NATIONAL RIVERS AUTHORITY

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TRIAL FORESHORE RECHARGE

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CONTENTS

1. ABSTRACT

Accelerating erosion on the Essex coast results in a required expenditure of £4 million per annum to maintain the 330 km of sea wall. Conventional concrete revetment systems are expensive and labour intensive. Approval was given in 1990 to proceed with a trial experiment to recharge eroded foreshores utilising suitable material available from Harwich Harbour.

Two open coast and one estuary site were identified to receive material; Foulton, Stone Point and Horsey Island. Extensive monitoring was undertaken both before and after the trial to ascertain the impact on the affected areas.

Selected materials were placed in the Autumn of 1990, with additional minor amounts in the Autumn of 1991. In total 57,000cm were positioned with 12,000cm to Foulton, 27,000 to Stone Point and 18,000cm to Horsey. Previous erosion rates were estimated at 60,000cm per annum on a comparison from 1925 to 1983 for the area monitored.

Comparative monitoring revealed no increase in heavy metal pollutants; a slightly coarser grading curve to the foreshore at Stone Point and Foulton; a total change to material properties at Horsey; minor localised changes to the bathymetry; a rapid recolonisation by marine invertebrates to open coast sites and a predicted increase in species diversity to Horsey.

Pre-recharge measurements to all three sites by Hydraulics Research showed a wave climate that would cause erosion and offshore material movement, very strong flood tide currents to Horsey and a North to South long shore transport movement that is probably interrupted by Harwich Harbour. The overall evaluation was to place a material coarser than that existing; such material migrating landward during storm waves. For the Horsey site material should preferably be positioned to reduce tidal current flows.

The experiment has shown a potential for reducing capital and maintenance expenditure for suitable locations, using an engineering method that has environmental and visual benefits and a very fast construction time.

2. INTRODUCTION

In January 1990 a report was prepared that outlined problems of Sea Defence instability due to salting and foreshore loss (ref.1) i.e. lower foreshores allow greater wave attack with consequent higher sea walls to provide an effective defence. The reasons for this loss are complex but are summarised as relative sea level rise being major cause with additional damage being created by pollution, dredging activities and loss of marine grass beds from disease. Ordnance survey map comparisons from 1925 to 1983 for Walton Backwater approaches show a loss during that 60 year period of 75 hectares of salting, 218 hectares of foreshore and a combined volume of 3.5 million tons of silt and sand eroded. The consequences have been an increasing expenditure on flood defences and total loss of high conservation and recreation value areas.

The report proposed an experimental solution that would utilise available pollutant free dredgings from Harwich Harbour, such material is normally dumped at sea 12 miles to the east of Harwich. Three sites were suitable, Foulton Hall, Stone Point and Horsey Island (see map appendix 1). Research and monitoring would be required i.e. -

Pre recharge - wave climate and current transport processes, material properties and grading curves, bathymetric survey, marine invertebrate survey, pollutants in existing dredgings, pollutants in existing foreshore

Post recharge - bathymetric survey, material properties and grading curves, marine invertebrate survey, foreshore pollutants.

The report proposals were accepted with the intention of placing up to 30,000 cubic metres to each of the three sites.

3. R & D AND MONITORING

3.1 Pollution (Ref.2)

All materials that are dredged from Harwich are tested by Ministry of Agriculture laboratories at Burnmham-on-Crouch. The recipient sites at Foulton, Stone Point and Horsey were all sampled by NRA staff with the two samples per site being analysed at the Peterborough laboratories. Samples are taken three months before materials were placed and three months after.

3.2 Grading Curves (Ref.3)

A total of eleven locations were tested, four each at Foulton and Stone Point and three at Horsey. The materials were tested at the NRA soils laboratory at Chelmsford using both wet and dry sieving to produce grading curves and material properties. Samples were taken three months before materials were placed and three months after.

3.3 Bathymetric Survey (Ref.4)

A pre-recharge survey was undertaken in June 1990 with 1km transects from 51°55'N (1km north of Foulton Hall Point) at 500 metre intervals with a reading every 100 metres to 1.5k south of Foulton Hall Point. South of that location i.e. the mouth of Walton Backwaters transects were taken at 200 metre intervals with a reading every 100 metres for a total of 6 transects, with additional readings in Walton Channel, Kirby Creek and Walton Channel. A further three transects were taken off Stone Point at 500 metre intervals. In total 245 individual readings were monitored with results corrected to Ordnance Datum and correlated with the tidal computer information from Harwich Harbour.

The complete survey was repeated in June 1991 with the intention of a repeat survey in June 1992.

All survey work was undertaken by Read Survey.

3.4 Marine Invertebrate Survey (Ref.5)

Unicomarine Ltd. undertook two comparative surveys in July of 1990 and 1991. Field samples were taken and analysed in the companies laboratories for frequency of occurrence of species and biomass, taxonomic and trophic analysis and cluster analysis. Fauna were classified by assigning to one of five groups i.e. crustaceans, molluscs, oligochaetes worms, polychaetes worms and other. Four feeding categories were used i.e. detritus, filter, scavenger/predator and particulate. A total of 91 sampling stations were used over 15 transects.

3.5 Wave Climate and Current Transport Processes (Ref.6,7,8)

Hydraulics Research Ltd. were employed to produce an assessment of the trial replenishment scheme at each of the three sites, with a report date of August 1990. Sediment gradings of the present foreshore materials were analysed and wave predictions made for varying weather conditions. Tidal current monitoring was undertaken in the lee of the off-shore breakwater at Horsey. Predictions of current transport processes and directions were made for each site. Guidelines for selection of material and use of sediment control structures were presented.

4. MATERIALS DEPOSITED

Before material could be positioned consultations had to take place with all interested groups and organisations and the required permits and consents obtained (see attached appendix 2).

Material was transported from the Autumn of 1990 utilising split hopper barges of 770cm capacity to Stone Point and Foulton Point for a duration of 5 weeks. Exact navigation was used with control by a computer based system at Harwich Harbour (see attached appendices 3 and 4).

Because of restricted water depth to Horsey transport of material was by self load/discharge vessel of 1,100cm capacity part loaded to between 550cm and 730cm to have a laden draught of 3.5m. Cargoes were delivered on spring tides only with discharge by water jet 'rainbow' at high water. This method enables material to be jetted and placed up to 70m from the vessels bow (see appendix 5).

The original beach replenishment licence (No.3625/90/0), valid until 19 November 1991 was extended for a 12 month period to allow additional available material from Sizewell in Suffolk to be positioned at Stone Point and Horsey.

Final quantities as placed are:

Foulton Point - 12,000cm of sand/clay mix with minor amounts of small sandstone rock, deposited at L.W.S.

Stone Point - 27,000cm of sand, gravel/clay, minor amounts of small sandstone rock, deposited at L.W.S.

Horsey Point - 18,000cm of sand, gravel and shell, minor amounts (2 cargoes only) of clay/shell mix, deposited inshore of the wavebreak.

Included in the above amounts are 6,000cm of sand from Sizewell, 3,000cm each to Horsey and Stone Point.

5. MONITORING RESULTS

5.1 Pollution

Figures are expressed in mg/kg in dry solids

Pollutant	Harwich	Foulton		Horsey		Stone Point	
		Pre	Post	Pre	Post	Pre	Post
Copper	24	22.50	7.27	17.40	4.06	35.10	4.18
Zinc	100	29.50	33.50	125.00	18.60	88.20	25.80
Cadmium	<0.50	<0.50	0.730	<0.50	0.49	<0.50	0.30
Lead	35	39.80	13.40	26.10	7.41	39.90	7.32
Chromium	62	31.90	17.20	39.10	12.50	60.70	9.00
Nickel	27	34.60	8.60	37.10	6.57	49.20	8.08
Tin Organic	<0.020	<0.020	<0.025	<0.025	<0.020	<0.025	<0.025

No increase in pollution levels was noted. Please note the similarity in pollution profiles between the Harwich sample and that existing in the foreshores at the other locations.

Separate research by Imperial College, London, (Ref.9) shows comparative figures for other Essex locations (average figures).

	Core 1 South Woodham	Core 1 Walton (Wade)	Core 1 Tollesbury
Copper	18	27	17
Zinc	80	86	66
Cadmium	<0.50	<0.50	<0.50
Lead	17	45	21
Chromium	45	24	38
Nickel	30	50	32
Tin Organic	>0.02	>0.05	>0.02

5.2 Grading Curves

Foulton and Stone Point foreshores have a great range of material types with visual inspection showing Foulton differing from fine silts to coarse gravels with occasional sandstone rocks. Stone Point is mainly fine to coarse sands with a mix of stone and shell with outcrops of London Clay. Horsey is single type fine silts with fine sands. This mix is shown in the results of the samples taken before recharge operations (see appendix 6).

Comparative results of before and after recharge are shown on the following page, with representative average figures shown below.

