

National Rivers Authority

South Western Region

Tidal Waters Group

Cataclews Impact Assessment

Summer 1995

TWQ/96/02

DRAFT DATA REPORT



NRA

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ENVIRONMENT AGENCY



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1.0 Introduction

As part of the technical appraisal of the Camel Waste Water Treatment Scheme, two surveys were undertaken in the coastal waters offshore of the Cataclews STW. The work was specified by the Tidal Waters Quality Group and undertaken by the Cornwall Area Investigations Team in association with the Tidal Waters Quality Group. The surveys were designed to investigate the tidal regime and dispersion characteristics of the coastal waters in the Mother Ivey's Bay area in North Cornwall. The objective of the surveys was to investigate the impact of a new treated waste water outfall discharging from Cataclews STW on the EC Designated Bathing Waters at Harlyn Bay and Mother Ivey's Bay (Figure 1). The data collected was to be used to determine the presence and location of a shear zone in the flows in the bay as an aid to establishing the most suitable site for the proposed discharge. This report describes the work undertaken during the NRA surveys and presents the data collected.

Also included in the discussion section of this report are the results from similar surveys carried out during 1995 by South West Water Services Limited (SWWSL).

2.0 Methods

2.1 General

The NRA surveys were carried out to cover neap and spring tidal conditions. It was required that wind conditions were to be calm or light onshore (NW to NE). Qualitative dye and drogue releases were undertaken throughout a tidal cycle. Locations were fixed by use of post-processed differential GPS. The base station used for this post-processing was located at Manley House, Exeter. Photographs of the dye patches were also taken from the cliffs to assist in the location of the patches.

To define any vertical structure that may have been present during the period of each survey, CTD data was collected in the vicinity of the dye patches and along the line of the proposed outfall. Meteorological observations were taken at periods throughout each survey.

2.2 Dye Releases

Two litres of dye, either Rhodamine or Fluorescein, diluted 9:1 with freshwater, were released on each occasion. Two release sites were used, at 50 and 250 metres offshore, along the approximate line of the proposed outfall. Releases were made at two hourly intervals throughout a tidal cycle. Following each dye release, the edge of each visible dye patch was fixed using GPS. The positions of the patches were determined at intervals dependant upon the rate of advection and dispersion.

2.3 Drogue Releases

Drogues were released at distances along the line of the proposed outfall and tracked for approximately 1.5 hours or until they were advected outside the area of interest. The drogues were released concurrently with the dye at two hourly intervals. Positions were marked by post-processed differential GPS at time intervals dependant upon the advected distance of the drogues.

3.0 NRA Survey 21 June 1995

3.1 Tidal Conditions

These are summarised below:

Milford Haven		Padstow	
Time	Height	Time	Height
GMT		GMT	
00:15:00	5.8m	23:20:00	6.2m
06:44:00	2.0m	05:54:00	2.1m
12:48:00	5.5m	11:53:00	5.9m
19:16:00	2.2m	18:26:00	2.3m
Mean Range 3.55m (Intermediate/Neap)			
Milford Haven (MNR: 2.7m MSR: 6.3m)			

3.2 Meteorological Conditions

The meteorological observations obtained from the boat and onshore are summarised below:

Time	Boat Obs					Shore Obs	
	Wind	Dirn	Cloud	Waves	Swell	Wind	Direction
GMT	(Beaufort)		(Oktas)	(m)	(m)		(Beaufort)
530	1 - 2	N	8	0.3	0.5 - 1		
650	1 - 2	N	8	0.3	0.5 - 1	N	1
800						N	1
820	2	NE	7	0.3	0.5 - 1	N	1
900						N	1.5
1000						N	2.5
1150	2 - 3	NE	1	0.5	1		
1240	2 - 3	NNE	1				
1300						NE	3
1315	4	NNE	1	1	1 - 1.5		
1330						NE	2
1400						NE	4
1500						NE	4
1600						NNE	4
1630						NNE	3
1700	4	NNE	1	1	1 - 1.5		
Note:	Drizzle from 0600 - 0700 Shore observations used a handheld anemometer Boat observations estimated						

3.3 Results

The results of the dye releases and the salinity/temperature profiling carried out on 21 June 1995 are presented in Figures 2 and 3.

4.0 NRA Survey 15 August 1995

4.1 Tidal Conditions

These are summarised below:

Milford Haven		Padstow	
Time	Height	Time	Height
GMT		GMT	
09:02:00	6.6m	08:10:00	6.8m
15:20:00	1.0m	14:40:00	0.8m
21:22:00	6.6m	20:30:00	6.8m
Mean Range 5.6m (Intermediate/Spring)			
Milford Haven (MNR: 2.7m MSR: 6.3m)			

4.2 Meteorological Conditions

The meteorological observations obtained from the cliff are summarised below:

Cliff Obs				
Time	Wind	Dirn	Cloud	Waves
GMT	(m/s)		(Oktas)	(m)
07:00:00	0	-	0	Calm
08:20:00	0	-	0	Calm
09:55:00	3	N	0	<1m
11:30:00	3.5	N	1	<1m
12:30:00	2.5	N	2	1m
14:10:00	2	N	1	1m
15:30:00	1.5	N	1	<1m
16:30:00	<1	N	0	<1m
17:00:00	0	-	-	-
18:00:00	1	S	-	-

4.3 Results

The results of the dye releases, drogue tracking and salinity/temperature profiling carried out on 15 August 1995 are presented in Figures 4,5 and 6.

5.0 Discussion

The surveys described in this report have been carried out to assist in the determination of outfall position and required level of treatment for the discharge from Cataclews STW.

During the Summer, when the catchment population is greatly increased by tourists, the existing treatment works is overloaded. The incoming flows often exceed the hydraulic capacity of the works and significant spills to the overflow channel occur under dry weather conditions. These spills of untreated waste water cause a highly visible slick to form (Plate 3). At peak flow the performance of the treatment process is significantly reduced due to re-suspension of sludge in the settlement tank. The deterioration in effluent quality during the Summer is demonstrated by the results of final effluent sampling (Table 3).

SWWSL have proposed that the Cataclews STW will be upgraded and enlarged to accept flows from a larger catchment, including Trevone and also possibly Padstow. A new outfall has been drilled to the base of the cliff and this could be extended to a location further offshore. The decision about required levels of treatment for differing lengths of outfall has yet to be made and is dependant on the flows to be discharged and a detailed assessment of the oceanography of the receiving waters.

The offshore tidal current regime is rectilinear with an eastward movement during the flood period of the tide and a westward movement during the ebb. However, in the embayment to the east of Trevoze Head, the rectilinear flow offshore is modified by headlands. During most of the flood tide a clockwise gyre forms. This feature dominates the inshore flow and for most of the flood tide the currents in the middle of the embayment are directed south towards the shore. During the latter period of the flood a smaller clockwise gyre is set-up within the confines of Harlyn Bay.

The advection of the dye patches measured during the SWWSL survey of 14 June 1995 and the NRA survey of 15 August 1995 clearly demonstrates the clockwise rotation of a gyre within Harlyn Bay (Figure 4 and Plate 5). During these surveys, both undertaken during spring tidal conditions, this gyre advected the inshore releases of dye across the entire width of the Harlyn Bay Bathing Water. During the SWWSL survey of 10 April 1995, undertaken during neap tidal conditions, there was no measurable impact on the Harlyn Bay Bathing Water. It may be conjectured that the amount of vorticity will be tidally dependent (ie varying between neaps and springs) and that during neap tidal conditions there is insufficient energy in the tidal currents to set up a strong secondary circulation within Harlyn Bay.

During the ebb phase of the tidal cycle, the flows within Mother Iveys Bay are modified by the embayment formed by Trevoze Head and Merope Rocks. An area of relatively still water forms close inshore at the proposed discharge site. Tidal currents slightly further offshore are deflected to the North-West as they move into the embayment. These flow patterns are apparent from the drogue releases carried out on 15 August at HW +2 and HW +4.5 hours (Figure 5).

During the flood phase of the tidal cycle the inshore currents move West to East. However, under intermediate/spring tidal conditions, during the late period of the flood, a gyre is set up within Mother Iveys Bay. This circulation is apparent from the data collected during the NRA survey on 15 August (Figures 4 and 5). The HW -4 dye and drogues were released into the gyre and were initially advected inshore and then to the North-West around Merope Rocks.

The NRA survey of 15 August 1995 included the release of dye and drogues at 300 metres offshore. During the ebb phase of the tide these dye patches and drogues were rapidly advected beyond Merope Rocks and had no potential impact on the Mother Ivey's Bay Bathing Water (Figures 4 and 5). The advection of these dye patches and drogues indicated no influence from the secondary circulations present closer inshore, except, under intermediate/spring tidal conditions, during the late flood. During the flood period of the tide these offshore dye and drogue releases were advected towards Harlyn Bay and Trevone

Bay but did not encroach into either Bathing Water.

