
Perranporth	689	50°21'30"	5°09'42"	wrb	13m	26.9.80	14.12.81	DTp	HRL	
Perranporth (off)	34	50°23'	5°21'	wrb	45m	30.8.78	27.6.79	MoD	HRL	
Boyle (Celtic Sea)	142	50°40'	7°30'	swr	60m	May 74	30.6.77	UKOOA	IOS	
Clovelly	445	51°00'	4°23'	pg	10m	21.4.67	18.11.67	CEGB/IOS	Alexander Gibb/IOS	
Hinkley Point	163	51°14'	3°10'	pg	10m	Mar 59	Jun 59	IOS	IOS	
Farley	136	51°30'	2°43'	wrb	8m	15.12.71	31.5.72	Port of Bristol Auth	Port of Bristol Authority	
Severn Site A	31	51°19'12"	3°34'24"	wrb	27m	10.4.78	Mar 79	DoE	HRL	Buoy was repositioned
Severn Site A (Rep)	683	51°20'48"	3°34'30"	wrb	27m	1.4.79	31.3.80	DoE	HRL	
						(Dec 80	Apr 81)			
Severn Site B	32	51°20'42"	3°08'18"	wrb	17m	10.4.78	Apr 81	DoE	HRL	
Severn Site C	33	51°23'30"	3°03'12"	wrb	14m	10.4.78	Apr 80	DoE	HRL	
						(Dec 80	Apr 81)			
Burry Port	1486	51°41'	3°47'	pg	3.5m	13.11.84		Robinson/Jones		Data poor
Barry	1485	51°23'37"	3°15'30"	pg		1.12.80	30.4.81	ABP	ABP	
Cardiff Harbour Entrance		51°26.8'	3°9.8'W	pg	3m	Dec 86	Jul 88	ABP	ABP	Dries at low water
Penrhyn Bay				wrb		Dec 83	Mar 84	Aberconwy DC	NMI	
Llandudno				wrb		Dec 83	Mar 84	Aberconwy DC	NMI	
Wylfa, Anglesey		53°25.3'	4°29.3'W	wrb	21m	1.7.85	30.6.86	CEGB/IOS	Hunting Surveys	
Wylfa, Anglesey		53°25.2'	4°28.0'W	wrb	16.4m	1.7.85	30.6.86	CEGB/IOS	Hunting Surveys	
Porthcawl	1556	51°28.2'	3°42.5'W	pg	4.8m	June 82	88	Polytechnic of Wales	Driver Seawave Services	Intermittent analysis
Barrow-in-Furness		54°1'24"	3°11'53"W	pg	8m	15.12.87	17.11.88	MoD	HRL	
Barrow-in-Furness		54°1'24"	3°11'53"W	pg	8m	15.12.87	17.11.88	MoD	HRL	Intermittent records for long-wave analysis

Appendix 2: Wave data sets for the South Coast

LOCATION	MIAS REF	LAT (N)	LONG	INSTRUMENT	MEAN WATER DEPTH	PERIOD OF DATA RECORDING FROM	TO	OWNER	COLLECTOR	NOTES
Brighton	128	50°49'	0°09'W	pg	5.5m		1967		Wimpey Laboratory	
Brighton	127	50°49'	0°09'W	cs	5.5m	1975	1976	Lewis and Duvivier		
Owers	177	50°43'	0°47'W	swr	26m	22.1.68	Mar 71	IOS	IOS	
Portsmouth (West Winner)	132	50°46'	1°02'W	wrb	4.6m	20.1.72	5.1.73	Land reclamation & dev corporation		
Christchurch Bay	130	50°42'	1°45'W	wrb		1.9.76	14.10.76	SERC	NMI	
Poole Bay	131	50°42'42"	1°48'W	wrb	14m	Jun 74	Mar 79	Bournemouth BC	Univ of Southampton	
Bournemouth	129	50°43'	1°54'W	wrb			1976	Bournemouth BC	Univ of Southampton	