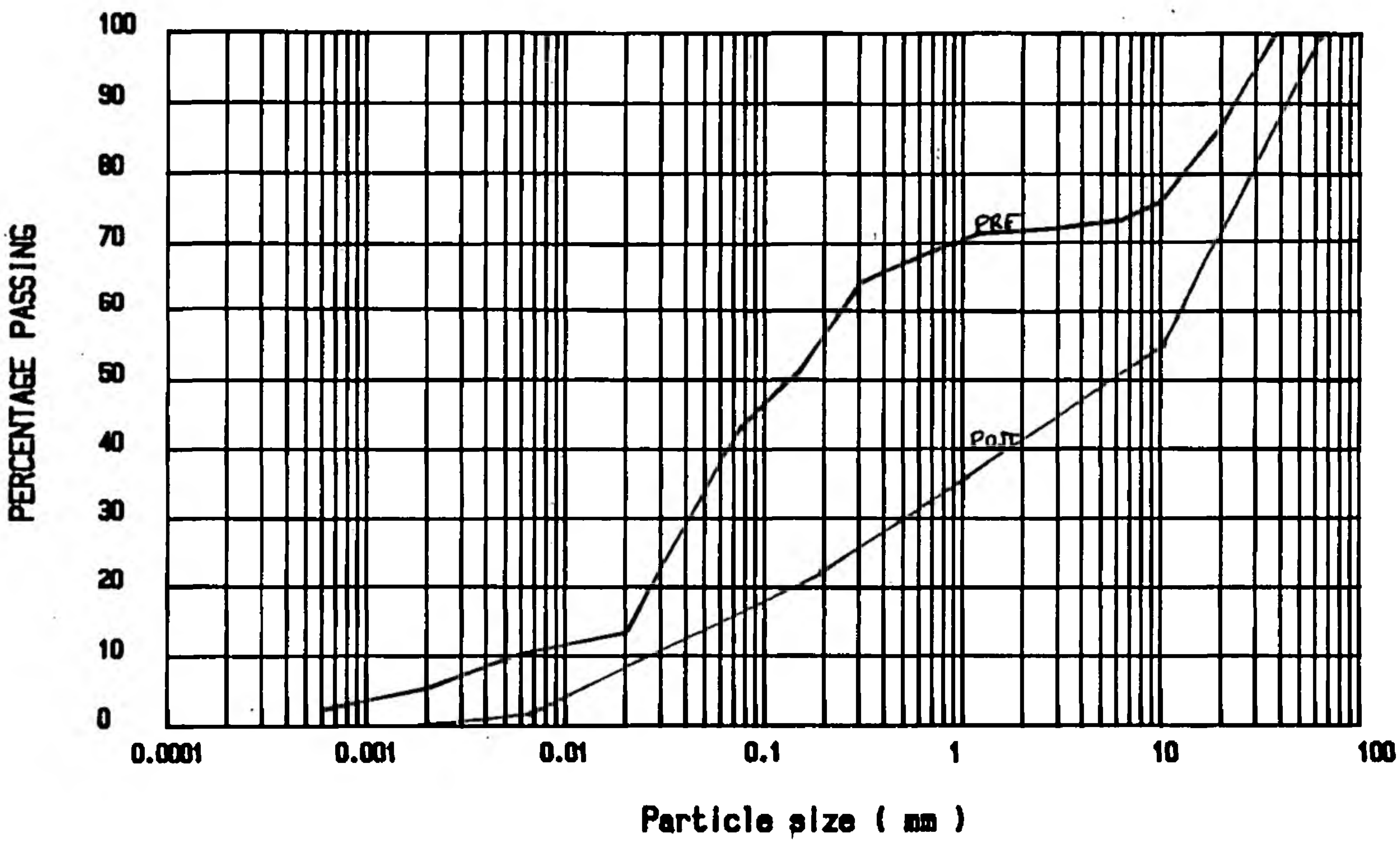
DRY MASS AFTER WASHING - % PASSING						
Sieve Size	Foulton		Stone Point		Horsey	
	Pre	Post	Pre	Post	Pre	Post
75.00	100.00	100.00	100.00	100.00	100.00	100.00
63.00	100.00	100.00	100.00	100.00	100.00	100.00
37.50	100.00	90.23	100.00	100.00	100.00	100.00
20.00	86.80	70.98	100.00	100.00	100.00	98.32
10.00	76.34	54.31	100.00	100.00	100.00	86.40
6.30	73.60	48.33	100.00	100.00	100.00	72.74
3.35	72.55	42.79	100.00	99.93	100.00	57.47
2.00	71.99	39.53	99.96	99.92	100.00	43.47
1.18	71.54	36.53	99.94	99.88	100.00	35.02
0.60	67.88	30.29	99.91	99.84	100.00	20.43
0.30	63.73	24.26	99.88	99.79	100.00	9.78
0.15	51.44	19.24	96.72	95.14	100.00	5.94
0.075	43.32	14.77	95.98	94.09	2.56	5.60

Foulton - slight increase in coarser materials

Stone Point - slight increase in coarser materials

Horsey - complete change from fine silts to silt/sand/gravel mix.

PARTICLE SIZE ANALYSIS



CLAY	SILT			SAND			GRAVEL			C
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	

NHSC	Site ref : HARWICH	Job No : 11 Borehole No : 1	Sample No: 4 FOULTON Depth : 0	Fig No :

5.3 Bathymetric Survey

Please refer to location map appendix 7

A = Serial number location on map
B = Minus O.D. Levels
C = Gain or loss in metres

5.3.1 Foulton Point

A	B	C	A	B	C	A	B	C
5	2.73	-0.14	19	2.23	+0.02	31	3.53	-0.24
6	2.78	-0.01	20	2.58	+0.02	32	3.48	-0.24
7	2.94	-0.03	21	2.68	+0.04	33	2.61	+0.64
8	2.93	-0.07	22	2.83	-0.05	35	2.50	-0.31
9	2.93	+0.07	23	2.94	+0.09	36	2.46	-0.33
10	3.00	+0.04	24	2.93	-0.09	37	2.18	-0.01
11	3.04	+0.04	25	3.05	-0.01	38	2.16	+0.01
12	3.04	+0.08	26	3.08	-0.02	39	2.94	-0.22
13	3.08	+0.14	27	3.13	-0.08	40	3.05	-0.08
14	3.15	+0.01	28	3.39	-0.18	41	3.26	+0.15
15	3.32	-0.19	29	3.58	-0.21	42	3.85	-0.04
16	3.18	-0.03	30	3.53	-0.10	43	3.70	+0.01
44	3.40	+0.01	58	6.01	+0.31	69	3.30	+0.49
45	2.67	+0.02	59	3.62	+0.34	70	3.30	+0.58
46	2.74	-0.08	60	2.65	-0.14	71	4.05	-0.37
47	2.96	+0.04	61	2.04	+0.06	78	2.84	+0.69
48	3.28	+0.12	62	2.20	-0.05	79	5.94	+0.47
49	3.46	+0.02	63	2.31	+0.11	80	1.99	-0.13
50	3.57	+0.12	64	2.45	-0.05	81	1.91	0.00
54	1.05	+0.13	65	2.68	+0.17	82	2.10	-0.04
55	1.35	+0.11	66	2.91	-0.38	83	2.18	-0.03
56	1.46	+0.15	67	3.38	+0.01	84	2.45	-0.05
57	1.25	+1.66	68	3.67	-0.08	85	2.56	-0.15
86	2.60	+0.04	98	0.28	-0.04	109	2.23	-0.01
87	2.80	+0.03	99	0.71	-0.06	110	1.95	+0.02
88	2.80	+0.02	100	0.90	+0.08	111	1.44	+0.09
89	2.98	-0.11	101	1.40	+0.38	112	1.47	-0.01
90	3.06	-0.05	102	2.93	+0.24	113	1.71	-0.07
91	3.15	+0.01	103	6.50	+0.02	114	1.99	+0.04
92	3.40	-0.06	104	1.50	-0.19	115	2.51	-0.04
93	3.55	+0.01	105	2.15	-0.64	116	2.75	-0.08
94	3.70	-0.08	106	2.40	-0.45	117	3.05	+0.03
95	3.96	+0.19	107	2.36	-0.06	118	2.09	-0.08
96	4.01	+0.14	108	2.35	-0.04	119	3.06	+0.01
						120	3.28	-0.06
						121	3.45	-0.03
						122	3.53	+0.04

No relevant change, differences probably caused by rough nature of ground.

5.3.2 Stone Point

A	B	C	A	B	C	A	B	C
126	1.05	+0.02	146	2.90	+0.48	167	1.90	−0.47
127	1.40	+0.01	147	3.20	−0.26	168	2.44	−0.67
128	4.80	+2.26	148	2.40	−1.01	169	3.77	−1.66
129	6.75	−5.44	149	1.30	−0.81	170	3.05	−0.29
130	1.80	+0.14	150	0.55	+0.45	171	2.66	0.00
131	2.10	+2.44	153	1.08	−0.03	172	3.16	−0.14
132	2.10	+0.46	154	4.60	−0.71	173	3.40	−0.10
133	2.68	−0.47	155	5.60	+0.71	174	3.50	−1.36
134	2.30	+0.25	156	2.65	+0.28	175	3.60	−0.01
135	2.65	−0.66	157	2.67	−0.35	176	3.66	−0.03
136	2.15	−1.01	158	2.08	+1.73	177	3.80	−0.07
138	0.55	+0.03	159	4.30	−1.25	178	3.89	+0.02
139	0.70	+0.03	160	3.50	+0.59	179	4.00	+0.02
140	1.00	+0.87	161	1.05	+0.28	180	4.06	+0.01
141	4.70	+1.42	162	0.88	−0.10	181	4.15	+0.11
142	5.30	−0.92	163	0.88	−0.16	182	3.85	−0.04
143	1.50	−0.02	164	1.15	−0.29	183	4.25	−2.16
144	1.89	+0.49	165	1.50	−0.35			
145	2.55	+2.23	166	1.66	−0.32			

