

NRA-South West 424

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St Agnes Qualitative Dye Surveys 1995
Data Report

TWQ/96/04

Tidal Water Quality

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Information Services Unit

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St Agnes Qualitative Dye Surveys 1995

1.0 Introduction

As part of SWWSL's "Clean Sweep" sewerage scheme for the North Cornwall town of St Agnes, an application was made on 5 April 1995 to discharge screened sewage from a new outfall 600m west of the EC bathing water of Trevaunance Cove. It is intended that during the 1997 bathing season that the sewage will receive a higher level of treatment ensuring that SWWSL discharges do not cause failure of the EC Bathing Water Directive at Trevaunance Cove. This new discharge replaces one located near the natural arch just to the west of Trevaunance Cove.

An NRA desk study into the tidal currents active around the proposed discharge point and Trevaunance Cove highlighted the fact that currents in the area are complex (Ref 1). Subsequent NRA dye tracing surveys (Refs 2 & 3) confirmed this. Table 1 shows the differing results from each of the tracing surveys studied.

It is important to understand the factors influencing the formation, duration, direction, speed and variation in currents around the discharge in order to quantify the frequency and duration of potential impact on the bathing water and further, to identify worst case conditions for impact.

In order to evaluate potential conditions for transport of effluent towards Trevaunance Cove a further series of dye tracing surveys were undertaken.

The surveys were specified by Tidal Water Quality and undertaken in conjunction with Cornwall Area Investigations.

2.0 Methods

In order to evaluate the potential for transport towards Trevaunance Cove simple tracing methods were decided on for the following reasons;

- i) Easily repeatable at short notice
- ii) Minimum manpower and equipment requirements for qualitative tracking

Easily repeatable surveys were required as a range of environmental (mainly wind) and tidal conditions were to be viewed to assess flood tide transport towards the bathing water.

From Table 1 it can be seen that the flood tide can begin as early as HW +4:00. It was decided to use pulsed dye releases beginning at HW +3:00 to view potential flood tide transport.

Tracking of each dye patch to the beginning of the ebb tide was envisaged. However due to the amount of daylight available during the survey period (October and November 1995) it was not possible to track a dye patch over a whole flood tide during Neap Tides. In these cases it was decided to try and establish the end of one flood tide and the beginning of the next flood i.e. quantify the ebb tide period.

Eight surveys were planned over tides with ranges (at Perrenporth, 4km NE of St Agnes) of between 2.2m and 6.7m. The 6.7m range survey was subsequently cancelled due to very stormy conditions on the day. A 5.7m tide range was the largest actually utilised for tracking.

Nominally, 2 litres of neat dye (rhodamine and fluorescein) were syphoned down 50m of tubing and flushed through with 10 litres of fresh water. The tubing was hung over the cliffs directly above the newly drilled outfall and allowed dye to discharge approx. 0.75m below a surface buoy.

After the initial timetabled release the on site scientist took decisions on further releases. These subsequent doses were normally undertaken when the previous release had moved away from the dosing point or to create a new patch if the previous was becoming too diffuse to visibly track.

Visual tracking was undertaken from the cliff top between the outfall location and Trevaunance Cove. A written and photographic record was made of each patch along with wind speed and direction measurements undertaken with an anemometer.

3.0 Results

Each of the surveys are reported in the following separate sections. The data presented includes;

- a brief overview of the survey,
- cliff top observations,
- meteorological records,
- diagrams of dye progression, and
- photographic records.

Table 9 summarises the main points arising from each survey (eg. duration of flood and ebb tides and furthest easterly excursion of the dye patches).

4.0 Discussion

The surveys undertaken represent a good variation in tidal ranges, however no survey was undertaken with a tidal range $>3.5\text{m}$ concurrent with a westerly wind.

A brief view of the data shows the current regime affecting the discharge to be complex with no easily discernable relationship between the timing (and duration) of the flood tide and tidal range/wind field. Overall the weak currents present in the discharge embayment (Newdowns Head to the natural arch) may cause deposition of sewage solids in the near vicinity, and the ponding of effluent in the region of the outfall (esp. in Polberro Cove). The scale and extent of any deposition will depend on the solids content of the effluent.