The SWWSL survey of 14 June 1995 included the release of drogues at distances of 50, 100 and 200 metres offshore. Drogues released at each location demonstrated the potential of a discharge at that location to impact on both Bathing Waters at different stages of the tidal cycle. During the survey period there was significant wind with a northerly component (Ref 2). Significant variation was noted between surface and depth drogues. Wind influence on the 200 metre offshore drogues was likely to be responsible for the advection of the surface drogue into the Harlyn Bay Bathing Water. Inshore and offshore current speeds, estimated from the advection of the dye patches and drogues during the NRA surveys, clearly indicate the difference in current regime (Table 1).

The dye tracking undertaken during the two preliminary SWWSL surveys and the two NRA surveys was purely qualitative and the potential dispersion between the various release points and the Bathing Waters is therefore difficult to gauge. However, it can be seen from the coherent nature of the dye patch observed in the Mother Ivey's Bay Bathing Water during the SWWSL survey of 14 June 1995 that at times the available dispersion is limited (Plate 7).

A more accurate assessment of the dispersion characteristics may be gained from the results of the SWWSL survey of 19 May 1995 which included spore tracer releases and the SWWSL survey of 14 June 1995 which included quantitative dye tracking. The spore release data indicates that the discharge made at the base of the cliff impacts on both Bathing Waters.

The dye release survey of 14 June 1995 was undertaken during Spring tidal conditions. Dye releases were made at 100 metres offshore, as this was the discharge point under consideration by SWWSL at that time (Ref 2). Dye patch 2, released at HW +05:10, remained close to the discharge point for approximately 1 hour before the onset of the flood. It was then advected eastward towards Harlyn Bay. During this time the patch was subject to a limited degree of dispersion. The subsequent release at HW -05:05 was rapidly advected into Harlyn Bay and became confused with the previous release. These patches then moved within the Harlyn Bay clockwise gyre and impacted on the Bathing Water. Dye concentrations measured indicated a higher level of dispersion than experienced by the patches advected to Mother Ivey's Bay. The data from the late flood tidal period indicates that the dye patch released at HW -03:22 was advected into the Bathing Water at Mother Ivey's Bay after only 30 minutes and experienced only a very limited degree of dispersion.

Temperature and salinity profiles were carried out during both the NRA surveys and during the SWWSL survey of 19 May 1995. There is considerable doubt regarding the integrity of the salinity data from the SWWSL survey and no temperature data was presented. Profiles from the NRA surveys indicate the presence of weak density structures within the area of interest (the maximum recorded change in salinity was 0.8 ppt in 3 metres and temperature 0.9°C in 5 metres). This structure, although weak, can have a considerable influence on the advection and dispersion characteristics of the tidal currents and will increase the wind influence on near-surface currents (Figures 3 and 6).

6.0 Conclusions

The surveys have demonstrated the potential for an inshore discharge from Cataclews STW to impact on the EC Designated Bathing Waters at Harlyn Bay and Mother Ivey's Bay. The potential for discharges made from an offshore location to impact on the Bathing Waters is significantly reduced.

Releases from the inshore locations have been shown to impact on Mother Ivey's Bay Bathing Water during neap and spring tidal conditions. Discharges made further offshore have less impact as the tidal range increases.

Harlyn Bay Bathing Water was not impacted from the inshore release site during neap conditions but was during springs. The releases made during intermediate/neap conditions from 50 metres offshore were advected into the Bathing Water. Under spring conditions impacts on the Bathing Water were recorded from releases made at 50, 100 and 200 metres offshore.

Releases at distances at about 300 metres offshore did not impact on the Harlyn Bay or Mother Ivey's Bay Bathing Waters under any of the tidal conditions.

An initial appraisal of the data from these surveys indicates that an inshore discharge point, within 200 metres of the cliffs, will require a high level of treatment, probably including a tertiary disinfection treatment. A lesser degree of treatment may be acceptable for discharges outside of this distance offshore as they would rarely impact on the Bathing Waters in question.

To provide a more detailed requirement for length of outfall and required level of treatment it is recommended that further surveys are undertaken. These should provide details of advection and dispersion through quantitative dye and spore releases at discharge points both from the drilled outfall at the base of cliff and at a site 250 metres offshore. However, the need for these surveys is dependant on the preferred scheme option proposed by SWW; this is still awaited.

7.0 References

1. Trevone Regional Sewage Treatment: Cataclews STW Dye Release Surveys: Data Report. SWWSL. 28.04.1995.
2. Trevone Discharge Study. Survey Report 14 June 1995. Wimpey Environmental. Draft. Report Dated August 1995.
3. Trevone (Cataclews) STW Dye and Tracer Study. SWWSL. Draft. Report Not Dated.

Table 1**Estimated Current Velocities**

The current velocities have been estimated from the centroids of the dye patches measured during the NRA Surveys, as presented in figures 2 and 4.

21 June 1995

Tidal Range: 3.9 metres (Intermediate/Spring)

Time wrt HW	Inshore Release Site		Offshore Release Site	
	Speed	Direction	Speed	Direction
-5h40m	0.12 m/s	71°	0.10 m/s	97°
-3h45m	0.10 m/s	78°	0.07 m/s*	138°*
-1h40m	0.12 m/s	263°	0.10 m/s	281°
+0h10m	0.03 m/s	48°	0.30 m/s	264°
+2h15m	0.00 m/s	-	0.16 m/s	287°
+4h10m	-	-	0.09 m/s	262°

* Wind dominated, insignificant tidal velocity

15 August 1995

Tidal Range: 6.0 metres (Spring/Intermediate)

Time wrt HW	Inshore Release Site		Offshore Release Site	
	Speed	Direction	Speed	Direction
HW	0.10 m/s	75°	0.38 m/s	293°
+2h00m	0.00 m/s	-	0.40 m/s	285°
+4h30m	0.00 m/s	-	0.29 m/s	297°
LW	0.16 m/s	81°	0.10 m/s	86°
-4h00m	0.09 m/s	-	0.08 m/s	196°

Table 2**Bathing Water Impact Times**

Bathing Water impact times from the two dye release points have been approximated from the dye release plots. Also included in the table is impact times from the SWWSL surveys carried out during 1995.

Harlyn Bay

	Date	Padstow Range	Impact Times
SWWSL	31.03.1995	6.5m (Sp)	HW -4.0h to HW -3.0h
SWWSL	10.04.1995	3.0m (Np)	No Impact
SWWSL	19.05.1995	4.2m (Sp/I)	HW -4.0h to HW -3.0h
SWWSL	14.06.1995	7.2m (Sp)	HW -4.5h to HW -3.5h
NRA	21.06.1995	3.9m (I/Np)	HW -5.5h to HW -4.0h
NRA	15.08.1995	6.0m (Sp/I)	HW -5.5h to HW -3.5h
Range			HW -5.5 to HW -3.0h

Mother Ivey's Bay

	Date	Padstow Range	Impact Time
SWWSL	31.03.1995	6.5m (Sp)	HW -0.5h to HW +1.5h
SWWSL	10.04.1995	3.0m (Np)	HW +1.0h to HW +2.0h
SWWSL	19.05.1995	4.2m (Sp/I)	HW -2.5h to HW -1.5h
SWWSL	14.06.1995	7.2m (Sp)	HW +4.0h to HW +5.0h
NRA	21.06.1995	3.9m (I/Np)	HW -1.0h to HW +0.5h
NRA	15.08.1995	6.0m (Sp/I)	HW -2.5h to HW -1.5h
Range			HW -2.5h to HW +2.0h and HW +4.0h to +5.0h (Springs)