5.3.3 Horsey Island

A	B	C	A	B	C	A	B	C
184	0.52	+0.01	194	3.10	+0.04	206	0.35	+0.29
185	0.73	+0.06	195	4.90	+0.10	207	0.75	+0.04
186	0.84	+0.61	197	5.50	+0.51	208	0.40	−0.03
187	1.70	+2.71	198	5.70	+1.24	210	0.25	+0.03
188	6.20	+0.87	199	6.22	−0.01	211	0.20	−0.07
189	6.00	−2.72	200	1.90	+0.04	212	0.39	0.00
190	4.00	−2.22	201	1.20	+0.03	214	1.70	+0.06
191	1.42	+0.22	202	1.13	0.00	215	1.15	−0.12
192	1.60	−0.04	203	1.20	+0.07			
193	1.10	+0.18						

5.3.4 Stone Point

A	B	C	A	B	C	A	B	C
217	1.80	+0.11	222	3.25	+0.16	227	4.00	−0.01
218	2.00	−0.05	223	3.45	+0.03	228	4.05	−0.02
219	2.78	−0.50	224	3.70	−0.12	229	4.03	+0.39
220	2.60	−0.03	225	3.76	0.00	230	4.52	−0.12
221	2.98	+0.08	226	3.85	−0.29			

5.3.5 Backwaters

A	B	C
231	5.05	−0.01
232	5.35	−0.01

5.3.6 Stone Point

A	B	C	A	B	C	A	B	C
233	2.00	+0.11	239	4.45	-0.05	245	2.21	-0.12
234	2.70	-0.43	240	3.37	+0.01			
235	3.51	-0.33	241	5.48	0.00			
236	4.12	-0.08	242	4.87	0.00			
237	4.45	-0.06	243	5.43	-0.01			
238	4.90	+0.10	244	4.94	-0.11			

Marked change on 126 to 136 transect indicating a migration of the navigation channel to Eastward. This trend is shown by O.S. map comparison 1925 to 1983. Similar trend shown on transect 138 to 150, 153 to 161 and on 186 to 190.

All other changes too small or too random to be relevant.

5.4 Marine Invertebrate Survey

5.4.1 Foulton Hall Point (see appendix 8) (quotes from Unicomarine report)

"In 1990 this area was characterised by three species of bivalve molluscs, Cerastoderma, Macoma and Nucula (see appendix 11 and 12) and three species of polychaete worm Nephtys, Pygospio and Scoloplos. The most abundant species was a crustacean, the tanaid Tanaissus Lilljeborgi; which was found at just under 50% of the stations sampled.

Sampling in 1991 found a similar situation ......"

"There were two instances of a large change in frequency of occurrence from 1990 to 1991, both involving bivalves. Cerastoderma and Nucula were each recorded at a higher proportion of sites in 1990 than 1991. In both years only juveniles were found .... In 1991 juveniles are recorded as a new category (ud bivalve spat) which will contain juveniles of both species ......"

5.4.2 Horsey Island (see appendix 9)

"The fauna was dominated in 1990 by five species found in high numbers at every station; three Polychaete worms - Cossura, Tharyx and Nephtys, the bivalve Macoma, and an Oligochaete worm Tubificoides. The situation was broadly similar in 1991 ..... There were several marked changes in occurrence however, with Cossura and Phoronis for example occurring at a markedly smaller proportion of sites post recharging. In the case of the latter species, it seems likely that the decrease observed was directly related to the dumped material ...."

5.4.3 Stone Point (see appendix 10)

"The most widely occurring species at this site in 1990 and also the most numerous was an amphipod, Bathyporeia Pilosa. The tanaid Tanaissus was also found at more than 50% of sites. The situation in 1991 was very similar .... Bathyporeia Pilosa was again the most numerous species, though present in considerably smaller numbers than found in 1990."

5.4.4 Comparison of the three areas

"There was some evidence at Stone Point that stations sampled at the extreme seaward end of transect 1 were sandier than found in 1990."

There were no observable differences at Foulton. At Horsey the material was considerably coarser, with complete blanketing of large parts of the previous foreshore; the new banks of shell and stone have a completely different fauna.

5.4.5 Discussion

"The results presented above clearly indicate that there have been changes in the biology of the areas from 1990-91; determining the cause of these changes however is not straightforward .... There was no evidence in the field that the upper shore stations had been affected in any way by the recharging operations ..... Corophium in particular is known to exhibit marked fluctuations in number between years. Stone Point appears on the basis of the sediment found to be a more active site .... Such movements alone could result in major changes in the numbers of amphipod fauna .... changes in the numbers of Macoma are probably the result of differences in spat-fall between years .... Sampling on the new banks created by the dumping revealed the presence of species not found at the 'normal' sites, possibly indicating the exploitation of a new habitat (rather than the introduction of new animals with the recharge material).

It is inevitable that modification to the tidal activity in an area, such as that which the recharging is designed to achieve, will have effects upon the sediment. The aim of the process is, after all, to reduce or even reverse saltmarsh loss. Such changes are highly likely to be reflected in changes to the fauna ...."

5.4.6 Summary

"The species present at each site were in the main the same as found in the first survey ...... The Horsey site appears to have been most affected by recharge operations ..... Evidence is presented that the recharge sediment is being colonised by species not found in large numbers elsewhere at the site. Decreases in the numbers of certain species were found at Foulton Hall and Stone Point, although it seems unlikely that these were directly attributable to the foreshore operations."

5.5 Wave Climate and Current Transport Processes

5.5.1 Physical environment - beach gradings

Analysis of the existing foreshores and beaches showed large variations in mean size, a probable reflection of the low levels and exposure of relic gravels, with relic salt marsh at Stone Point probably reducing the amount of recharge material that could reach the upper beach. Foulton showed a tendency for a north to south transport of material, whilst Stone Point showed the opposite.

The Horsey site showed no variation in grain size of existing material, indicating that the strong tidal current in this location would naturally move material further westward into Walton Backwaters.

- Wave Climate - offshore wave conditions

Event	Direction °N	Height (M)	
Typical	52	0.64	Typical events were calculated using 70% wind speed with a 12 hour duration
	58	0.74	
	63	0.82	
	70	0.87	
	77	0.90	
	86	0.92	
1/1 year event	63	2.06	
	69	2.20	
	77	2.29	
	85	2.32	
1/50 year event	63	2.96	
	69	3.16	
	77	3.27	
	85	3.31	

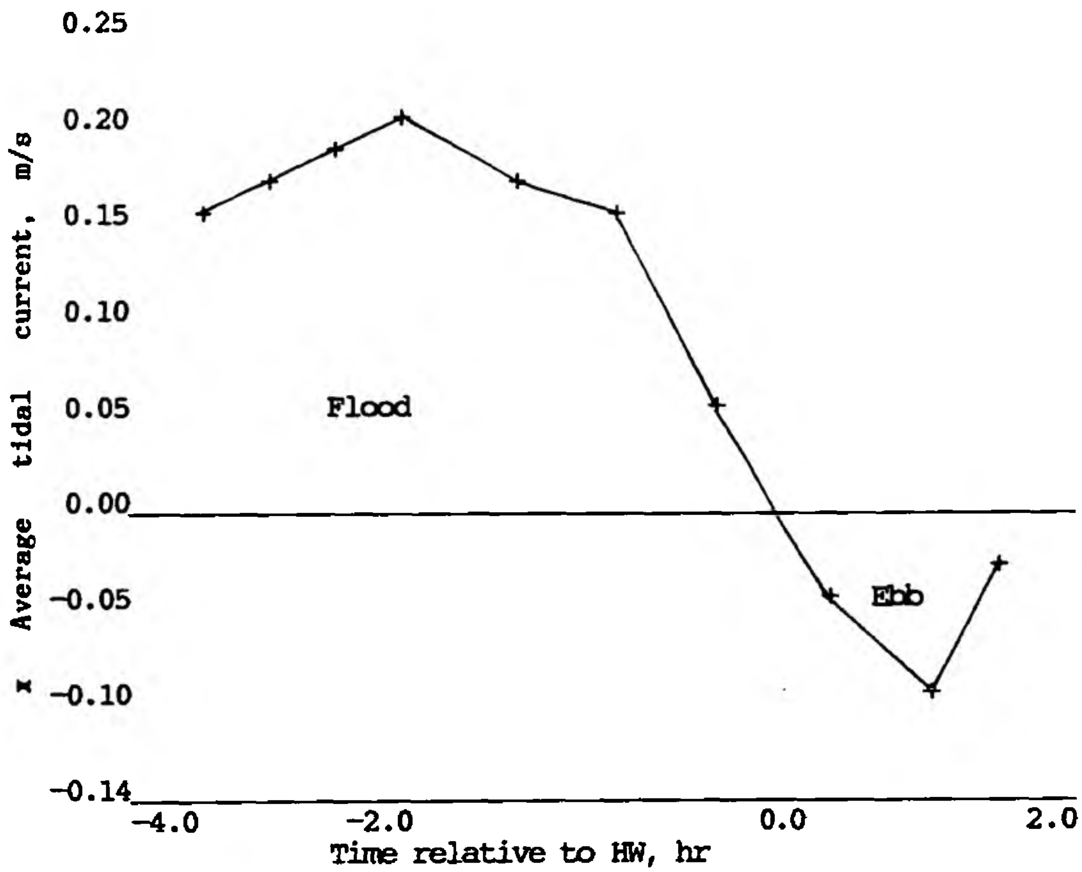
- Wave Climate - inshore wave conditions

Site	Event	Height (M)
Horsey	Typical	0.39
	1/1 year event	0.91
	1/50 year event	1.24
Foulton & Stone Point	Typical	1.18
	1/1 year event	2.51
	1/50 year event	3.54

5.5.1 Physical Environment (continued)

- Tidal currents

Readings were taken by floats inshore of the Horsey wavebreak.