Only one survey (19 October) showed any dye enter the Trevaunance Cove bathing water itself. This small patch of dye crept into the bathing area close to the natural arch but soon became too dilute to continue tracking.

19 October 1995.

Environmental conditions; Tidal range 2.7m, sea state calm.
Wind - Westerly, mainly 0-2 m/s occasionally upto 6m/s.

Initial easterly movement began around HW+6:10. Impact offshore of Trevaunance Cove between HW-3 (perhaps earlier but initial dye dose was small and therefore not visible east of Polberro Cove) and HW-1:40. There was a small impact in the bathing water around HW-2:15 as a small amount of dye rounded the natural arch. This patch was dilute and once in the bathing area quickly became impossible to visibly track. Significant and prolonged pooling in Polberro Cove (dye still visible at HW+1:00) was identified.

Release at HW-2:55 showed dominant offshore advection (with slight easterly component) up to HW+1 when slow westerly transportation commenced.

EASTERLY MOVEMENT: from HW+6:10 to HW-2:20
SLACK WATER: from HW-2:20 to HW-1:00
WESTERLY MOVEMENT: commencing approximately HW+1:00

22 October 1995

Environmental conditions; Tidal Range 5.4m, sea state smooth.
Wind - S to SE, 0-4 m/s.

Initial dose (at HW+4:17) showed no advection away from the dosing point until approx. HW-5:43 when easterly movement began. A second release confirmed eastward advection at HW-5:13. The furthest easterly excursion of the dye was the western side of Polberro Cove, with most of the dye still present around the discharge location.

The dye began moving west, towards Newdowns Head, around HW-2:50 and continued for the next hour after which observations were ceased.

SLACK WATER: to HW-5:40
EASTERLY MOVEMENT: from HW-5:40 to approx. HW-3:30
SLACK WATER: from approx.-3:30 to HW-2:50
WESTERLY MOVEMENT: commenced at HW-2:50

1st November 1995

Environmental conditions; Tidal Range 3.5m, sea state initially calm becoming progressively worse.
Wind NE backing to NW. Mostly 0-3 m/s.

Continuous westerly dye movement from HW-2:35 (commencement of dye dosing) to HW+5:35 (end of observations due to poor light).

WESTERLY MOVEMENT: Throughout the survey duration (HW-2:35 to HW+5:35).

4th November 1995

Environmental conditions; Tidal Range 5.0m, sea state calm with NW swell
Wind E, mostly <2m/s occasionally up to 4 m/s.

Initial release showed slow advection away from dosing point with turbulent mixing the dominant process acting on the newly discharged dye. The patch moved east from HW-5:17 along the base of the cliffs reaching the eastern side of Polberro Cove at HW-3:45 and nearly reaching the Natural Arch around HW-3:10, but no further easterly transport was evident.

Dye at the discharge location headed west around HW-1:50.

SLACK WATER: from HW+6:00 to HW-5:20

EASTERLY MOVEMENT: from HW-5:20 to HW-3:00

SLACK WATER: from HW-3:00 to HW-1:50

WESTERLY MOVEMENT: commenced at HW-1:50

6th November 1995

Environmental conditions; Tidal Range 5.7m, sea state calm
 Wind mainly E (initially variable), 1 - 2m/s

Initial dye release at HW+4:15 moved west up to LW with easterly movement from HW-5:30. This patch was just visible east of Polberro Cove at HW-4:00 (the furthest excursion east of any dye). Subsequent dye releases showed easterly movement up to HW-2:40 with westerly movement from approximately HW-2:30.