Table 3

Cataclews STW Final Effluent Samples

Date	Time	Ammonia	Sus Solids	Date	Time	Ammonia	Sus Solids
	BST	mg/l	mg/l				
07.05.89	1100	16.2	26	20.01.92	1045	36.9	292
18.05.89	1230	31.4	404	04.02.92	1310	22.1	84
23.06.89	1245	48.7	376	04.03.92	1030	7.1	62
20.07.89	1240	113.0	17310	22.04.92	940	8.1	39
18.08.89	1255	53.7	284	07.05.92	835	1.9	46
25.09.89	1436	93.7	452	02.06.92	1340	37.9	207
05.10.89	1245	53.1	320	01.07.92	1045	56.0	38
30.10.89	1215	45.5	9580	04.08.92	1100	112.0	182
08.11.89	1230	0.5	31	19.08.92	935	50.0	243
23.11.89	1245	16.0	158	01.09.92	1426	27.6	166
30.11.89	1231	9.2	116	01.10.92	1145	11.5	50
05.12.89	1120	30.5	446	02.11.92	1000	4.7	35
13.12.89	1225	11.0	58	25.11.92	1030	2.2	21
12.01.90	1135	4.9	36	19.01.93	1200	3.5	26
16.02.90	1025	1.4	54	17.02.93	925	19.3	28
22.03.90	1045	12.6	45	29.03.93	1125	29.0	30
05.04.90	1125	23.9	106	15.04.93	1145	10.0	64
03.05.90	1000	26.3	228	05.05.93	940	29.9	19
15.06.90	1100	49.9	140	10.06.93	925	27.9	110
13.07.90	1120	63.9	299	22.07.93	1105	28.0	53
07.08.90	1210	86.5	240	27.08.93	1140	57.0	869
19.09.90	1035	39.1	184	24.09.93	1035	21.3	51
29.10.90	1036	40.4	292	06.10.93	1055	1.3	123
30.11.90	1210	8.0	128	12.11.93	1138	0.5	58
13.12.90	1115	7.6	64	21.12.93	1050	0.7	57
11.01.91	1335	1.0	24	05.01.94	855	0.5	24
21.01.91	1210	2.3	38	17.02.94	1010	2.0	27
06.02.91	1240	10.9	68	25.03.94	920	0.5	67
12.02.91	1215	13.6	75	07.04.94	1032	1.1	70
15.02.91	1100	14.0	76	25.05.94	800	0.5	9
29.04.91	1018	9.4	58	28.06.94	935	47.6	102
14.05.91	1100	6.4	86	22.07.94	1100	48.7	248
07.06.91	1125	30.2	220	05.08.94	1430	83.0	130
25.07.91	1155	54.3	242	30.09.94	1600	27.6	173
16.08.91	845	50.0	182	06.10.94	1230	23.3	34
10.09.91	1100	51.8	1940	16.11.94	1250	2.5	28
03.10.91	1045	28.2	106	14.12.94	940	0.5	25
08.11.91	1136	10.4	63	16.01.95	1245	0.9	23

Figure 1 Location Map

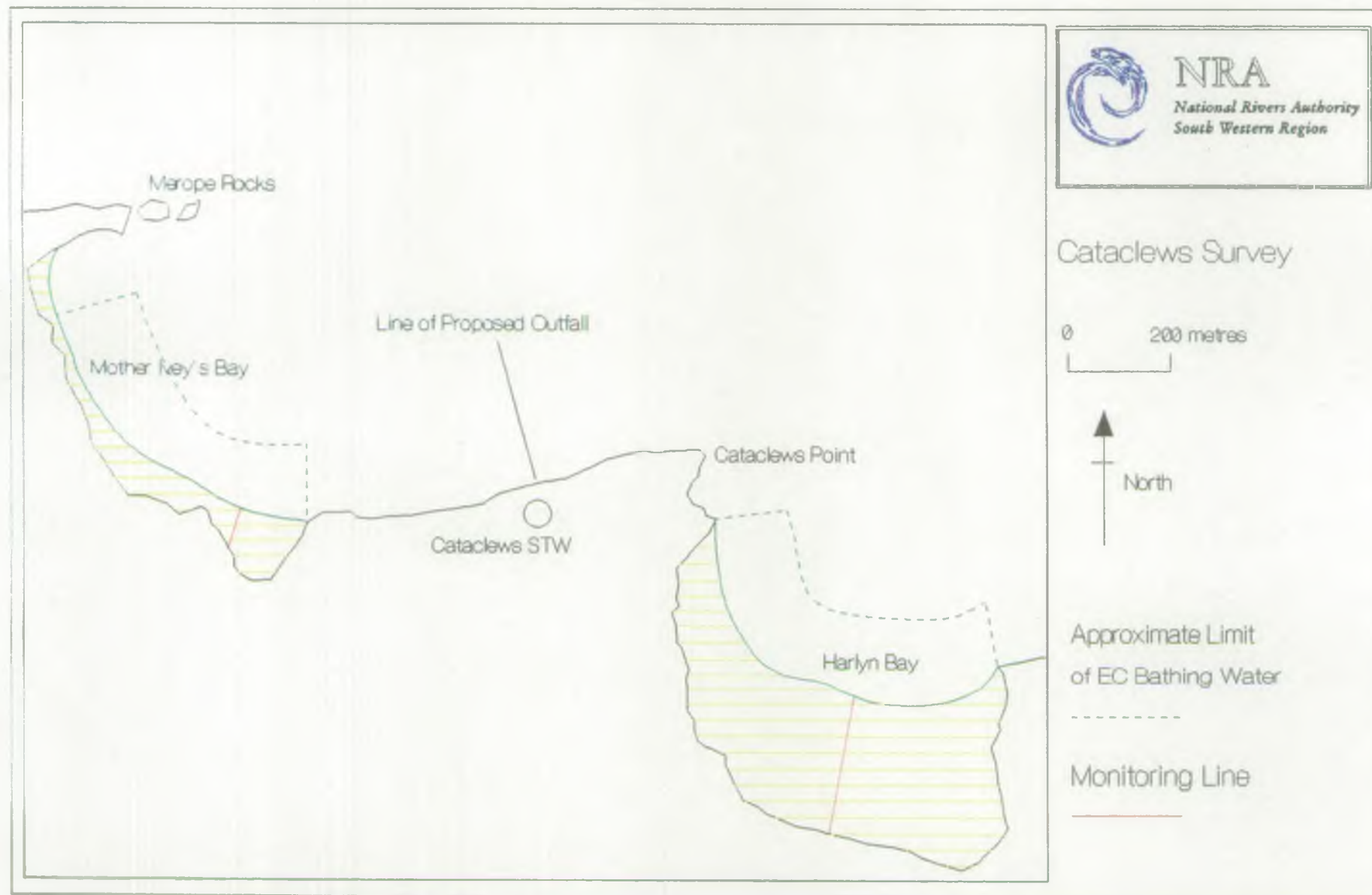


Figure 2 Dye Release 21 June 1995

Cataclews Outfall Survey

21 June 1995

Dye Release Plots

Padstow HW at 11:55 GMT

Range 3.5m (Int/Np)

(times represent start of track)