Portland (South b/w)	133	50°34'	2°25'W	pg	9m	1964	1966		HRL	
West Bexington	467	50°40'	2°39'W	pg	9m	8.5.73	Sep 77	IOS	IOS	
Budleigh Salterton	468	50°37'30"	3°19'W	pg	6m	24.4.73	Dec 77	IOS	IOS	
Slapton Sands	469	50°17'12"	3°38'30"W	pg	7.5m	Dec 72	Jan 76	IOS	IOS	
Bee Sands	466	50°15'06"	3°39'12"W	pg	6m	Apr 72	Jul 74	IOS	IOS	
Hall Sands	470	50°14'18"	3°39'30"W	pg	6m	Mar 74	Sep 76	IOS	IOS	
Prawle Point	147	50°12'	3°44'W	wrb		28.4.75	10.7.75	British Tel	British Telecom	
Eddystone	171	50°10'	4°15'W	wrb	40m	Jul 73	31.12.81	IOS	IOS	
Littlehampton	1511	50°43.7'	0°25.7'W	wrb	13m	5.3.85	30.4.86	Arun D C	HRL	
Seaford	1278	50°45.8'	0°5.2'E	wrb	13m	Sep 83	Jan 85	Southern Water	HRL	
Hayling Island	1549	50°46.8'	0°58.0'W	pg	HW only	10.9.86	1.11.86	HRL	HRL	High water springs
Hayling Island	1549	50°46.8'	0°58.0'W	pg	HW only	30.1.87	Mar 87	HRL	HRL	only. Gauge on groyne
Hayling Island		50°46.2'	0°58.0'W	pg	5m	29.10.87 (4.10.88)	20.12.87 (29.3.89)	Havant BC	HRL	
Portland Harbour	1550	50°35.7'	2°26.7'W	wrb	11m	Sep 85	Feb 86	BP Development	HRL	Within Portland Harb
Portland Harbour	1551	50°35.7'	2°26.7'W	pg	11m	Nov 85	Feb 86	BP Development	HRL	Within Portland Harb
Shoreham	1552	50°48.2'	0°15.6'W	pg	10m	1.3.86	31.3.86	Shoreham Port Authority	HRL	Intermittent records for long-wave analysis
Falmouth	1496	50°4.5'	5°2.0'W	wrb	45m	6.6.84	31.5.85	Falmouth Cont Terminal Ltd	HRL	
Falmouth	1553	50°9.1'	5°2.4'W	pg	7m	5.6.84	21.3.85	Falmouth Cont Terminal Ltd	HRL	Data good, but only Nov/Jan/Feb analysed
Channel Light	864	49°54'30"	2°55'30"W	swr	70m	1.9.79	88	IOS	IOS	
Portland (South b/w)	134	50°34'	2°25'W	flwr	9m	1964	1966		HRL	
Shambles	180	50°30'42"	2°19'30"W	swr	25m	Mar 67	Mar 70	IOS	IOS	
Scilly	863	49°51'48"	6°41'W	wrb	100m	20.2.80	Jun 85	IOS	IOS	
Dover Harbour	1554	51°6.2'	1°19.3'E	pg	17m	1.12.85	31.12.85	Dover Harbour Board	HRL	Intermittent records for long-wave analysis
Dover Harbour	1510	51°6.2'	1°19.3'E	wrb	17m	5.12.84	22.1.86	Dover Harbour Board	HRL	
Milford-on-Sea	1555	50°42.7'	1°35.7W	wrb	8m	24.4.87	14.4.89	New Forest DC	HRL	
Chesil Cove	1246	50°34.1'	2°28.1'W	pg	22.5m	20.11.79	26.3.80	Wessex Water	C H Dobbie & Ptns	
Swanage (Pier)		50°36.5'	1°56.8'W	pg	5m	29.1.87	Apr 87	Lewis & Duvivier	Lewis & Duvivier	