WESTERLY MOVEMENT: Already commenced at HW+4:15, to LW

SLACK WATER: from LW to HW-5:30

EASTERLY MOVEMENT: from HW-5:30 to HW-2:40

SLACK WATER: from HW-2:40 to HW-2:30

WESTERLY MOVEMENT: from HW-2:30

15th November 1995

Environmental conditions; Tidal Range 2.8m, sea state medium to large with westerly swell dominating

Wind mostly Westerly (occasionally offshore), light, gusting to 5 m/s.

Initial movement at HW-2:30 was easterly and offshore. A foam line produced by the swell breaking on the cliffs indicated a limiting factor on the offshore component. Slow westerly movement commenced at HW-00:45 and showed similar offshore transport with dye stained foam as far east as Polberro Cove. Mixing offshore past the foam line did occur but was less rapid than inshore. Gradual easterly movement began around HW+01:15 with the maximum extent of the dye being about 25m east of Polberro Cove (inshore of the foam line). Easterly flow was observed until cessation of the survey at HW+5:50, although much dye from a HW+4:50 release was evident around the discharge point indicating reduced transport from previous releases.

WESTERLY MOVEMENT: From HW-00:45 to HW+01:15

EASTERLY MOVEMENT: From HW+01:15

29th November 1995

Environmental conditions; Tidal Range 4.4m, sea state calm with a slight swell

Wind Easterly, initially 2 m/s increasing to 12-14 m/s

Westerly movement of the initial dye patch (HW-2:15 release) occurred with subsequent offshore and slight easterly movement. Dye was visible nearly all the way to Newdowns Head. A short period of easterly transport followed, from HW-00:25 to HW+00:20. The dye patch was then split in two with one sub-patch moving east and the other west. Around HW+1:00 both sub-patches were advected west.

Subsequent dye releases all moved west and offshore, nearly reaching Newdowns Head. Slack water possibly occurred around HW+4:55 (but observations of the dye were difficult in the fading daylight inhibiting confirmation of cessation of dye movement).

EASTERLY MOVEMENT: From HW-00:25 to HW+00:20

CONFUSED MOVEMENT: From HW+00:20 to HW+1:00

WESTERLY MOVEMENT: From HW+1:00 to (possibly) HW+4:55

TABLE 3: Dye Tracing Survey - 22 October 1995.

Predicted Tidal Times (Perranporth): Range = 5.4m *Personnel:* P.Salmon (Tidal Water Quality)
M.Walton (Cornwall Investigations)
T.Geaches (Cornwall Investigations) - Initially

	Time (GMT)	Height (mAOD)
HW	03:27	6.5
LW	09:45	1.3
HW	15:43	6.7
LW	22:09	1.1

Release No 1 (fluorescein)

Time			Notes
(GMT)	(wrt HW)	(wrt release)	
07:44	HW+04:17	00:00	Release of 0.5 litre of dye.
08:00	HW+04:33	00:16	Dye showing westerly movement.
09:03	HW+5:36	01:19	Slack water with dye still around dosing location.
10:00	HW-05:43	02:16	Difficult to tell but dye looks like it is heading east.

Release No 2 (fluorescein)

Time			Notes
(GMT)	(wrt HW)	(wrt release)	
10:30	HW-05:13	00:00	Flourescein patch around outfall topped up with a further 3 litres.
11:49	HW-03:54	01:19	Dye is still very concentrated around the release point fading to an indistinct front at the entrance to Polberro Cove.
12:32	HW-03:11	02:02	No change from 11:49.
12:46	HW-02:57	02:16	Dye now only visible directly around the dosing point.
12:55	HW-02:48	02:25	The dye is moving off west.
13:25	HW-02:18	02:55	The dye is definately heading towards Newdowns Head.

Meteorological Records

Time (BST)	Wind		Notes
	Speed (m/s)	Direction	
07:44	0 - 2	SE	Seastate smooth.
11:09	0 - 1	S	Seastate smooth.
12:32	0 - 4	SE - S	Seastate smooth.