Plot Times In GMT

Edge of EC Bathing Water - - - - -



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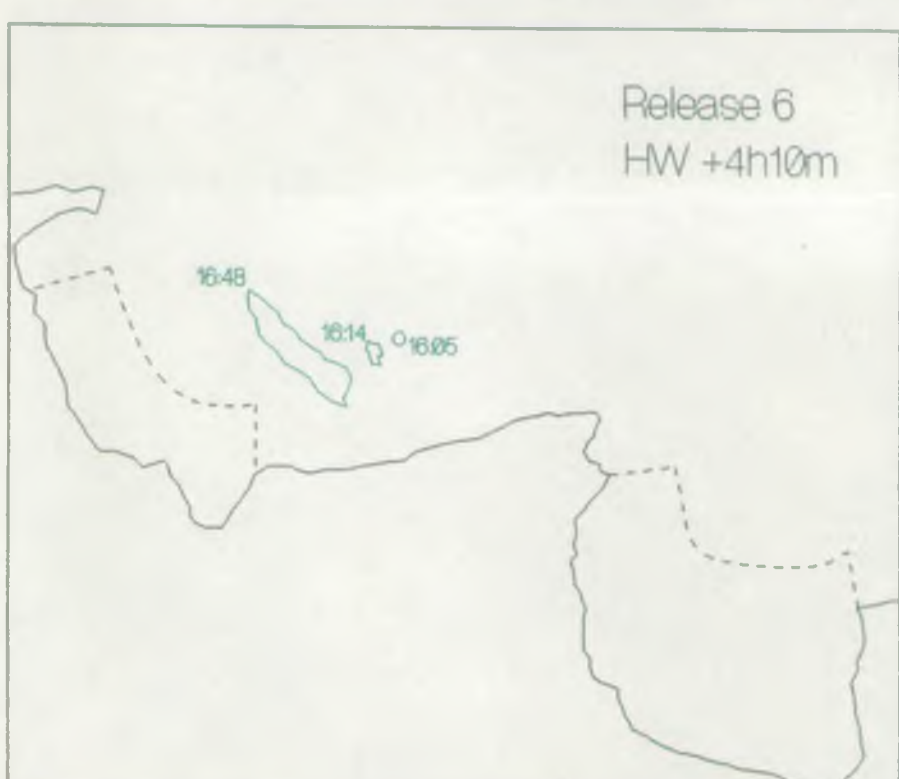
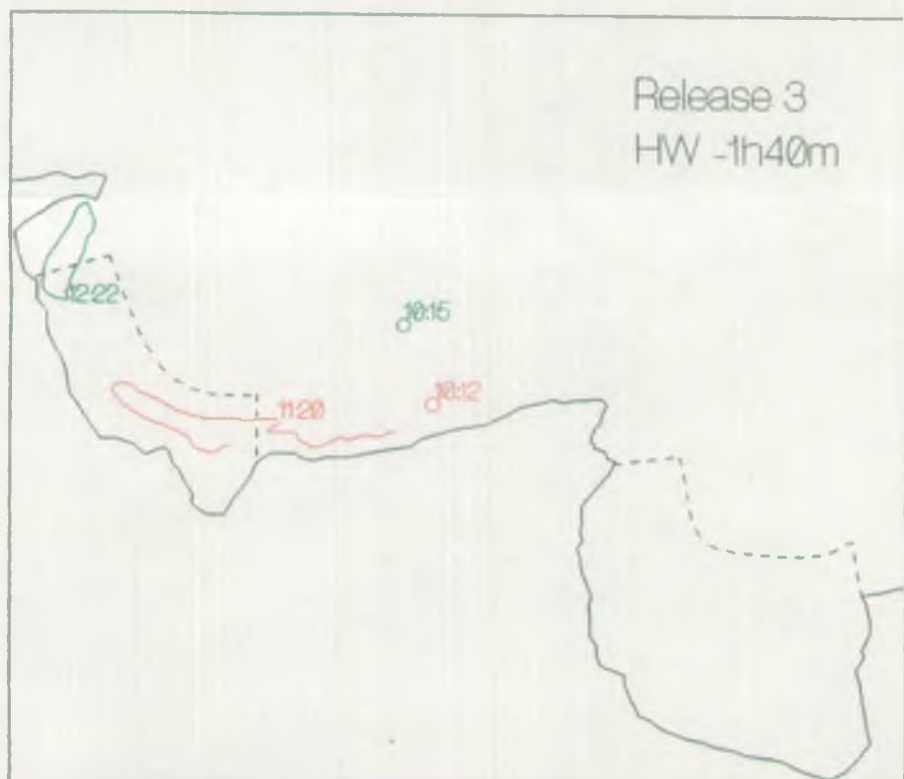
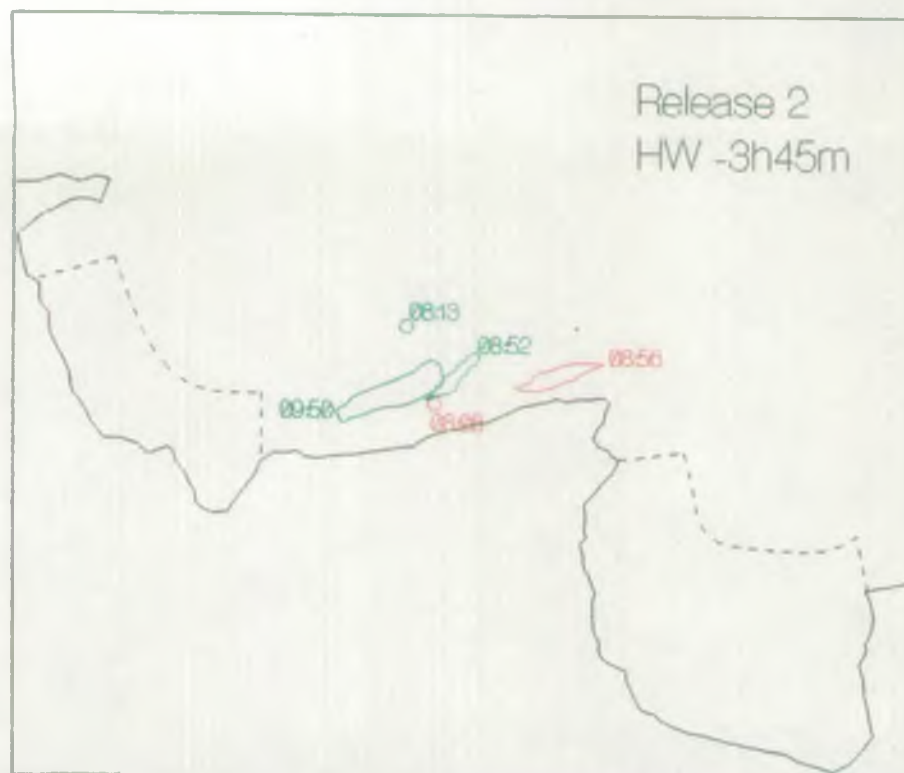
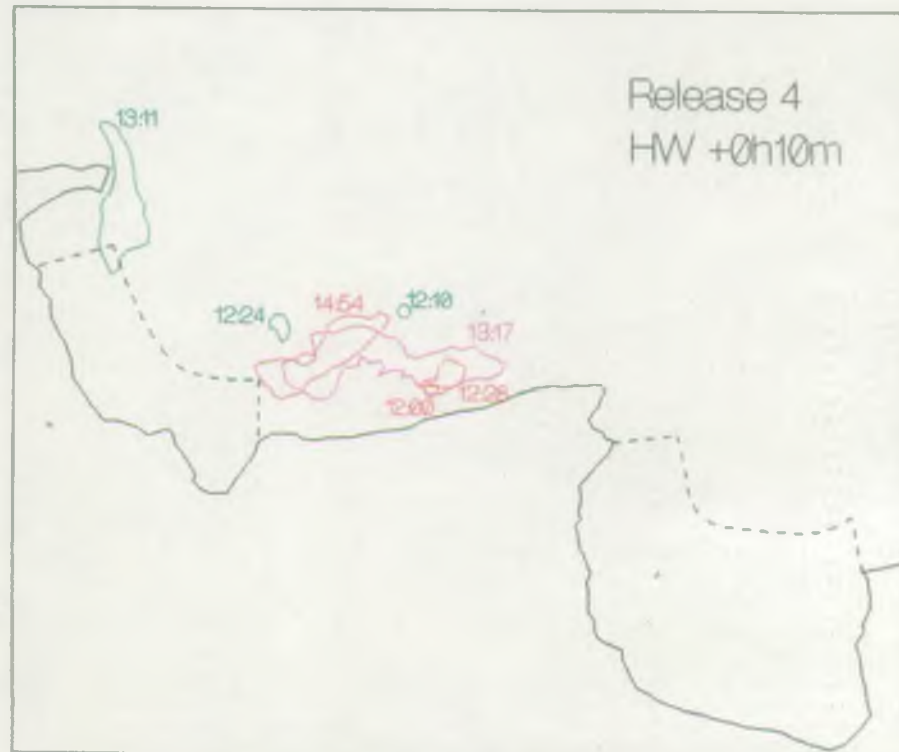
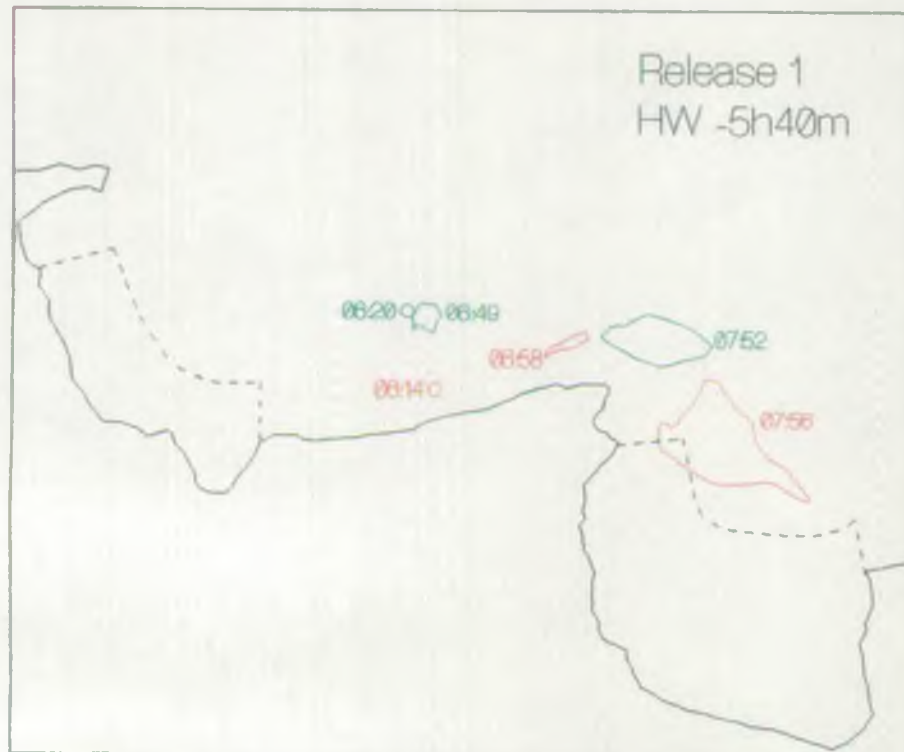


