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Environmental Protection Report

BIDEFORD FINE SCREEN OUTFALL POST SCHEME APPRAISAL

June 1992
TWU/92/11

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SUMMARY

The Bideford Fine Screen Plant and Outfall (FSO) was commissioned in October 1990 by South West Water Services Ltd. (SWWSL) as an interim measure to alleviate the growing problems of aesthetic pollution, deteriorating water quality and sewage odours in and around the Torridge estuary. In awarding consent for this new discharge and following the public inquiry into the scheme the Secretary of State for the Environment required that an assessment be made of the resulting improvements.

Further improvements to the Taw/Torridge estuary as a whole are due for commissioning in 1997. Therefore the Bideford FSO installation will need to operate effectively for a further five years.

On three occasions during the summer of 1991 the Tidal Waters Investigations Unit (TWIU) of NRA South West undertook fieldwork designed to assess the following:

i) The suitability of the discharge regime in use at the new FSO.

ii) Whether the commissioning of the scheme has resulted in any change in the water quality and aesthetic appearance of the Torridge estuary as a whole.

iii) Whether the commissioning of the scheme has resulted in any change in the microbiological quality of the E.C. identified bathing waters at Instow (ECB1030).

The resulting data were passed to Wimpey Environmental Ltd. for analysis and reporting.

Available discharge records and operational information relating to the FSO were studied to appraise the suitability of the discharge regime in relation to the theoretical and actual operating conditions. The theoretical discharge regime is considered to be an acceptable compromise with regard to the dispersive and assimilative capacity of the estuary. However, marked discrepancies between the theoretical and observed discharge times were identified relative to the local tidal regime. In addition, three out of the five diffuser ports fitted to the outfall appeared to be blocked by sediment.

Water quality data, both historic and that collected by TWIU, were reviewed to appraise the degree to which the commissioning of the scheme had altered the water and aesthetic quality of the estuary. No notable change in water quality was detected. The aesthetic quality of the estuary could not be quantitatively assessed, however no gross sewage related solids were identified during any of the summer 1991 surveys.

Historic bathing water quality data for Instow beach was studied to appraise any change in the microbiological impact of the Torridge estuary subsequent to the implementation of the scheme at Bideford. A slight improvement in the

microbiological quality of Instow bathing water occurred through 1988 and 1989, but subsequent to that time there has been no discernable change. It was observed that the microbiological quality of the bathing waters at Instow were probably influenced by the Bideford FSO, but that the commissioning of the discharge has not notably altered the bathing water quality.

In view of the inadequacies identified in the operation of the FSO discharge and as a result of the above appraisal the following recommendation is made:

- A copy of this report should be sent to SWWSL together with a requirement that a specific investigation into the discharge regime of the Bideford FSO be carried out to assess the compliance of the actual regime with respect to the theoretical regime. Also, SWWSL should carry out a review of the diffuser array design criteria for the FSO, to assess the potential environmental significance of the sediment blocked diffuser ports. Results of both the above studies should be reported to the NRA.

  ACTION: Tidal Waters Officer

C. Sharp,
Assistant Oceanographer.

July 1992

CONTENTS:

1. INTRODUCTION:

During the latter part of the 1980's the water and aesthetic quality of the Torridge estuary deteriorated as a result of the disposal of increasing quantities of domestic waste water and trade effluent direct to the estuary, largely without treatment. At times a considerable sewage odour problem also occurred in Bideford due to the inadequacies of the town's sewerage and sewage disposal systems.

As an interim measure primarily to alleviate the aesthetic and odour problems outlined above prior to the commissioning of further improvements in 1997, the then South West Water Authority (SWWA) proposed the construction of a new Fine Screening Plant and Outfall at Bideford.

Following the commissioning by South West Water Services Ltd. (SWWSL) of the Bideford Fine Screen Plant and Outfall (FSO) on the Torridge estuary in 1990, the Tidal Waters Officer of NRA South West instructed the Tidal Waters Investigations Unit (TWIU) to appraise the "effectiveness" of the new FSO. During 1991 the TWIU of NRA South West planned and carried out three field investigations on the Torridge estuary as a result on the above instruction. The work was designed to achieve three primary objectives:

- To assess the suitability of the discharge regime in use at the FSO.
- To assess whether the commissioning of the FSO has resulted in any significant changes in the water quality and aesthetic appearance of the Torridge estuary.
- To assess any changes in the microbiological quality of the E.C. identified bathing waters at Instow as a result of the commissioning of the FSO.

Under the instruction of TWIU, Wimpey Environmental Ltd (formerly Wimpol Ltd., hereafter referred to as the Contractor) were commissioned in December 1991 to undertake a study of the data resulting from the above fieldwork. The study was to include a comparison of the water quality data collected by the TWIU with similar water quality data collected by Wimpol Ltd. (under the instruction of the then SWWA) in 1988 and 1989, prior to the commissioning of the FSO. In this way the effects of the commissioning of the Bideford FSO on the water quality of the Torridge estuary could be assessed.