TABLE 2: Dye Tracing Survey - 19 October 1995

Predicted Tidal Times (Perranporth): Range = 2.7m **Personnel:** P.Salmon (Tidal Water Quality)
P.Long (Cornwall Investigations)

	Time (BST)	Height (mAOD)
HW	02:00	5.1
LW	08:21	2.7
HW	14:26	5.4
LW	21:00	2.4

Release No 1 (fluorescein)

Time			Notes
(BST)	(wrt HW)	(wrt release)	
07:45	+05:45	00:00	Release of 1 litre of dye.
08:05	+06:05	00:20	No advection away from dosing point.
08:12	+06:12	00:27	Easterly movement beginning.
09:14	-05:12	01:29	Dye along base of cliffs. Very nearly into Polberro Cove.
09:16	-05:10	01:31	Tail of dye still at outfall position but very dilute.
09:37	-04:49	01:52	Front edge reached Polberro Cove.
10:10	-04:16	02:25	Dye now diffuse and still heading east at eastern side of Polberro Cove.
10:34	-03:52	02:49	Faint dye past Polberro Cove.

Release No 2 (fluorescein)

Time			Notes
(BST)	(wrt HW)	(wrt release)	
09:16	-05:10	00:00	Top up tail of fluorescein still at outfall position with a further 2 litres.
09:37	-04:49	01:52	Dye moving east. No dye remaining to west of outfall.
10:10	-04:16	02:25	Dye between outfall and Polberro Cove.
10:34	-03:52	02:49	Leading edge offshore of Polberro Cove.
11:08	-03:18	03:23	Leading edge up to headland between Polberro and Natural Arch.
11:26	-03:00	03:41	Dye stretching from dosing point to just offshore of Natural Arch. Main concentration is just into Polberro Cove.
11:40	-02:46	03:55	Leading edge ~30m past Natural Arch heading across Trevaunance Cove.
11:52	-02:34	04:07	Main concentration still in Polberro Cove.
12:04	-02:22	04:19	Dilute dye extending across Trevaunance Cove.
12:11	-02:15	04:26	Small amount of dilute dye creeping past the old outfall into Trevaunance Cove.
12:28	-01:58	04:43	Very concentrated dye still present in Polberro Cove.
12:46	-01:40	05:01	Leading edge in approx. the same position as at 12:04.
13:04	-01:22	05:19	No dye visible east of the Natural Arch. Still mainly in Polberro Cove.
15:23	+00:57	07:38	Only fluorescein visible is in Polberro Cove. Dye here is still very concentrated.

Release No 3 (rhodamine)

Time			Notes
(BST)	(wrt HW)	(wrt release)	
11:31	-02:55	00:00	3 litres of dye released.
12:25	-02:01	00:54	Dye has dispersed offshore (and very slightly more to the east than west).
12:52	-01:34	01:21	No advection alongshore noticeable.
13:29	-00:57	01:58	Dye extending ~100m offshore. No along shore movement.
15:23	+00:57	03:52	Definite westerly movement of the dye patch although this is very slow.

Meteorological Records

Time (BST)	Wind		Notes
	Speed (m/s)	Direction	
07:50	0 - 2	W	Gusting up to 4 m/s. Seastate calm.
09:14	0 - 2	W	
12:04	2 - 4	W	Seastate calm.
12:52	4 - 6	W	
15:12	0 - 2	W	

TABLE 4: Dye Tracing Survey - 1 November 1995

Predicted Tidal Times (Perranporth): Range = 3.5m Personnel: P.Webb (Tidal Water Quality)
P.Long (Cornwall Investigations)

	Time (GMT)	Height (mAOD)
LW	06:04	2.3
HW	12:00	5.8
LW	18:45	2.1

Release No 1 (fluorescein)

Time			Notes
(GMT)	(wrt HW)	(wrt release)	
09:05	HW-02:55	00:00	2 litres of fluorescein released.
09:25	HW-02:35	00:20	Slow westerly movement.
10:00	HW-02:00	00:55	Dye moving almost directly towards Newdowns Head (away from base of cliffs).
11:30	HW-00:30	02:25	Dye patch extending from dosing location nearly to Newdowns Head and is stationary.
12:05	HW+00:05	03:00	As at 11:30
13:00	HW+01:00	03:55	Dye has moved onshore reaching the foot of the cliffs and is beginning to round Newdowns Head.