Figure 3 Temperature and Salinity Profiles 21 June 1995

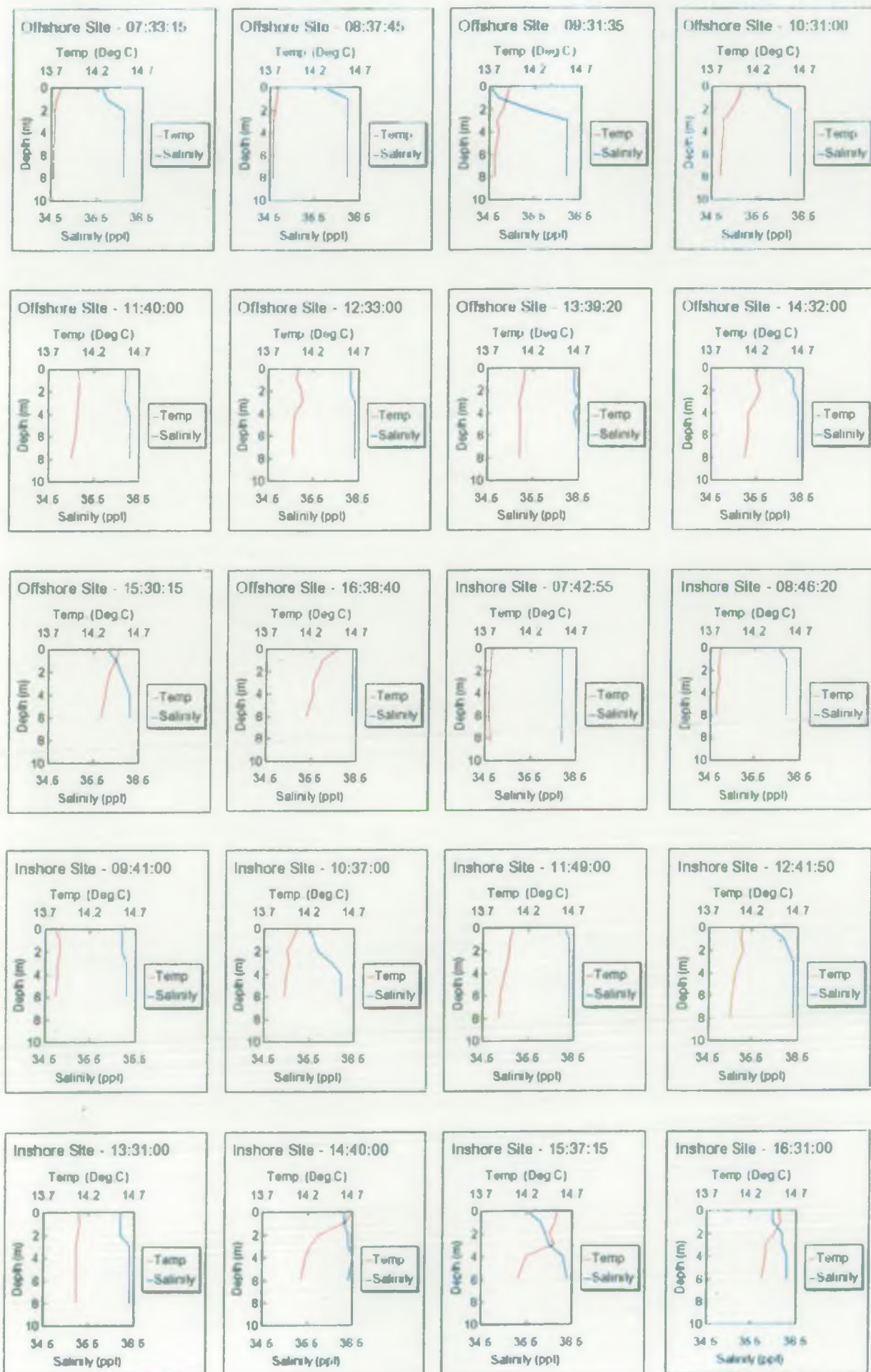


Figure 4 Dye Release 15 August 1995

Cataclews Outfall Survey

15 August 1995

Dye Release Plots

Padstow HW 0810 GMT

LW 1430

HW 2030

Range: 5.6m (Spr/Int)