Dungeness		50°54.2'	0°57.4'E	wrb	14m	18.7.83 (16.11.84	9.7.84 16.5.85)	CEGB/IOS	Hunting Survey	
Dungeness		50°55'10"	0°59'33"E	wrb	15m	27.10.87	1.11.88	CEGB	HRL	
West Bexington	467	50°38.2'	2°42.5'W	wrb	25m	Sep 85	Mar 87	IOS	IOS	
Wyke Regis	-	50°35'	2°30W	pg						Brief publication only
Shakespeare Cliff		51°5'45"	1°16'40"	wrb	30m	7.11.87	27.2.90	Transmanche Link	HRL	
Pevensey Bay		50°43.5'	0°27.0'E	dwrb	15m	28.9.89	29.3.90	Dobbie and Partners	HRL	

Appendix 3: Wave data sets for the East Coast

LOCATION	MIAS REF	LAT (N)	LONG	INSTRUMENT	MEAN WATER DEPTH	PERIOD OF DATA RECORDING FROM	TO	OWNER	COLLECTOR	NOTES
Seahouses	151	55°35'	1°39'W	pg	4m	Feb 68	Jun 68	Lewis and Duvivier	HRL	Poor data, H_{MAX} only
Dowsing	183	53°34'	0°50'12"E	swr	26m	Dec 69	Sept 71	IOS	IOS	
Dowsing	184	53°34'	0°50'12"E	swr	26m	26.10.75	88	IOS	IOS	
The Wash	125	52°52'30"	0°15'E	pg	5m	May 72	16.4.79		Binnie & Ptns	
Cromer	120	52°55'	1°17'E	pg	4.8m	1.9.74	8.10.74	Univ of E Anglia	Univ of E Anglia	
Happisburgh	122	52°48'	1°33'E	wrb	6m	1.11.74	28.4.75	Univ of E Anglia	Univ of E Anglia	
Smiths Knoll	182	52°43'	2°18'E	swr	49m	Mar 59	1.6.60	IOS	IOS	
Smiths Knoll		52°43'	2°18'E	swr	49m	88	Cont May 90	IOS	IOS	
Lowestoft N Hbr	123	52°29'	1°45'E	pg			1974	BTDB	BTDB	
Lowestoft Offshore	124	52°29'	1°45'E	wrb	5.6m	22.7.74	25.9.79	Univ of E Anglia	Univ of E Anglia	
Lowestoft (3 miles off)	106	52°23'48"	1°48'12"E	wrb	40m	Dec 75	Feb 77	IOS	IOS	
Southwold	441	52°20'	1°42'E	pg	8m	13.1.75 (Feb 77	22.8.76 Oct 77)	IOS	IOS	
Aldeburgh	439	52°09'	1°37'E	pg	6m	15.4.75	Mar 79	IOS	IOS	
Dunwich	440	52°17'	1°39'E	pg	8m	15.4.75	Mar 79	IOS	IOS	
Dunwich	121	52°17'	1°35'E	wrb	5.5m	28.8.75	12.6.76	Univ of E Anglia	Univ of E Anglia	
Dunwich Bank	865	52°15'	1°42'E	wrb	15m	Aug 77	May 79	IOS	IOS	
Heacham Stubb Bank	1512	52°55'	0°29'E	pg	HW only	1.11.85	13.3.86	HRL	HRL	High water springs springs only. Gauge on groyne
Dunwich Bank (insh)	866	52°15'	1°39.0'E	wrb	8m	Nov 78	May 79	IOS	IOS	
Great Yarmouth (off)		52°35'	1°52.0'E	wrb	25m	14.12.84	11.12.85	Posford Pavry and Partners	BMT	
Great Yarmouth (insh)		52°35'	1°45.0'E	wrb	12m	14.12.84	9.12.85	Posford Pavry and Partners	BMT	
Maplin Sands Site 1	117	51°31'50"	0°54'E	wrb	8.4m	1.4.73	30.9.74	DoE	HRL	