Release No 2 (rhodamine)

Time			Notes
(GMT)	(wrt HW)	(wrt release)	
11:30	HW-00:30	00:00	2 litres of rhodamine released.
11:50	HW-00:10	00:20	Slow movement west.
12:05	HW+00:05	00:35	Streaming west along base of cliffs.
12:45	HW+00:45	01:15	Rhodamine caught up with release no 1 by Newdowns Head.
13:35	HW+01:35	02:05	Offshore of release no. 1 rounding Newdowns Head.

Release No 3 (rhodamine)

Time			Notes
(GMT)	(wrt HW)	(wrt release)	
13:35	HW+01:35	00:00	1 litre of rhodamine released.
13:45	HW+01:45	00:10	Greater offshore mixing than previous releases but moving west as previous releases.
14:10	HW+02:10	00:35	Discrete patch moving quickly away from dosing point towards Newdowns Head.
14:50	HW+02:50	01:15	Patch now much more elongated than at 14:10 and moving offshore directly towards Newdowns Head.

Release No 4 (fluorescein)

Time			Notes
(GMT)	(wrt HW)	(wrt release)	
15:00	HW+03:00	00:00	1 litre of dye released.
15:20	HW+03:20	00:20	Movement west, very slow. Wave induced mixing greater than previous releases.
16:15	HW+04:15	01:15	Dye extending from foot of cliffs to the west of the discharge point offshore towards Newdowns Head.
16:45	HW+04:45	01:45	Dye patch not linked to cliffs anymore but has not reached Newdowns Head. Still moving west.

Release No 5 (fluorescein)

Time			Notes
(GMT)	(wrt HW)	(wrt release)	
16:55	HW+04:55	00:00	1 litre of dye released.
17:10	HW+05:10	00:15	Slow movement west but exposed rocks impeding progress.
17:35	HW+05:35	00:40	Dye still around dosing location but edging slowly west.
17:50	HW+05:50	00:55	Dark

Meteorological Records

Time (GMT)	Wind		Notes
	Speed (m/s)	Direction	
09:05	1	NE	Calm Sea. Misty
10:00	0 - 1.5	NE	
11:00	<1	NE	
12:10	3	NE	
13:35	2 - 3	NW	Less mist.
15:00	3	NW	Sea state worsening.
15:40	2	NW	
16:55	3 - 4	N - NNW	

TABLE 5: Dye Tracing Survey - 4 November 1995

Predicted Tidal Times (Perranporth): Range = 5.0m *Personnel:* D.Marshall (Tidal Water Quality)
R.Hocking (Cornwall Investigations)

	Time (GMT)	Height (mAOD)
HW	02:47	6.3
LW	09:16	1.6
HW	15:07	6.6
LW	21:38	1.3

Release No 1 (fluorescein)

Time			Notes
(GMT)	(wrt HW)	(wrt release)	
07:00	HW+04:13	00:00	2 litres of dye released.
07:30	HW+04:43	00:30	Dye mainly at base of outfall. Advection west with wave mixing dye both east and west.
08:15	HW+05:28	01:15	Dye continuing to move west.
08:50	HW+06:03	01:50	Dye stationary.
09:50	HW-05:17	02:50	Dye moving east.
09:55	HW-05:12	02:55	Patch still around outfall location.

Release No 2 (fluorescein)

Time			Notes
(GMT)	(wrt HW)	(wrt release)	
09:55	HW-05:12	00:00	2 litres of fluorescein added to the first release located at the discharge point.
10:00	HW-05:07	00:05	Dye moving rapidly east.
10:37	HW-04:30	00:42	Dye tight to bottom of cliffs, halfway to Polberro Cove.
11:15	HW-03:52	01:20	Dye almost across Polberro Cove with trailing edge still concentrated at the discharge point.
11:57	HW-03:10	02:02	Fluorescein almost level with the Natural Arch.
12:06	HW-03:01	02:11	No further eastwards movement of fluorescein.