The high initial velocities on the flood reflect the height of the foreshore above the main Hamford Water channel, which itself has high velocities. The decrease in velocities coincides with the tide overtopping saltings. When the tide ebbed there is a noticeable shift in current to seaward of the lighters. Average velocity on the flood was 0.16m/s with an observed peak of 0.21m/s. On the ebb the average was 0.07m/s and a peak of 0.10m/s. Direction was parallel to the wavebreak.

5.5.2 Movement of beach material

At Foulton and Stone Point four modes of transport were considered - bed load, intermittent suspension, suspended load and sheet flow.

Typical conditions indicated little cross shore movement of material i.e. fairly stable. The 1/1 year storm is likely to produce onshore migration with the 1/50 year storm causing offshore movement.

Longshore movement is thought to play a role at both sites and it is noted in the report from Hydraulics Research "...this will particularly be emphasized by the obstruction of the natural transport path southwards along the Essex coast by the construction of Harwich Harbour and other man-made structures."

The Horsey site transport of sediment process is more complicated due to the complex relation of the electro-chemical processes within the local physical environment. Material suspended in the water column is subject to turbulent motions generated by tidal flow. Using site measurements suspended particles could travel up to 800m landward on the flood and 350m on the ebb. Any placed fine material is liable to be eroded unless steps could be taken to contain material.

5.5.3 Evaluation of material for replenishment

Hydraulics Research recommendations were to place material coarser than existing foreshore grading curves to reduce the potential to erode and to provide protection to existing fine material. "Non-native material should move onshore if its average grain size is greater than 0.06mm (fine to medium sand)." Movement of local materials will still take place, particularly during storm events, "... however there should be no large loss of material offshore."

At Horsey material would stand the best chance of consolidating if placed as near high water as possible. Pumping of fine silts between the wavebreak and saltings was not recommended, but pumping of such material onto the top of saltings was. The polders already constructed to the north and south of the wavebreak should help capture any suspended sediments. The best solution would be to restrict the gaps between each lighter that forms the wavebreak with a coarse material. This was achieved by using a mix of stone and shell with a percentage of coarse sands.

6. BENEFITS

The approved budget for the trial experimental scheme was £60K (L.F.D.C. 13 July 1990). Expenditure was as follows :-

Marine invertebrate survey	£18,400	
Bathymetric survey	£ 5,800	
Hydraulics Research	£ 3,000	
Pollution survey	-	in-house
Grading curves & material properties	-	in-house
Payments to dredging contractors	£37,375	
TOTAL	£64,575	

over-expenditure = 8%

The enabling monies paid to the dredging contractors was above budget, but still represents placed material at £0.66p/cm. Compared to conventional sea defence engineering schemes there is a dramatic saving. Assuming a 1km frontage that requires new seaward toe works of, say, an additional 2sm/lm of revetment (£160/lm) and a new toe of steel sheeters (£80/lm) a total budget of £240,000 would be required.

Placing re-charged material to a depth of 4m at the toe in a profile to extend 30m seaward would require 54cm/lm. Paying even £3.00cm the total cost for the 1km frontage would not exceed £170,000, saving £70,000 or 30%.

Maintenance costs are reduced to a minimum. If such areas were created there would be considerable environmental benefits, both visually and in creating areas to allow greater species diversity.

7. PROBLEMS

As can be seen from the contact list (appendix 2), work on the foreshore demands a great deal of correspondence and communication with all interested groups and governmental bodies. Provided local requirements are met wherever possible, a negotiated compromise can avoid conflict. At Stone Point the original proposed recharge site was moved south to accommodate local yachting requirements; at Horsey Island the material placed was coarser than intended to ensure no damage from silt reaching oyster beds.

Although the material placed would normally be dumped at sea, enabling monies were required by the dredging contractors to offset a slower 'production' run time and additional marine plant.

Aggregate dredging licences issued by Crown Estates could create a major problem in the future, if a recharge policy is adopted on a wider scale and geographic area.

The greatest damage is created by the positioning of a relatively large amount of material onto a small area, which will cause mass death to existing marine invertebrates. The survey by Unicomarine indicates that the damage is very temporary. Where large amounts of alien materials are placed, such as Horsey where an existing soft mud foreshore has been replaced by sand, stone and shell, not only is damage extensive, but recovery will be by species that are not native to the existing foreshore i.e. recolonisation will take longer. It is hoped that the area in the future will have a greater species diversity which will compensate to a degree for the reduction in the biomass that soft silts are capable of.

As the majority of foreshores in Essex are under the jurisdiction of English Nature, their policy and opinions are paramount.

8. FUTURE POLICY

For areas like Stone Point and Foulton with total losses of material averaging 60,000cm per year, a policy of "trickle recharge" i.e. the placing of relatively small amounts (30,000cm) each year would help to counter-balance the existing erosive regimes and create a more stable foreshore profile. The alternative is to allow the erosion to continue until either large capital sums are required or the defence line is moved landward. The latter has been the case at Horsey, Foulton and Stone Point, but only after considerable monies had been expended from both capital and maintenance budgets. A similar problem now exists at East Mersea Hall, Rolls Farm, Orplands Wall, Trimley Marshes, Shotley Point, Old Hall Point, Tollesbury Wick, Cocket Wick, Foulton Hall, Sizewell, etc. Not all of these sites are suitable for replenishment, but it is an alternative worthy of consideration.

For the Horsey site to be fully effective a further 50,000cm of sand and stone would prevent further erosion taking place. With all three sites being of a low priority i.e. agricultural and conservation benefit, the cost of imported material must be to a minimum i.e. pence not pounds per cm.

A long term solution to the whole area might be afforded by the potential of large amounts of capital dredgings being available from Harwich. For other inshore locations, P.V.W. Ltd., a dredging company used, could produce a shallow draught (2m loaded) rainbow discharge vessel at a cost of £1.2 million pounds.

9. CONCLUSIONS

For work of an experimental nature a great deal has been learnt from this trial.

9.1 The scheme shows a potentially very cheap and maintenance free approach to sea defence problems associated with foreshore, beach or salting loss.

9.2 The construction time is incredibly fast, even allowing for tidal restrictions it is possible to place 1,500cm a day on two tides at one hour per time.

9.3 Although damage to the local environment is caused there is a reasonably quick recovery rate, the end result of the scheme being visually more acceptable than a 'concrete and steel' solution.

9.4 It is very important to ensure local groups interests, knowledge and requirements are taken into account wherever possible.

9.5 Pre and post monitoring is vital to fully assess the impact, benefits or problems that might be encountered. If the same criteria had been applied to past conventional schemes, it is probable that design modifications would have shown cost savings.

10. RECOMMENDATIONS

10.1 That both Stone Point and Foulton continue to be subject to MAFF licence for the receiving of up to 30,000cm a year each of suitable material.

10.2 That Horsey be recharged with a further 50,000cm of suitable material when available.

10.3 The Marine invertebrate survey should be continued at Horsey only to fully assess the recolonisation rate, species diversity and biomass. Cost £4,000.

10.4 With the major movements in the approach channel to Walton Backwater that were monitored in one year a repeat of the bathymetric survey is vital. Cost £4,000.

10.5 That other suitable sites be investigated for an extension to the foreshore recharge method.

10.6 Further negotiations should be held with Harwich Haven, dredging contractors and Crown Estates on source material and placing methods.

11. ACKNOWLEDGEMENTS

The co-operation of local individuals and interest groups was greatly appreciated, particularly Mr.Frank Bloom, Walton Backwaters Warden, for sound practical advice and local knowledge, Mr.V.D.Titchmarsh for use of his Marina facilities that were made freely available to R & D contractors and Harwich Haven Authority, without whose co-operation the trial experiment could not have taken place.

12. REFERENCES

Ref. 1 Sea Defence instability due to salting and foreshore loss : Foreshore recharging. A.M.Dixon, National Rivers Authority, January 1990.

Ref 2. NRA sample numbers 91026318, 91026320, 91026319, 32589, 32570, 14325, 32569, 14326, 14324.

Ref 3. NRA Foreshore Recharge R & D file, Kelvedon - Grading curves and soils analysis - separate file.

Ref 4. NRA Foreshore Recharge R & D file, Kelvedon - Bathymetric surveys June 1990 and June 1991 - separate files.

Ref. 5 Unicomarine Ltd., Essex - Intertidal Survey 1 & 2 of July 1990 and July 1991.

Ref. 6 Hydraulics Research Ltd. report EX 2191 August 1990, Walton Backwater - An assessment of a trial replenishment scheme (see also HR reports EX 1906).