Plot Times in GMT

(times represent start of track) Edge of EC Bathing Water - - - - -



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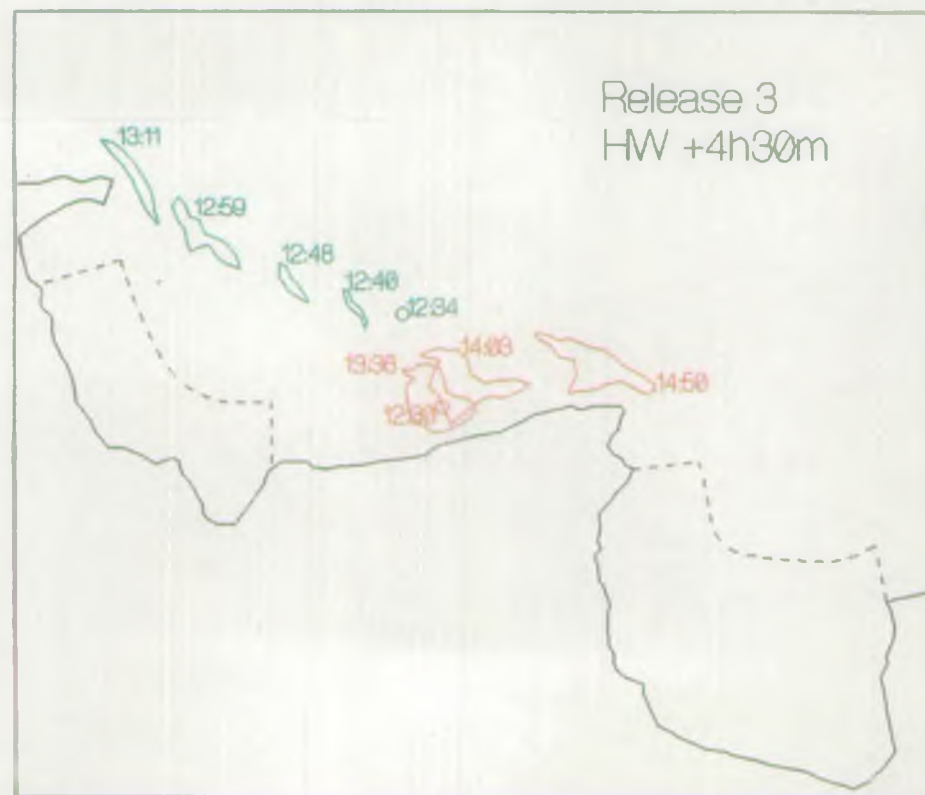
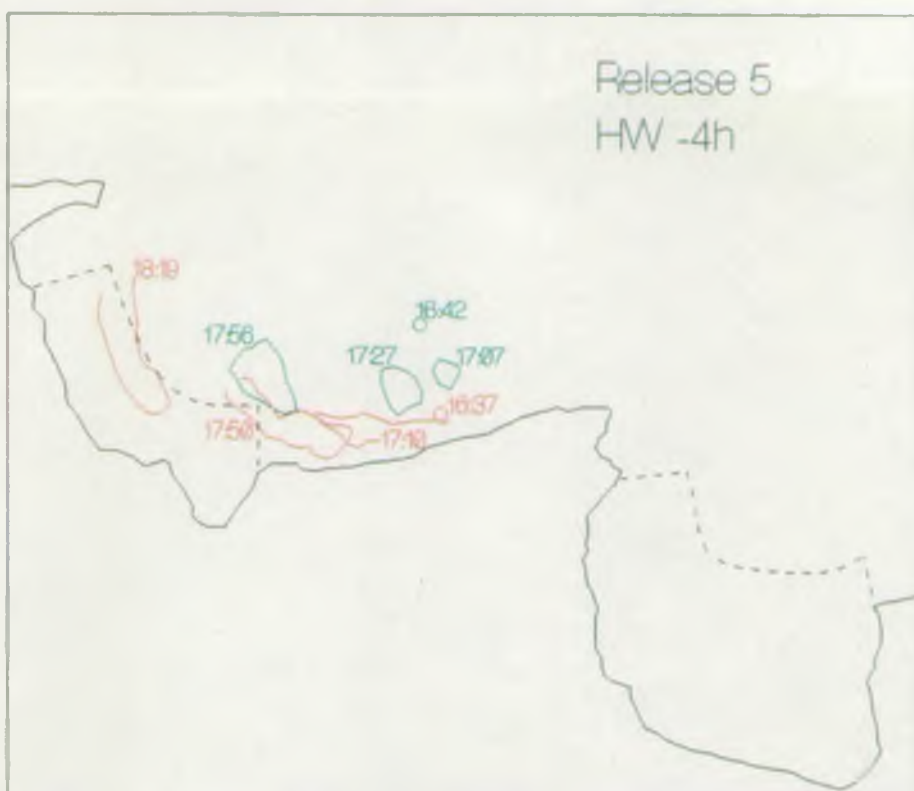
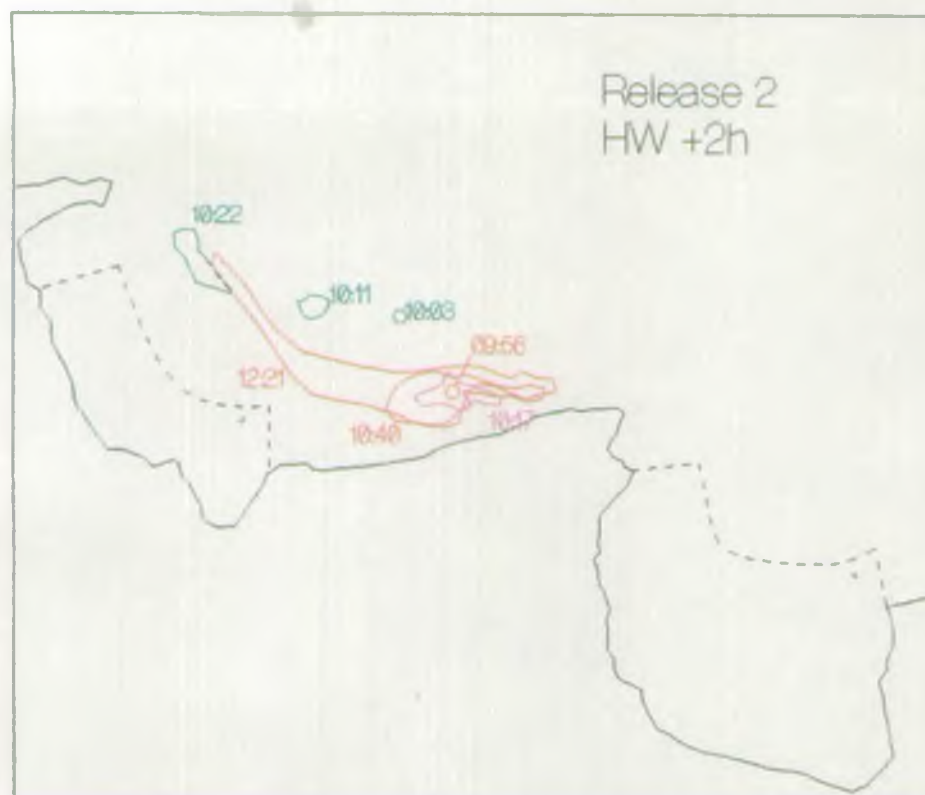
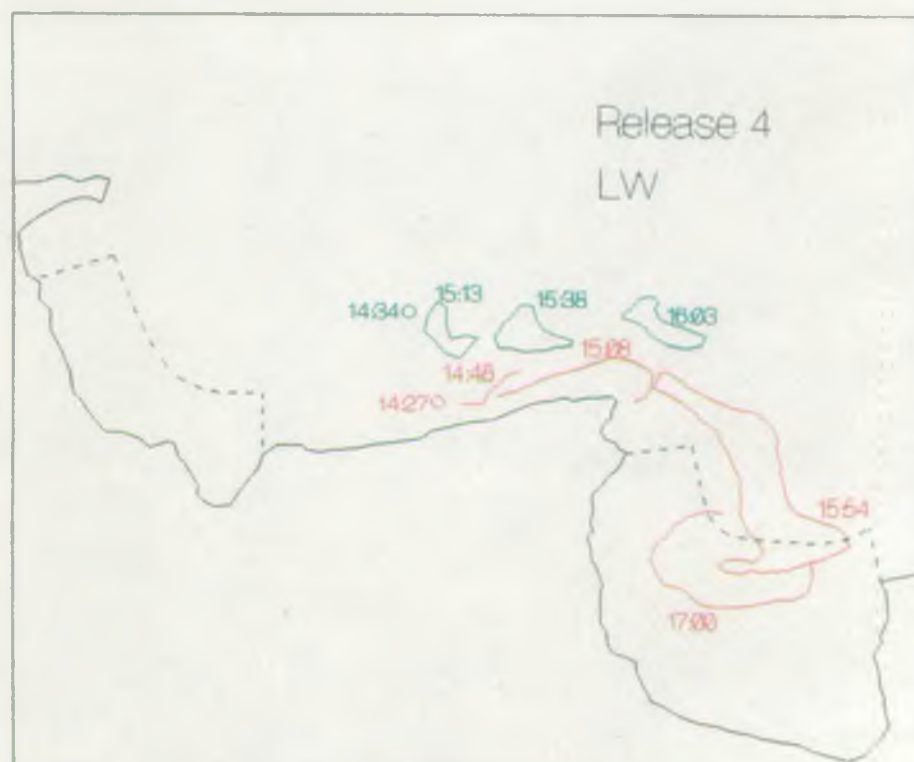
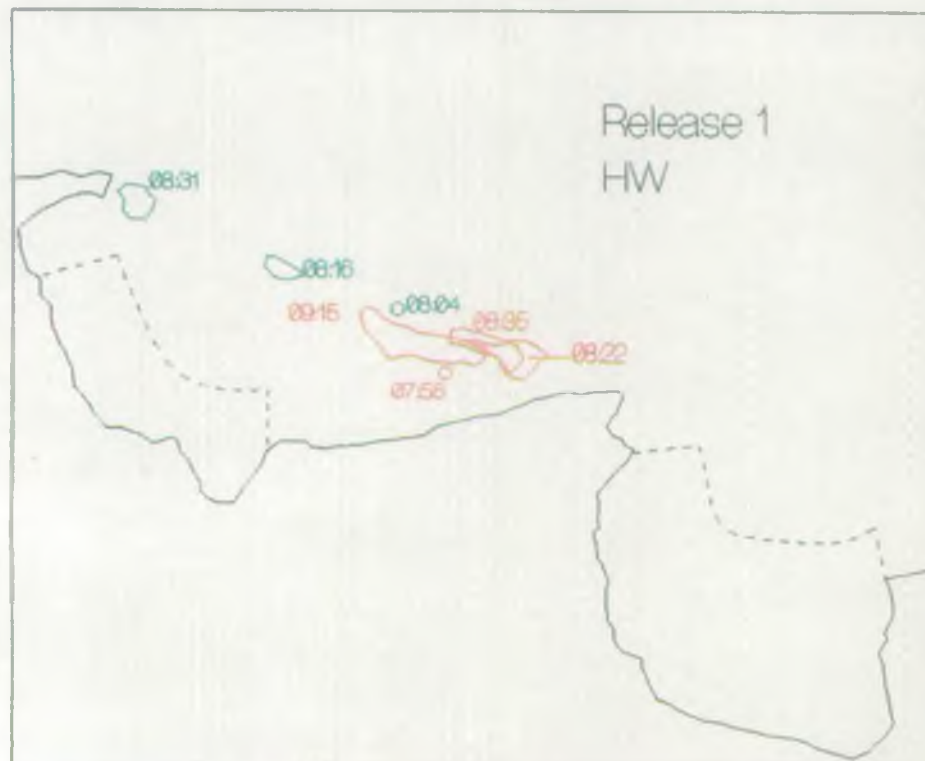


Figure 5 Droque Release 15 August 1995

Cataclews Outfall Survey

15 August 1995

Droque Plots

Padstow HW 0810 GMT

LW 1430

HW 2030

Range: 5.6m (Spr/Int)