**Release No 3 (rhodamine)
15:07**

Time			Notes
(GMT)	(wrt HW)	(wrt release)	
11:30	HW-03:37	00:00	2 litres of rhodamine released. Moved rapidly into small inlet at discharge location.
12:06	HW-03:01	00:36	Rhodamine pooling at dosing point.
12:25	HW-02:42	00:55	Little dye movement apart from wave dispersion.
13:15	HW-01:52	01:45	Dye moving west although mainly pooled still at discharge point.

Meteorological Records

Time (GMT)	Wind		Notes
	Speed (m/s)	Direction	
07:00	2 - 4	E	1m swell from NW
08:15	1	E	1.5m swell from NW
10:00	1	E	1.5m swell from NW
10:40	1 - 3	E	
11:15	1	E	<1m swell from NW

TABLE 6: Dye Tracing Survey - 6 November 1995

Predicted Tidal Times (Perranporth): Range = 5.7m Personnel: D.Marshall (Tidal Water Quality)
T.Geaches (Cornwall Investigations)

	Time (GMT)	Height (mAOD)
HW	04:10	6.8
LW	10:34	1.2
HW	16:28	6.9
LW	22:50	1.0

Release No 1 (rhodamine)

Time			Notes
(GMT)	(wrt HW)	(wrt release)	
08:25	HW+04:15	00:00	2 litres of dye released.
08:40	HW+04:30	00:15	Dye moving rapidly west
09:30	HW+05:20	01:05	Dye moving west
10:00	HW+05:50	01:35	As at 9:30. Nothing east of outfall
10:30	LW	02:05	Dye movement ceased.
11:00	HW-05:28	02:35	Dye beginning to move east
11:15	HW-05:13	02:50	Dye moving rapidly east
12:00	HW-04:28	03:35	Leading edge moving past Polberro Cove
12:20	HW-04:08	03:55	Patch very indistinct. Just past Polberro Cove
12:30	HW-03:58	04:05	Dye difficult to see but probably as far east as small headland between Polberro and Trevaunance Coves

Release No 2 (rhodamine)

Time			Notes
(GMT)	(wrt HW)	(wrt release)	
11:15	HW-05:13	00:00	2 litres of dye to top up initial release
11:36	HW-04:52	00:21	Rhodamine moving east
12:00	HW-04:28	00:45	Dye nearly in to Polberro Cove
12:20	HW-04:08	01:05	Patch stretching from release position to Polberro Cove
13:10	HW-03:18	01:55	Dye still evident at the discharge point
13:50	HW-02:38	02:35	Dye does not appear to be moving

Release No 3 (fluorescein)

Time			Notes
(GMT)	(wrt HW)	(wrt release)	
13:50	HW-02:38	00:00	Fluorescein release (2 litres)
14:00	HW-02:28	00:10	Dye moving west
14:15	HW-2:13	00:25	Dye moving rapidly west and away from the cliffs

Meteorological Records

Time (GMT)	Wind		Notes
	Speed (m/s)	Direction	
08:25	Light	Variable	Calm
09:30	Light	Variable	Flat
12:00	1 - 2	E	Small wind waves
13:10	1	E - SE	Small swell
14:15	1	E	Calm

TABLE 7: Dye Tracing Survey - 15 November 1995

Predicted Tidal Times (Perranporth): Range = 2.8m Personnel: E.Darbyshire (Tidal Water Quality)
R.Hocking (Cornwall Investigations)

	Time (GMT)	Height (mAOD)
LW	03:52	2.6
HW	09:52	5.4
LW	16:36	2.6
HW	23:30	5.1

Release No 1 (fluorescein)

Time (GMT)	Time		Notes
	(wrt HW)	(wrt release)	
07:20	HW-02:32	00:00	Dye released. Immediate easterly transport.
08:00	HW-01:52	00:40	Dye up to approx 50m off cliffs and just entering Polberro Cove.
08:15	HW-01:37	00:55	Dye not entering Polberro Cove but offshore as far as foam line produced by breaking swell.
08:30	HW-01:22	01:10	Dye up to 100m offshore and half way across Polberro Cove.
08:45	HW-01:07	01:25	Dye looks stationary.
09:20	HW-00:32	02:00	Easterly movement of diffuse patch.
09:40	HW-00:12	02:20	The fluorescein patch is offshore and not moving.