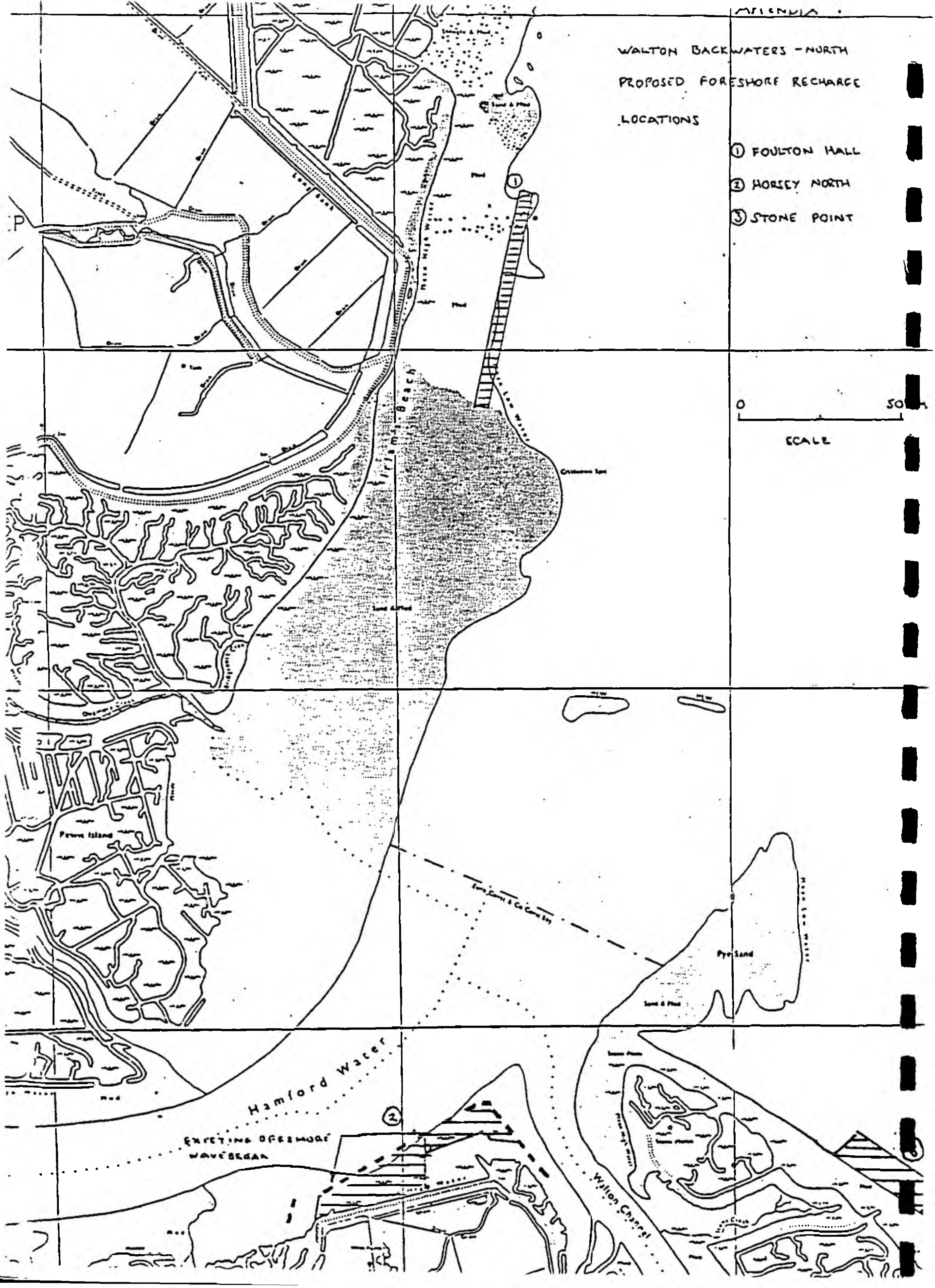
Ref. 7 Hydraulics Research Ltd., report EX 1835 December 1988 - Harwich Harbour Mud Properties.

Ref. 8 Rheological behaviour of cohesive sediment taken from Harwich Harbour. T.E.R.Jones, Dept. of Mathmatics and Statistics, Plymouth Polytechnic, 1988.

Ref. 9 A survey of metal composition within sediments of East Anglian Salt Marshes October 1990 - September 1991. Imperial College, London.

13. APPENDICES

1. Location map of Foreshore Recharge Sites
2. List of correspondence contacts
3. Cargo position map for Stone Point
4. Cargo position map for Foulton Point
5. 'Rainbow' discharge method vessel
6. Grading curves
7. Bathymetric Survey location map
8. Invertebrates species Foulton
9. Invertebrate species Horsey
10. Invertebrate species Stone Point
11. Combined species list
12. Example of invertebrates
13. Recharge material Horsey


WALTON BACKWATERS - NORTH
PROPOSED FORESHORE RECHARGE
LOCATIONS
① FOULTON HALL
② HORSEY NORTH
③ STONE POINT
0
SCALE
Sand & Mud
Pewit Island
Pye Sand
Hamford Water
EXISTING OFFSHORE WAVEBREAK
Walton Channel

APPENDIX 2 – LIST OF CORRESPONDENCE CONTACTS

M.A.F.F.

Mr.J.Regan, Marine Environment & Protection, Division B
Room 542, Nobel House, 17 Smith Square, London SW1P 3JR

Regional Engineer, Block B, Government Buildings,
Brooklands Avenue, Cambridge CB2 2DR

Fisheries Division, Great Westminster House, Horseferry Road,
London SW1P 2AE

Mrs.L.Murry, MAFF Laboratories, Remembrance Avenue,
Burnham-on-Crouch, Essex.

CONSERVATION

Mr.R.Hamilton, English Nature, All Saints House,
High Street, Colchester CO1 1UG

Mr.P.Riches, English Nature, 60 Bracondale,
Norwich NR1 2BE

Mr.C.Durdin, R.S.P.B., 97 Yarmouth Road, Thorpe St.Andrew
Norwich NR7 0HF

Mr.J.M.Hall, Admin.Officer, Essex Naturalists Trust
Fingringhoe Wick Nature Reserve, South Green Road, Essex

Countryside Commission, South East Regional Office,
30/82 Southampton Street, London, WC1E 7RA

Naze Protection Society, 38 Alfred Terrace, Walton-on-the-Naze, Essex CO14 8PB

Frinton & Walton Heritage Trust – new address not known

FRONTAGER

Mr.J.Eagle, Devereux Farm, Frinton-on-Sea, Essex

Mr.W.Cullen, Foulton Hall, Ramsey, Essex

Mr.J.Backhouse, Horsey Island, Kirby-le-Soken, Essex

LANDOWNER

Marine Estates, Crown Estates Office, 16 Carlton House
Terrace, London SW1Y 5AH

MARITIME/NAVIGATION

Dept. of Transport, Marine Directorate, Room 44,
Sunley House, 90 High Holborn, London WC1V 6LP

Hydrographic Office, M.O.D., Taunton, Somerset TA1 2DN

Trinity House, Lloyds Chambers, 1 Portsoken Street
London E1 8BT

Dept. of Trade & Industry, Marine Division, Tavis House
1-6 Tavistock Square, London WC1A 9NL

Walton-on-Naze Fairways Committee, 4 Kirby Road
Walton-on-Naze, Essex

Mr.V.D.Titchmarsh, Titchmarsh Marina Ltd., Coles Lane,
Walton-on-Naze, Essex CO14 8SL

Harwich Haven Authority, The Quay, Harwich, Essex CO12 3HH

Harwich Area Saling Association, Royal Yacht Club,
Woolverstone, Ipswich IP9 1AT

Naze Oysters Ltd., Mill Lane, Walton-on-Naze, Essex

LOCAL GOVERNMENT

Mr.W.S.Colwill, Leisure Services Dept., Tendring
District Council, 23 Pier Avenue, Clacton-on-Sea
Essex CO15 1QP

Director of Planning & Economic Development
Tendring District Council, Council Offices, Weeley,
Clacton-on-Sea, Essex CO16 9AJ

Town Council of Frinton & Walton, Council House,
Triangle Shopping Centre, Frinton-on-Sea, Essex CO13 0AV