2. METHODOLOGY, RESULTS AND DISCUSSION:

Full details of the methodologies employed by the TWIU during the 1991 NRA investigations together with the resulting data, the historical data and the discussion thereof are provided in the Contractor's report, shown in ANNEX 1.

3. CONCLUSIONS:

(1) The theoretical discharge regime of the Bideford FSO is considered to be a realistic compromise with regard to the ability of the Torridge estuary to disperse and assimilate domestic effluent. However, marked differences between the theoretical and actual discharge regime of the FSO with respect to the local tidal regime were observed. The most significant of such discrepancies concerned discharges from the FSO in the period between HW+5 and HW-4, during which time all effluent should theoretically be stored. However, the above does not constitute non-compliance with consent conditions.

(2) Since the above discrepancies in the discharge regime were observed during a period of predominantly low effluent flows the ability of the system to cope with higher effluent flows is in doubt.

(3) At the time of the TWIU surveys in the summer of 1991 three of the five outfall diffuser ports were observed to be blocked by sediment. This implies that the FSO was not operating to its original design specification.

(4) No odour problems were associated with the fine screening plant.

(5) The commissioning of the Bideford FSO has resulted in no notable change in the water quality of the Torridge estuary on the basis of data collected to date. The chemical water quality of the estuary is primarily controlled by riverine inputs, particularly with respect to nutrients, although the FSO was noted to have some localised influence on dissolved ammonia levels. The microbiological quality of the estuary has remained poor since the commissioning of the FSO.

(6) Qualitative observations made by TWIU staff in 1991 suggest that some improvement in the aesthetic quality of the Torridge estuary has occurred since the commissioning of the Bideford FSO. No gross sewage related solids were observed in the discharge boil from the fine screening plant, although effluent flows at that time were such that all matter discharged would have received 1.5 mm screening. When flows exceed Formula A some effluent will only receive 18 mm screening, hence the aesthetic impact of the discharge will be greater under such conditions.

(7) The microbiological quality of the E.C. identified bathing water at Instow is probably influenced by the Bideford FSO as evidenced by the dye and citrus fruit releases carried out by TWIU. However, the microbiological water quality off Instow has not changed significantly as a consequence of the commissioning of the FSO.

4. **RECOMMENDATIONS:**

(1) SWWSL should be instructed to carry out a specific investigation into the discharge regime of the Bideford FSO in order to assess the accuracy and compliance of the actual regime with respect to the theoretical regime. Ideally this would include a comparison between the HW times used to control the discharge and the actual HW times for the area.

In addition SWWSL should undertake a review of the diffuser array design criteria for the FSO in order to assess the environmental significance of the sediment blocked diffuser ports.

ACTION: Tidal Waters Officer

ANNEX 1:

Report Type:		ENVIRONMENTAL	
Report Issue:		FINAL	
Reference Number:		RPOZ 5169/109	
	Name	***Signature***	***Date***
Originator:	R I SMITH		30 APRIL 1993
Checked & Approved:	R B WALKER		30 APRIL 1993

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The Torridge Estuary, depicted in Figure 1.1, extends approximately northwards from its tidal limit near Weare Giffard to its confluence with the Taw Estuary at Appledore. The major settlement is the port of Bideford and East-the-Water, which stands astride the estuary approximately 5 kilometres up-estuary from the confluence. At the mouth of the estuary the smaller settlements of Appledore and Instow lie on the west and east banks respectively. Appledore is a fishing village with a notable ship building industry, whilst Instow is of most importance to the tourist industry, with an EC designated bathing beach along the Torridge Estuary shore, also shown in Figure 1.1.

2. *EFFLUENT DISCHARGES TO THE TORRIDGE ESTUARY*

Bideford, associated smaller settlements and Appledore, have always depended on the Torridge Estuary as a means of disposal of largely untreated domestic and trade effluent. The most notable inputs were those related to the Bideford and East-the-Water area. Until recently effluent from the Bideford area was discharged to the estuary via four short outfalls, one from East-the-Water and three from Bideford. Of the above outfalls only the Bideford Victoria Park discharge received any kind of treatment in the form of coarse screening.

With increases in the ambient local population and the seasonal increases associated with tourism in the area, noticeable deterioration of water quality in the estuary occurred. This was highlighted by the increasing frequency of visual pollution such as sewage based solids, sanitary debris and fatty surface slicks. Further to this, the EC designated bathing beach at Instow failed microbiological bathing water standards on a regular basis.

A further problem was the shortfall in the capacity of the Bideford sewerage system which, under conditions of heavy rainfall and high tides, resulted in the flooding of some areas with effluent. Notable sewage related odour problems were also common.

In order to alleviate the above problems, the then South West Water Authority (SWWA) proposed the construction of the Bideford Fine Screening Plant and Outfall as an interim measure prior to the implementation of a larger scheme to improve the sewerage system, aesthetic quality and water quality of the Taw-Torridge area.

3. *BIDEFORD FINE SCREEN PLANT AND OUTFALLS*

The Bideford Fine Screen Plant and Outfalls were fully commissioned in October 1990 with the inclusion of crude discharges from Bideford. A list of the original crude and storm discharges re-routed to the fine screen plant are presented in Table 2.1.