Release No 2 (rhodamine)

Time (GMT)	Time		Notes
	(wrt HW)	(wrt release)	
09:05	HW-00:47	00:00	Dye released. Initial movement west.
09:20	HW-00:32	00:15	Dye moved straight offshore to foam line.
09:40	HW-00:12	00:35	Dye arced out in a westerly direction.
10:05	HW+00:13	01:00	Dilute rhodamine still around dosing point.
10:20	HW+00:28	01:15	Red foam as far as Polberro Cove.

Release No 3 (fluorescein)

Time (GMT)	Time		Notes
	(wrt HW)	(wrt release)	
10:30	HW+00:38	00:00	Fluorescein release. Initial movement straight offshore to foam line. Mixing beyond is much slower.
11:05	HW+01:13	00:35	Gradual drift east.
11:20	HW+01:28	00:50	Dye inshore of foam line is up to Polberro Cove. Offshore dye not as far east.
11:50	HW+01:58	01:20	Dye is virtually static.
12:35	HW+02:43	02:05	Easterly movement.

Release No 4 (rhodamine)

Time (GMT)	Time		Notes
	(wrt HW)	(wrt release)	
12:15	HW+02:23	00:00	Dye release.
12:20	HW+02:28	00:05	Rapid movement out to foam line.
12:25	HW+02:33	00:10	Slow movement east.
12:50	HW+02:58	00:35	Sudden surge of movement east. Approaching Polberro Cove from inshore of foam line.
13:05	HW+03:13	00:50	Dye held up at westerly extent of Polberro Cove.
14:10	HW+03:18	01:55	Diffuse dye up to 3/4 across Polberro Cove.
14:55	HW+05:03	02:40	Leading edge approx. 25m beyond eastern edge of Polberro Cove.
15:15	HW+05:23	03:00	Dye now only visible to 1/2 way across Polberro Cove.
15:20	HW+05:28	03:05	Red now not visible.

Release No 5 (fluorescein)

Time (GMT)	Time		Notes
	(wrt HW)	(wrt release)	
14:20	HW+04:28	00:00	Dye release.
14:30	HW+04:38	00:10	Dye staying tighter to cliff base than previous releases.
14:55	HW+05:03	00:35	Dye in to Polberro Cove.
15:05	HW+05:13	00:45	Progress east slowed down and dye stretches up to 100m offshore.
15:15	HW+05:23	00:55	Fluorescein up to 1/4 of way across Polberro Cove.
15:40	HW+05:48	01:20	Most of dye still hanging around discharge location.

Meteorological Records

Time (GMT)	Wind		Notes
	Speed (m/s)	Direction	
07:20	-	-	No wind discernable.
07:53	Light	-	Westerly swell.
08:00	Light	Offshore	
08:15	2	W	Swell increasing in size.
08:45	Light	Offshore	
09:20	-	-	No wind.
10:30	3	W	Wind freshening, swell large at times.
11:05	Up to 4	W	Wind stronger on cliff tops.
11:50	Light	-	Gusts up to 3 m/s. Seastate choppy.
12:25	Up to 5	Mainly W	Wind variable.
13:45	Light	-	

TABLE 8: Dye Tracing Survey - 29 November 1995

Predicted Tidal Times (Perranporth): Range = 4.4m Personnel: P.Webb (Tidal Water Quality)
M.Walton (Cornwall Investigations)