Harwich Town Council, Guildhall, Church Street, Harwich, Essex

OTHER

Mr.A.Mascall, 33 Coggeshall Road, Earls Colne, Essex

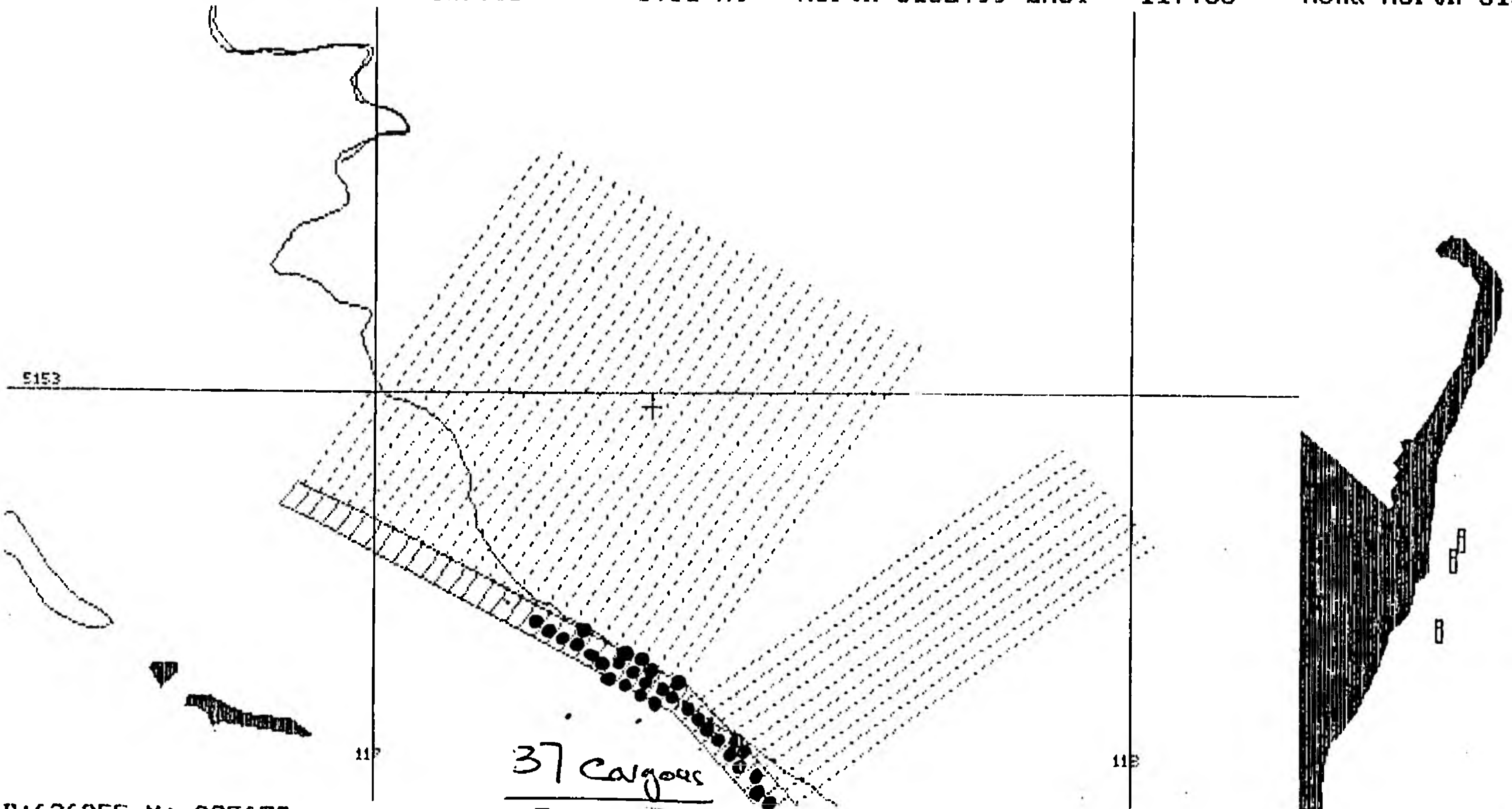
Mr.J.Novorol, Hamford Water Wildfowling Assoc., The
Brents, Sparrow Corner, Harwich Road, Gt.Oakley, Essex

Little Oakley & District Wildfowlers Assoc., Barnfield,
Hall Lane, Ingatestone, Essex CM4 9NX

APPENDIX 3.

CARGO POSITION - STONE POINT

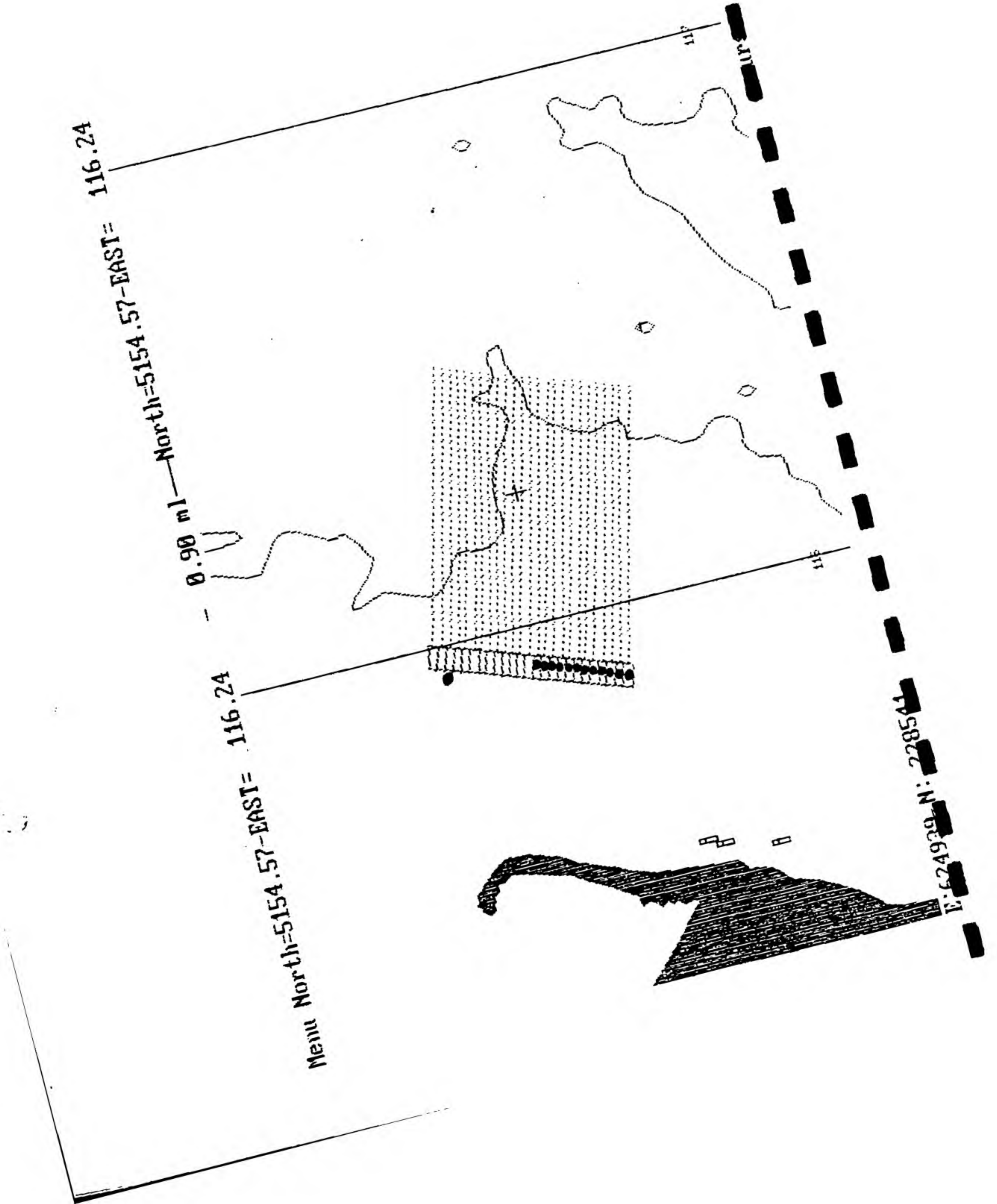
Menu North=5152.99-EAST= 117.36 0.81 ml North=5152.99-EAST= 117.36 Menu North=51!



E:626355 N: 225672 cursor E:624920 N: 2'

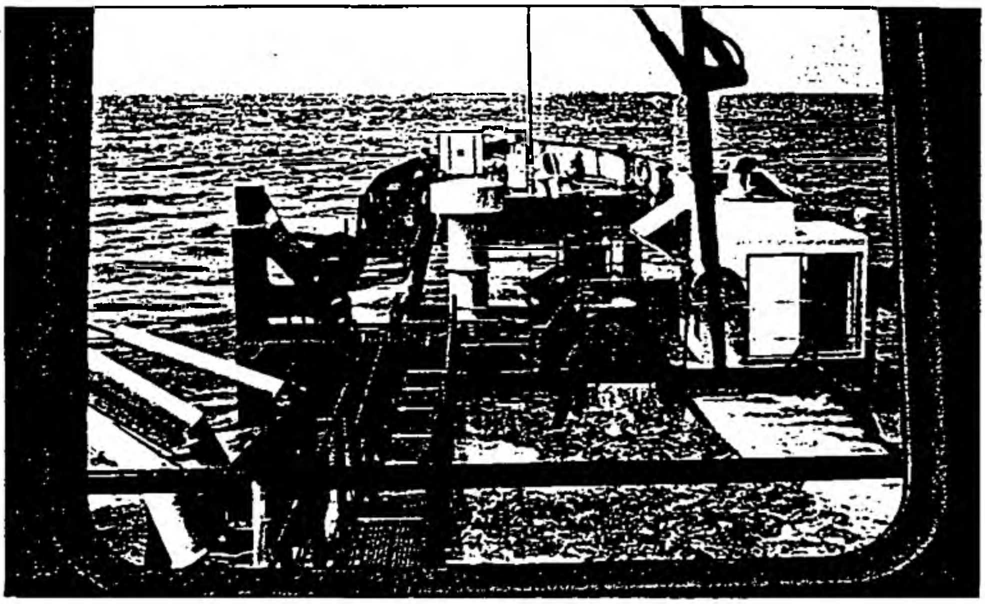
APPENDIX 4.