Plot Times In GMT

Edge of EC Bathing Water - - - - -

F1 100m Surface

F2 200m Surface

F3 200m Depth

F4 300m Surface

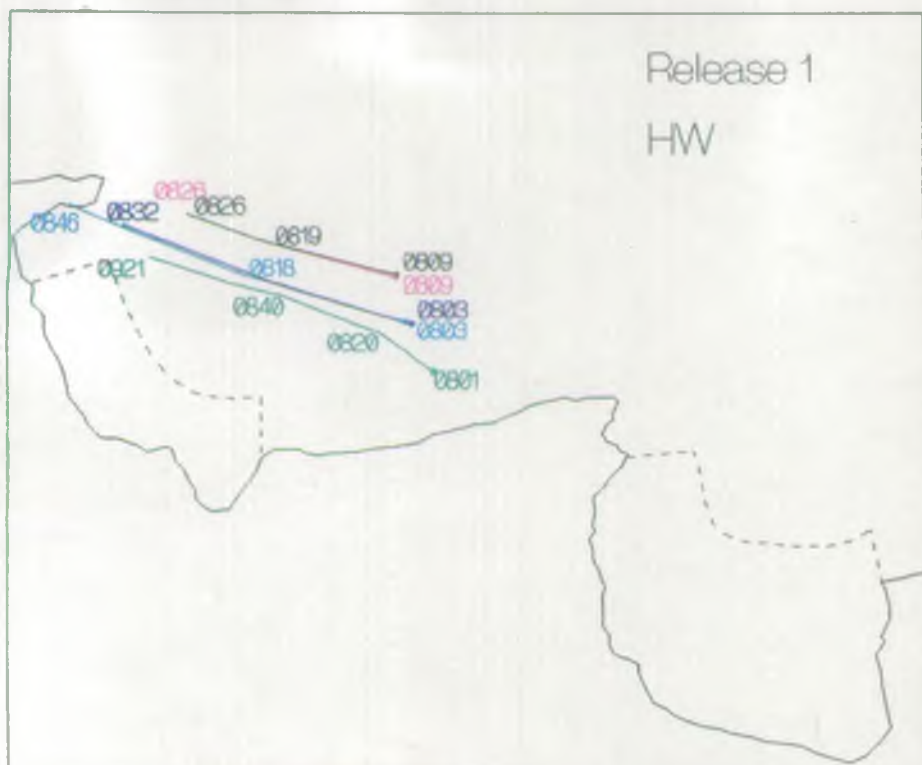
F5 300m Depth



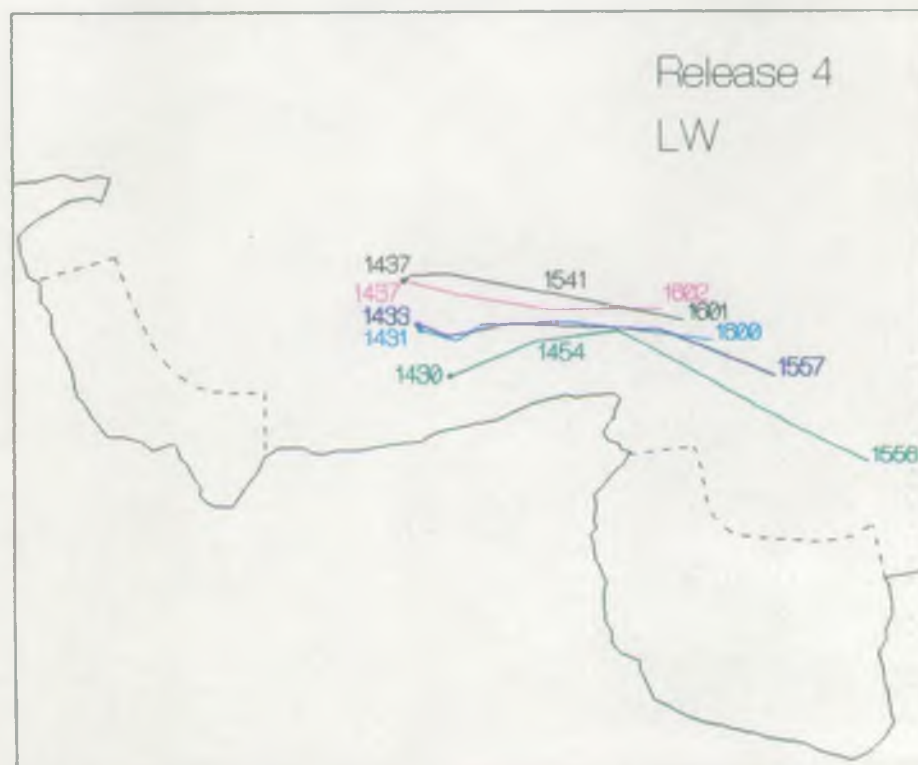
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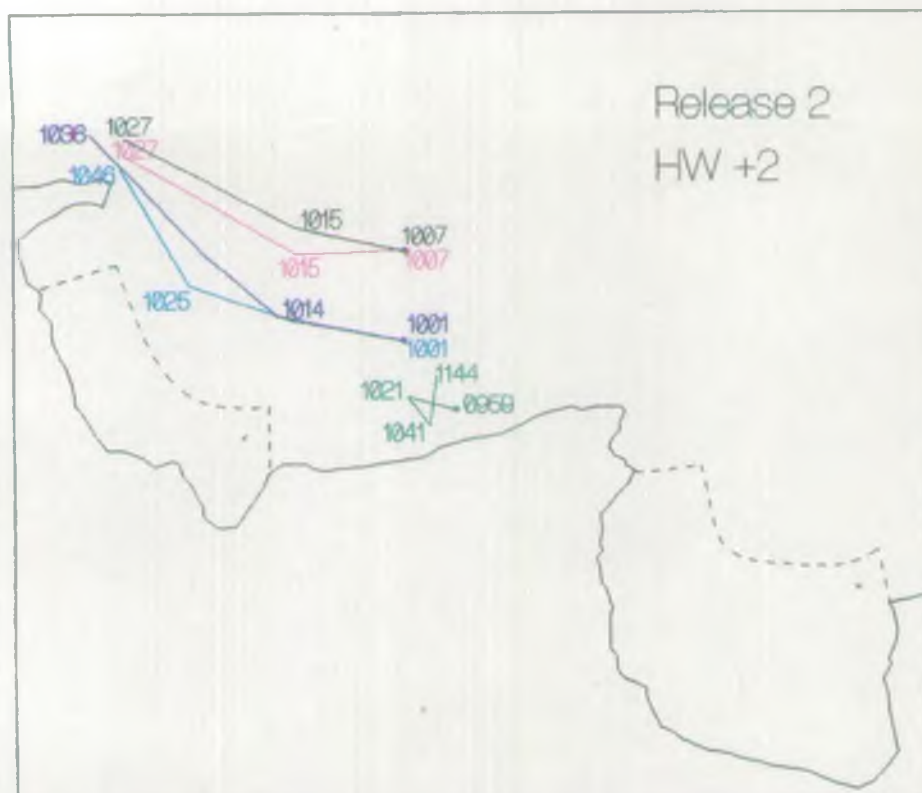
Release 1
HW