	Time (GMT)	Height (mAOD)
LW	04:18	1.9
HW	10:15	6.3
LW	16:56	1.9
HW	22:52	5.8

Release No 1 (rhodamine)

	Time		Notes
	(GMT)	(wrt HW) (wrt release)	
08:00	HW-02:15	00:00	Some rhodamine released. Problems experienced with the dosing equipment.
08:15	HW-02:00	00:15	Dye moving west.
09:15	HW-01:00	01:15	Dye patch located between dosing point and approx half way to Newdowns Head.
09:50	HW-00:25	01:50	Dye patch moved, as a whole, slightly offshore. Also, some easterly movement has occurred.
11:30	HW+01:15	03:30	Dye present, close in to cliffs, to the east of Newdowns Head.

Release No 2 (fluorescein)

	Time		Notes
	(GMT)	(wrt HW) (wrt release)	
09:50	HW-00:25	00:00	Dye released. More release problems. Immediate and fast movement east.
10:25	HW+00:10	00:35	Dye patch stretches from discharge location to the western side of Polberro Cove.
10:35	HW+00:20	00:45	Patch beginning to move west.
10:50	HW+00:35	01:00	Dye to west of discharge point moving west but dye to east of discharge point moving slightly further east.
11:00	HW+00:45	01:10	Eastern edge stationary whilst western edge continues westwards. Patch has effectively split in two.
11:15	HW+01:00	01:25	Eastern portion of the patch is now moving west.
12:00	HW+01:45	02:10	Patch has moved off west past dosing point and dissipated.

Release No 3 (rhodamine)

	Time		Notes
	(GMT)	(wrt HW) (wrt release)	
12:05	HW+01:50	00:00	Dye released. Equipment problems caused excessively long release time.
12:20	HW+02:05	00:15	Initial dye movement along base of cliffs predominantly west but also slightly east.
12:35	HW+02:20	00:30	Slow movement away from rocks near dosing point.
12:50	HW+02:35	00:45	Dye has moved off west and slightly offshore.
13:20	HW+03:05	01:15	Patch spreading from dosing point nearly to Newdowns Head. No dye travelled >30m east.

Release No 4 (fluorescein)

	Time		Notes
	(GMT)	(wrt HW) (wrt release)	
13:25	HW+03:10	00:00	Release.
13:45	HW+03:30	00:20	Slow westerly movement.
14:00	HW+03:45	00:35	Dye still moving slowly west.
15:10	HW+04:55	01:45	Dye stationary.

Meteorological Records

Time (GMT)	Wind		Notes
	Speed (m/s)	Direction	
08:00	2	East	Slight swell otherwise calm.
10:55	6 - 8	ENE	Fairly calm.
12:35	4	E	Cliff-top observation.
14:30	6 - 8	E	Little swell. Wind speed increasing. Blustery.
15:10	12 - 14	E	Ruffled sea surface.

TABLE 9: Survey Summary

Tidal Range (m)	Main Wind Conditions		Flood Tide Commencement (wrt HW)	Ebb Tide Commencement (wrt HW)	Date	Furthest Visible Excursion East
	Speed (Force)	Direction (Deg)				
2.7	0 - 2	270	HW+6:10	HW+1:00	19 October	Offshore of Trevaunance Cove
2.8	Mainly 1 - 2	270	Mainly Confused Dye Movement but Easterly Movement from HW+1:15. Offshore transport dominant around outfall.		15 November	Western side of Polberro Cove.
3.5	0 - 2	045 - 315		Whole Survey Duration (HW-2:35 - HW+5:35)	1 November	Outfall location
4.4	2 - 4	090	Confused dye patch movement	HW+1:00	29 November	Polberro Cove
5.0	1	090	HW-5:20 (Slack water from HW-3:00 to HW-1:50)		4 November	Nearly up to the Natural Arch (Old Outfall Location)
5.4	0 - 2	135 - 180	HW-5:40	HW-2:50	22 October	Western side of Polberro Cove
5.7	1	090	HW-5:30	HW-2:30	6 November	Eastern side of Polberro Cove.