CARGO POSITION FOULTON POINT



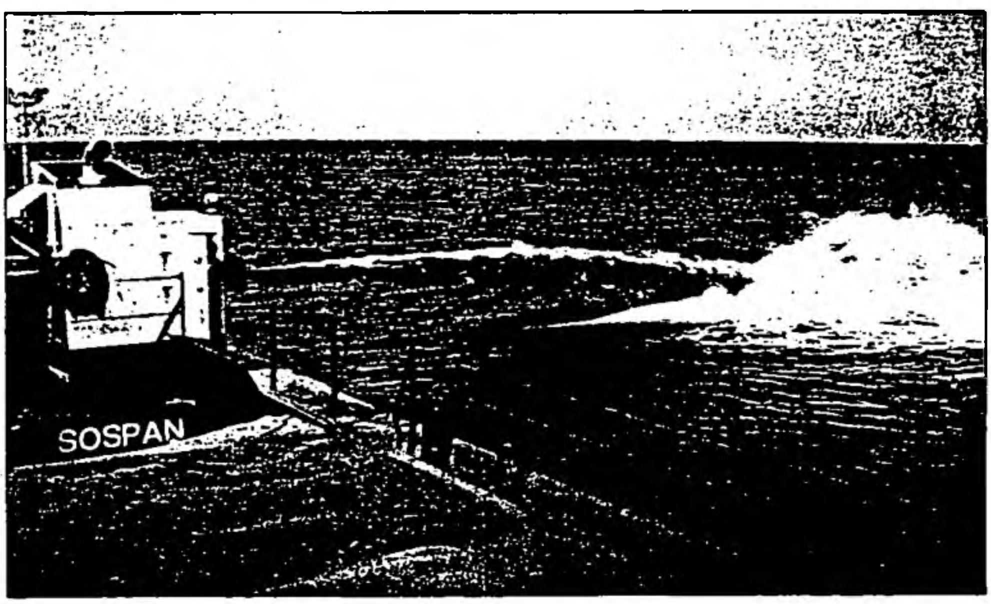
'RAINBOW' DISCHARGE METHOD VESSEL

The SOSPAN at work



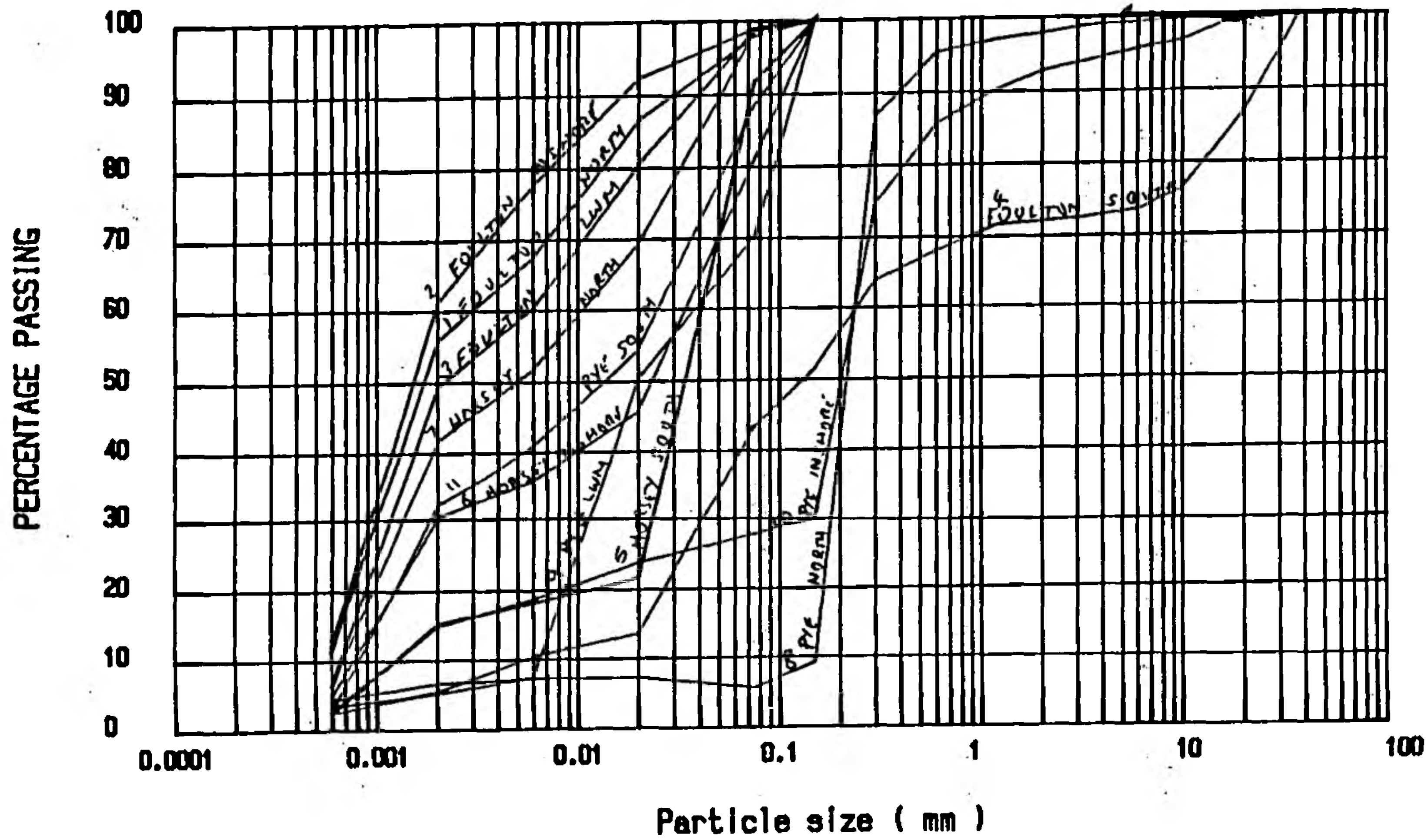
Loading.

Discharge, aided by water jetting.



Pumping overboard during tests.

B.S.1377 PARTICLE SIZE ANALYSIS TEST NO.7a AND 7d

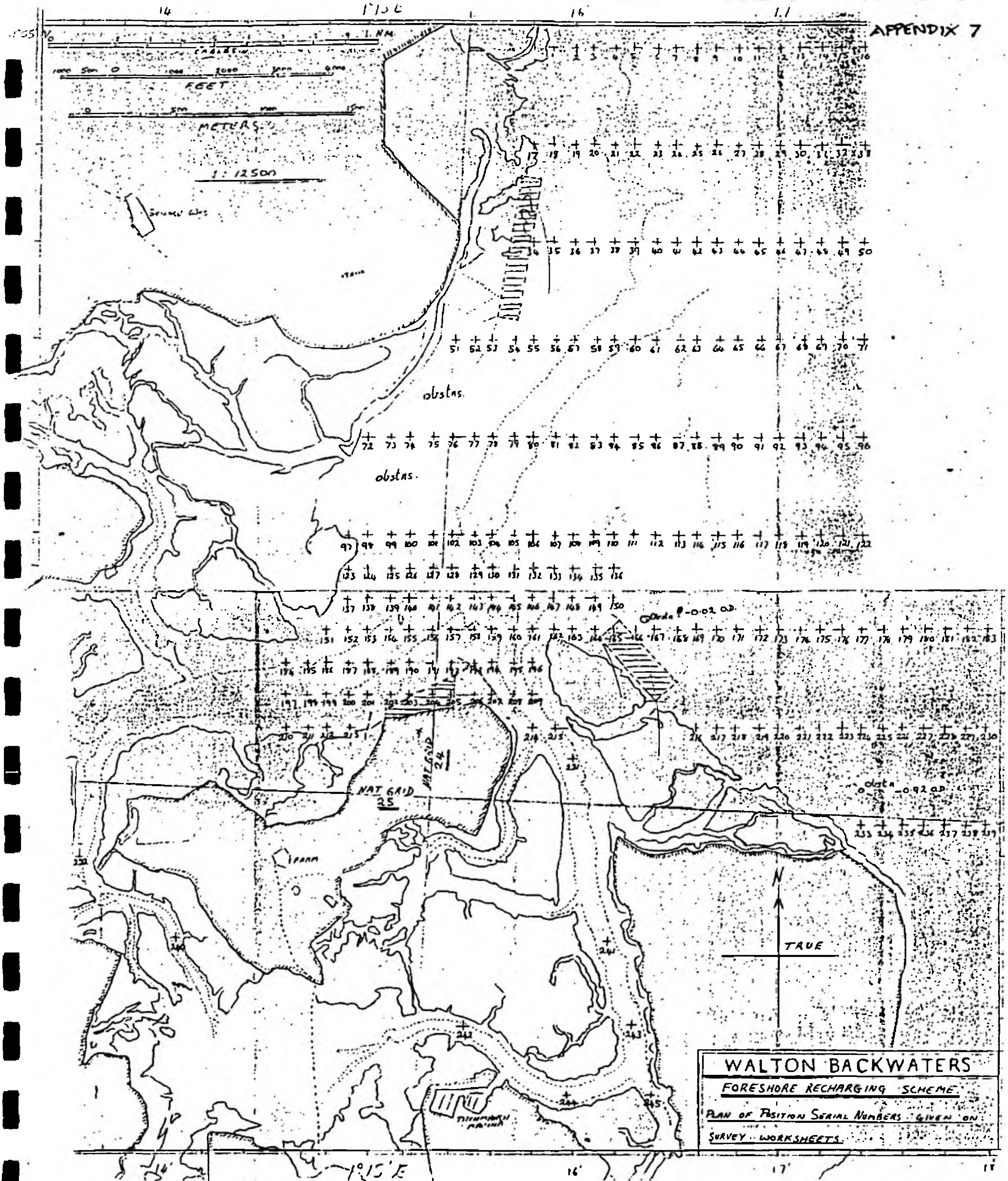


CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	C
	SILT			SAND			GRAVEL			

APPENDIX 6.