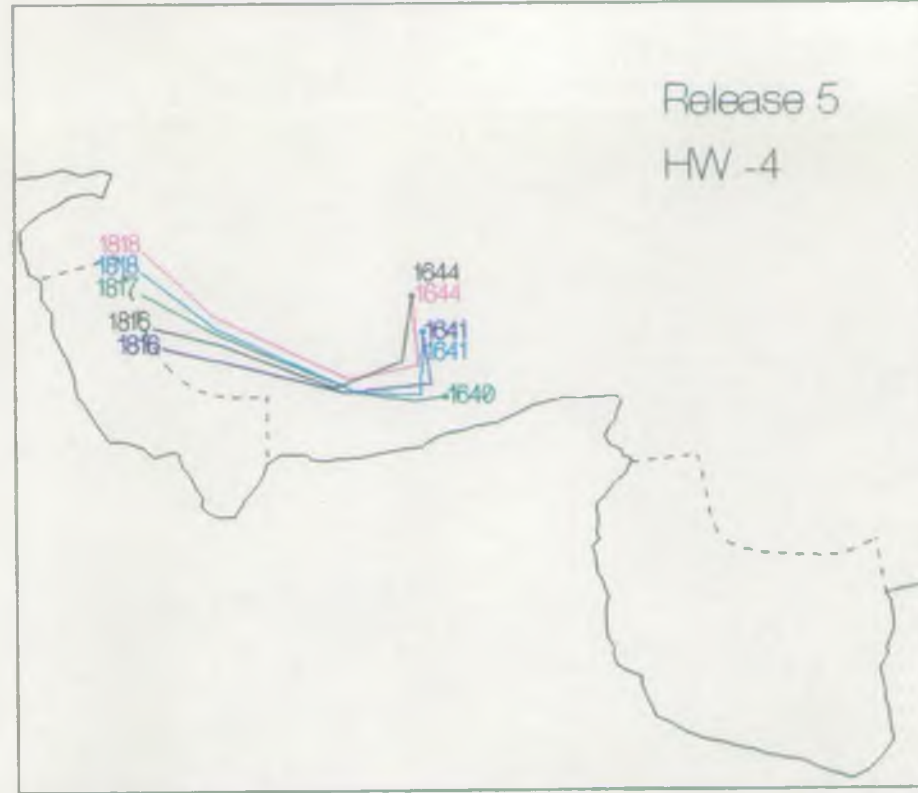
Release 4
LW



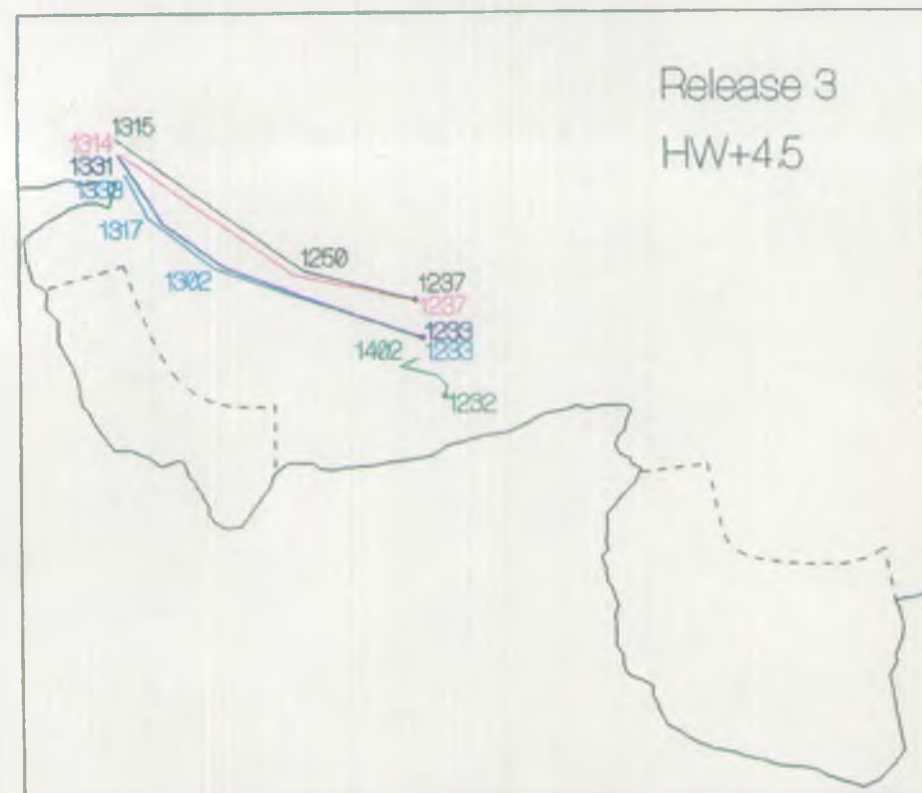
Release 2
HW +2



Release 5
HW -4



Release 3
HW+4.5



Release 6
HW -2

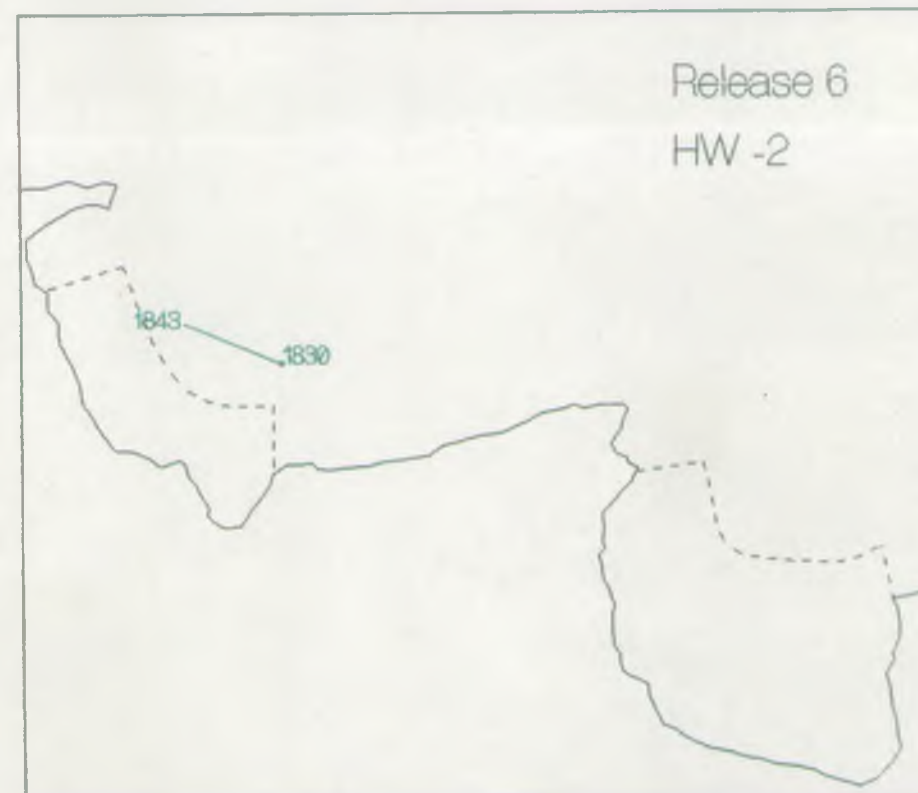


Figure 6 Temperature and Salinity Profiles 15 August 1995

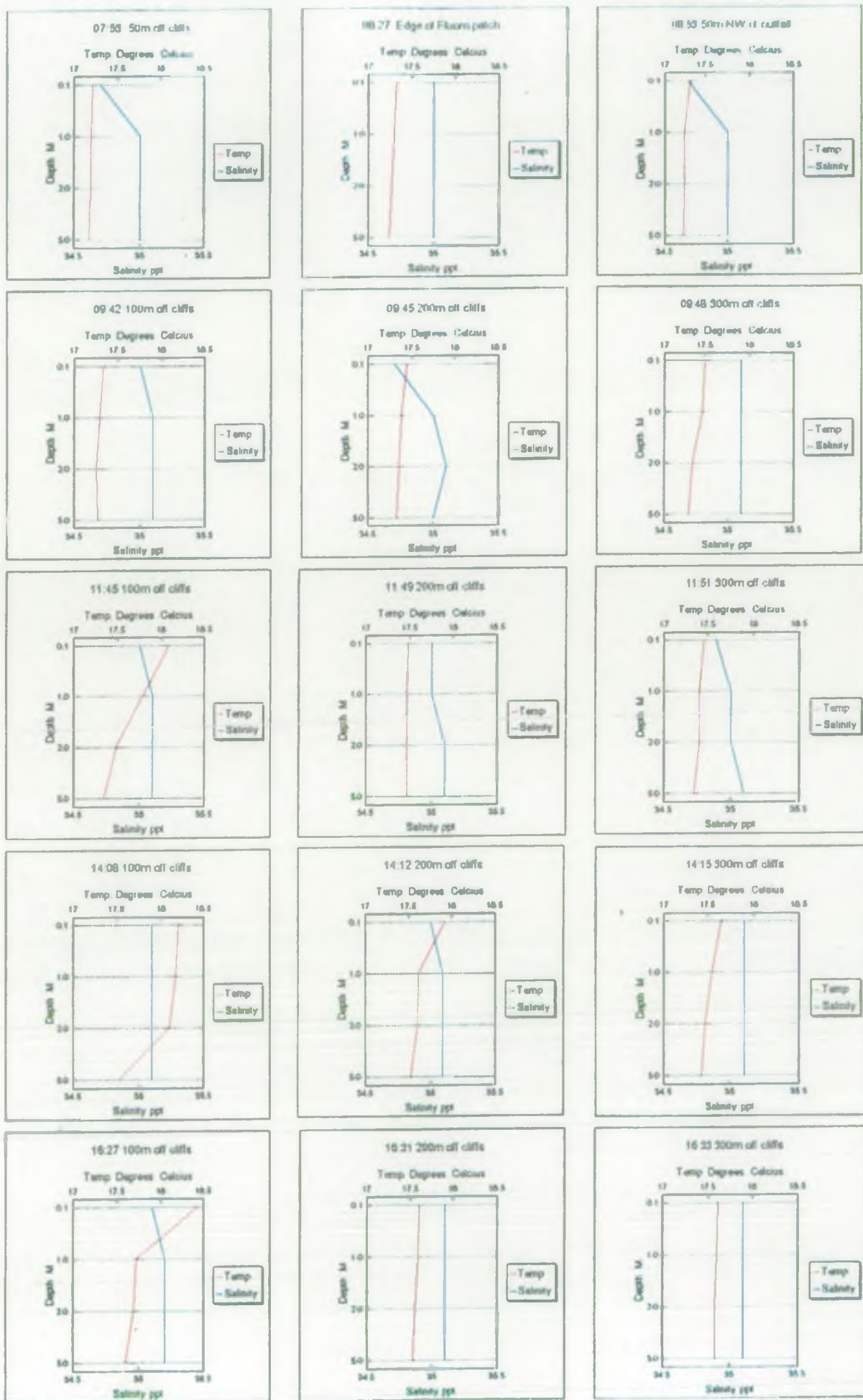


Plate 1 21.06.1995 NRA Survey



12:16 BST Inshore dye release impacting on Mother Ivey's Bay.

Plate 2 21.06.1995 NRA Survey



13:28 BST Inshore dye release impacting on Mother Ivey's Bay.

Plate 3 15.08.1995 NRA Survey



10:58 BST Inshore dye release. Note effluent from current discharge.

Plate 4 15.08.1995 NRA Survey



18:02 BST Inshore dye release impacting on Harlyn Bay.

Plate 5 14.06.1995 SWWSL Survey



14.06.1995 14:00 BST



14.06.1995 14:20 BST



14.06.1995 14:40 BST



14.06.1995 15:05 BST

Plate 6 14.06.1995 SWWSL Survey



14.06.1995 12:30 BST

Plate 7 14.06.1995 SWWSL Survey



14.06.1995 16:30 BST



Plate 8 (Above)

15.08.1995 10:41 BST
Excess untreated
wastewater being
discharged to the
Overflow Channel.



Plate 9 (Left)

15.08.95 10:40 BST
Overflow Channel
discharging untreated
wastewater to the outfall.