Maplin Sands Site 2	118	51°32'30"	0°58'48"E	wrb	8.4m	21.12.72	31.3.75	DoE	HRL	
Maplin Sands Site 3	114	51°34'42"	1°03'E	wrb	8.4m	15.3.73	30.6.74	DoE	HRL	
Maplin Sands Site 4	115	51°37'30"	1°04'12"E	wrb	8.4m	15.3.73	30.6.74	DoE	HRL	
Maplin Sands Site 5	119	51°37'48"	0°57'18"E	wrb	8.4m	18.5.73	30.6.74	DoE	HRL	
Kentish Knock	111	51°39'06"	1°40'E	wrb	17.5m	1.4.73	14.7.75	DoE	HRL	
Tongue Outer Thames	175	51°30'36"	1°23'06"E	swr	13m	Aug 65	Jan 69	IOS	IOS	
Galloper Outer Thames	178	51°43'54"	1°57'48"E	swr	30m	18.3.71	21.3.74	IOS	IOS	
Whitstable	116	51°23'36"	1°06'E	pg	4m	15.12.78	Cont May 90	Canterbury CC	Canterbury CC	
Varne (Dover Str)	181	50°56'16"	1°16'42"E	swr	27m	28.1.65	Dec 66	IOS	IOS	

Appendix 3: (Cont/d)

LOCATION	MIAS REF	LAT (N)	LONG	INSTRUMENT	MEAN WATER DEPTH	PERIOD OF DATA RECORDING FROM	TO	OWNER	COLLECTOR	NOTES
Dyck (Dover Str)	700	51°03'	1°51'54"E	swr	20m	1.1.66	31.12.66	IOS	IOS	
Sunk Head Buoy	189	51°46'30"	1°30'E	wrb	16m	10.4.72	30.3.74		PLA	
Tees Bay		54°40'32"	1°7'42"W	wrb	18m	4.2.88	Cont May 90	Tees & Hartlepool Port Authority	Tees & Hartlepool Port Authority	
Cromer (off)	1493	53°04'	1°31'E	dwrb	33m	7.12.85	30.6.87	IOS/DEn	HRL	Directional WAVEC buoy
Holderness	1515	53°56.05'	0°1.35'E	wrb	23m	Apr 86	Jun 86	IOS	IOS	
Holderness	1515	53°55.5'	0°03.6'W	wrb	19m	Apr 86	Mar 87	IOS	IOS	
Coquet Is (Amble)		55°20.0'	1°32.4'W					R T James	BMT	
Flamborough Head	1492	54°13.7'	0°1.7'E	dwrb	55m	6.12.84	9.5.86	IOS/DEn	IOS	Directional WAVEC buoy
Villages Field		54°02'	0°44'E	ir	47m	Oct 88	Cont May 90	BP International	Marex	
West Sole Field WA		53°42'	1°09'E	ws+ir	21m	Jan 74	Cont May 90	BP International	Marex	
West Sole Field WB		53°43'	1°07'E	ws	22m	Oct 73	Jul 81	BP International	Marex	
West Sole Field WC		53°45'	1°05'E	ws	25m	Aug 72	Oct 73	BP International	Marex	
Hewett Field		53°01'	1°41'E	ws	20m	Jan 74	Sep 75	Phillips Petroleum UK		
Sole Pit	1501							IOS		
Leman	1469/70							IOS		
Druridge Bay		55°15.9'	1°32.5'W	wrb	12m	2.10.83	8.3.84	CEGB/IOS	Hunting Surveys	3 positions. Intermittent data
Druridge Bay		55°14.7'	1°31.5'W	wrb	15m	2.10.83	8.3.84	CEGB/IOS	Hunting Surveys	2 positions. Intermittent data
Isle of Grain				wrb				CEGB/IOS		
Hornsea	1326	53°57'N	00°10'W	pg	7m	15.6.83	28.3.85	Univ of Sheffield		