[redacted] NHST [redacted] Site ref : HARWICH [redacted] Job No : [redacted] Borehole No : 1 [redacted] Sample No: 20 [redacted] Depth : 0 [redacted] Fig No : [redacted]

APPENDIX 7



BATHYMETRIC SURVEY LOCATION MAP

Table 4. List of species found at Foulton Hall in decreasing order of frequency of occurrence

FOULTON HALL 1991

Genus	species	TOTSTN	TOTIND	1991 - %	*1990 - %*
Macoma	balthica	26	49	79	*88*
Nephtys	hombergii	22	51	67	*73*
Eteone	longa	20	30	61	*30*
Tanaissus	lilljeborgi	19	161	58	*49*
ud bivalve spat		19	91	58	*0*
Scoloplos	armiger	16	37	48	*67*
Pygospio	elegans	13	111	39	*52*
Cumopsis	goodsiri	10	57	30	*9*
Nephtys	cirrosa	9	13	27	*6*
Bathyporeia	pilosa	8	30	24	*12*
Nucula	turgida	8	15	24	*61*
Tubificoides	benedeni	8	12	24	*18*
Bathyporeia	elegans	6	44	18	*0*
Tharyx	marioni	6	13	18	*15*
ud Ostracoda		6	8	18	*9*
Nereis	diversicolor	5	91	15	*0*
Cerastodermaedule		4	4	12	*67*
Cyathura	carinata	3	11	9	*0*
Ampharete	balthica	2	3	6	*0*
Anoplodactylus	petiolatus	2	4	6	*0*
Arenicola	marina	2	2	6	*3*
Aricidea	minuta	2	2	6	*9*
Polydora	ligni	2	45	6	*3*
Streptosyllis	websteri	2	7	6	*6*
Bathyporeia	guilliamsoniana	1	1	3	*18*
Capitella	capitata	1	1	3	*3*
Carcinus	maenas	1	1	3	*0*
Goniada	maculata	1	1	3	*0*
Phyllodoce	mucosa	1	1	3	*6*
Talitrus	saltator	1	1	3	*0*
Tubificoides	diazi	1	1	3	*3*
ud Enchytraeid sp.		1	9	3	*0*
ud Nemertean A		1	1	3	*0*
ud Nephtys (juv.)		1	1	3	*0*

Total of 33 stations sampled
Total of 34 species recorded

KEY:
TOTSTN – total number of sampling stations at which the species was recorded
TOIND – total number of individuals of that species at all stations
1991 – % – proportion of stations at which the species was recorded as percentage of all stations sampled
1990 – % – as above, indicating value found for species in 1990 survey

Table 5. List of species found at Horsey Island in decreasing order of frequency of occurrence

HORSEY ISLAND 1991

Genus	species	TOTSTN	TOTIND	1991 - %	*1990 - %*
Macoma	balthica	20	416	100	*100*
Tharyx	marioni	20	2498	100	*100*
Tubificoides	benedeni	20	970	100	*100*
Nephtys	hombergii	19	63	95	*100*
Streblospio	shrubsoiii	18	140	90	*80*
ud bivalve spat		16	408	80	*0*
ud Ostracoda		16	82	80	*95*
Cerastodermaedule		15	32	75	*90*
Pygospio	elegans	14	86	70	*90*
Eteone	longa	13	57	65	*25*
Nucula	turgida	12	21	60	*90*
Cossura	longocirrata	11	58	55	*100*
ud Nephtys (juv.)		9	19	45	*5*
Ampharete	balthica	7	10	35	*30*
ud Mytilidae spat		6	6	30	*30*
Exogone	naidina	5	37	25	*65*
ud Oligochaeta		5	21	25	*5*
Mya	arenaria	4	4	20	*5*
Abra	alba	3	5	15	*0*
Nereis	diversicolor	3	3	15	*15*
Hydrobia	ulvae	2	2	10	*0*
Manayunkia	aesturina	2	2	10	*0*
Melinna	palmata	2	2	10	*10*
Capitella	capitata	1	1	5	*5*
Cirriformia	tentaculata	1	4	5	*5*
Crangon	crangon	1	2	5	*0*
Eudorella	truncatula	1	1	5	*0*
Gammarus	salinus	1	2	5	*0*
Phoronis	muelleri	1	3	5	*50*
Polydora	ligni	1	1	5	*10*
Scrobicularia	plana	1	1	5	*5*
Tubificoides	pseudogaster	1	8	5	*0*
Tubificoides	scoticus	1	3	5	*0*
ud Barnacles		1	1	5	*10*

Total of 20 stations sampled
Total of 34 species recorded

KEY:
TOTSTN – total number of sampling stations at which the species was recorded
TOIND – total number of individuals of that species at all stations
1991-% – proportion of stations at which the species was recorded as percentage of all stations sampled
1990-% – as above, indicating value found for species in 1990 survey

Table 6. List of species found at Stone Point in decreasing order of frequency of occurrence

STONE POINT 1991

Genus	species	TOTSTN	TOTIND	1991 - %	*1990 - %*
Bathyporeia	pilosa	18	850	64	*71*
Tanaissus	lilljeborgi	15	152	54	*54*
Pygospio	elegans	9	118	32	*39*
Nereis	diversicolor	7	27	25	*36*
Eteone	longa	5	8	18	*32*
ud bivalve spat		5	122	18	*0*
Capitella	capitata	4	7	14	*21*
Talitrus	saltator	4	11	14	*11*
ud Enchytraeid sp.		4	11	14	*4*
Corophium	volutator	3	36	11	*32*
Cumopsis	goodsiri	3	4	11	*43*
Cyathura	carinata	3	19	11	*7*
Macoma	balthica	3	7	11	*4*
Anoplodactylus	petiolatus	2	4	7	*0*
Nephtys	cirrosa	2	2	7	*14*
Nephtys	hombergii	2	5	7	*14*
Tubificoides	benedeni	2	2	7	*0*
ud Mytilidae spat		2	2	7	*0*
ud Ostracoda		2	3	7	*0*
Cerastodermaedule		1	1	4	*25*
Nucula	turgida	1	2	4	*4*
Petricola	pholadiformis	1	1	4	*0*
Scoloplos	armiger	1	1	4	*21*
ud Corophium sp.		1	36	4	*0*
Bathyporeia	elegans	1	8	4	*0*

Total of 34 stations sampled
Total of 25 species recorded

KEY:
TOTSTN - total number of sampling stations at which the species was recorded
TOIND - total number of individuals of that species at all stations
1991-% - proportion of stations at which the species was recorded as percentage of all stations sam
1990-% - as above, indicating value found for species in 1990 survey

Table 7. Combined species list for all three study areas

Genus	species	Type	Common name	Feeding type
Abra	alba	moll		F
Ampharete	balthica	poly		D
Anoplodactylus	petiolatus	crus	Sea-spider	S
Arenicola	marina	poly	Lugworm	D
Aricidea	minuta	poly		D
Bathyporeia	elegans	crus		P
Bathyporeia	guilliamsoniana	crus		P
Bathyporeia	pilosa	crus		P
Capitella	capitata	poly		D
Carcinus	maenas	crus	Shore crab	S
Cerastoderma	edule	moll	Cockle	F
Cirriformia	tentaculata	poly		D
Corophium	volutator	crus		P
Cossura	longocirrata	poly		D
Crangon	crangon	crus	Brown Shrimp	P
Cumopsis	goodsiri	crus		P
Cyathura	carinata	crus		P
Eteone	longa	poly		D
Eudorella	truncatula	crus		P
Exogone	naidina	poly		D
Gammarus	salinus	crus	Sand hopper	P
Goniada	maculata	poly		S
Hydrobia	ulvae	moll	Mud-snail	D
Macoma	balthica	moll	Baltic Tellin	D
Manayunkia	aesturina	poly		F
Melinna	palmata	poly		D
Mya	truncata	moll	Blunt gaper	F
Nephtys	cirrosa	poly	Catworm	D
Nephtys	hombergii	poly	Catworm	D
Nereis	diversicolor	poly	Ragworm	S
Nucula	turgida	moll	Nut shell	F
Petricola	pholadiformis	moll	Boring Bivalve	F
Phoronis	muelleri	phor		F
Phyllodoce	mucosa	poly	Paddle-worm	S
Polydora	ligni	poly		D
Pygospio	elegans	poly		D
Scoloplos	armiger	poly		D
Scrobicularia	piana	moll	Furrow Shell	D
Sphaeroma	monodi	crus		P
Streblospio	shrubsolii	poly		D
Streptosyllis	websteri	poly		D
Talitrus	saltator	crus	Sand hopper	P
Tanaissus	lilljeborgi	crus		P
Tharyx	marioni	poly		D
Tubificoides	benedeni	olig		D
Tubificoides	diazi	olig		D
Tubificoides	pseudogaster	olig		D
ud Barnacles		crus		F
ud bivalve spat		moll		F
ud Corophium sp.		crus		P
ud Enchytraeid sp.		olig		D
ud Mytilidae spat		moll	Young Mussel	F
ud Nemertean A		neme	Ribbon Worms	D
ud Nephtys (juv.)		poly		D
ud Oligochaeta		olig		D
ud Ostracoda		crus		P

KEY: TYPE – Crustacean, Mollusc, Nemertean, Oligochaete, Phoronid, Polychaete
FEEDING TYPE – Detritus, Filter, Particulate, Scavenger/Predator

APPENDIX 12

EXAMPLES OF INVERTEBRATES

Bathyporeia - an amphipod CRUSTACEAN.

Hydrobia ulvae - a gastropod MOLLUSC.

Macoma balthica - a bivalve MOLLUSC.

Tubificoides - OLIGOCHAETE worms.

Nephtys hombergii - a POLYCHAETE worm.

RECHARGE MATERIAL POSITIONED AT HORSEY