Bideford fine screen plant was designed to screen effluent flows of up to the Formula A value for the year 2011 through a 1.5 millimetre (mm) screen, with removal of the screening by suction tanker. An on-site odour control system was also installed. The Formula A flow is calculated as:-

$$1.36P + DWF + 2E$$

where: P = Population
E = Trade Effluent
DWF = Dry Weather Flow

In the case of Bideford the estimated dry weather flow for the year 2011 was 88 litres per second (l/s), based on estimates of the population equivalent of the catchment area in the year 2011. As a result the Formula A flow estimate for the year 2011 is 396 l/s.

The Bideford Fine Screen Outfall (FSO) consists of a 700mm diameter pipe with a five port diffuser array at the discharge point, the location of which is shown in Figure 1.1. The discharge regime of the outfall, together with the way in which it is controlled, proved somewhat difficult to ascertain. However, from information obtained from the Taw district office of SWWSL, it is understood that the discharge regime is controlled, with respect to tidal oscillations, by a lunar clock logic discharge timing device. To facilitate this, the system was pre-programmed with predicted tidal times for Bideford, derived from Admiralty data for Avonmouth.

The theoretical discharge regime for effluent flows of up to 396 l/s, presented in Figure 2.1, is as follows:-

HW-4 to HW+2: All fine screened flows are pumped to the estuary via the FSO. The Victoria Park tank sewer contents are retained.

HW+2 to HW+4: All the fine screened flows are pumped to the estuary via the FSO. The contents of the tank sewer are allowed to drain into the FSO under gravity. The pumped discharges have priority to discharge to the FSO, with the tank sewer discharging when the pumps are not operating.

HW+4 to HW+5: All the fine screened flows are pumped to the estuary via the FSO. Any effluent remaining in the Victoria Park tank sewer gravitates to the storm water sump and is discharged to the estuary via the storm water outfall.

HW+5 to HW-4: All the screened effluent flows up to 200 l/s are pumped to the Victoria Park tank sewer (capacity 1180 cubic metres), for storage over the low water period. Flows of between 200 l/s and 396 l/s are pumped to the estuary via the FSO. If the tank sewer becomes full before HW-4, subsequent fine screened effluent is pumped to the FSO.

Under storm flow conditions all flows in excess of the 396 l/s capacity, up to a design limit of 2000 l/s, are passed through the overflow 18mm screen and discharged to the storm sump and thereafter pumped to the estuary via the 900mm diameter storm water outfall.

During the post scheme appraisal of the Bideford FSO, charted logs of the tank sewer level, Formula A sump level and sewage influx to the system were obtained for the spring tide and neap tide surveys undertaken on the 14th and 19th August 1991. Data from these traces have been re-plotted, together with a trace of predicted tidal elevation for Appledore, and used to assess the accuracy and suitability of the discharge regime described above. The tidal predictions were made using tidal constituents, derived from a 30 day set of observations made by Wimpol Limited in 1987 (Reference 2). The difference between HW times at Appledore and Bideford was not regarded as significant based on the results of simultaneous tidal measurements at both locations by Wimpol Limited in 1987 (Reference 2). The data are presented in Figures 2.2 and 2.3 for the 14th and 19th August 1991 respectively.

The discharge records for the 14th and 19th August covered periods of relatively low effluent flow conditions, with no flows in excess of the Formula A value. During the filling of the tank sewer, flows were less than 200 l/s implying no discharge to the estuary during the period HW+5 to HW-4. Similarly, during the tank sewer discharge, the contents were discharged totally by gravity via the FSO, with no excess effluent pumped to the storm water outfall. Under such conditions it would seem realistic to expect the actual discharge regime to correspond well with the theoretical regime and local tidal predictions. In order to appraise this, comparisons between the theoretical and actual discharge regimes for the 14th August and 19th August have been made and presented in Tables 2.2 and 2.3 respectively.

The discharge regime data for the 14th August 1991, presented in Figure 2.2 and Table 2.2, highlight some notable time delays in excess of thirty minutes relative to locally predicted tides. Of these anomalies, the most significant were those of the early morning and mid-afternoon discharges to the tank sewer which were 158 and 44 minutes late respectively. These occurrences are of significance not only because they represent inaccuracies of the actual discharge regime, but also because they covered periods during which flows should not be discharged to the estuary. The delay in the late night gravity discharge, although 32 minutes late, was not of such significance because the tank sewer was able to discharge completely within the period of peak ebb flow.

The discharge regime data for the 19th August 1991, presented in Figure 2.3 and Table 2.3, highlight time variations in excess of 30 minutes for all major aspects of the discharge regime relative to locally predicted tides. Of the aforementioned discrepancies, the most notable were again those related to the filling of the tank sewer and period of no discharge around low water (LW). During the morning the filling of the tank sewer commenced 52 minutes late and finished 42 minutes early. This resulted in a period of no discharge to the estuary of only 2 hours and 12 minutes compared to the 3 hours and 45 minutes that it should have been. Such a discrepancy is of significance in relation to the LW tidal state and subsequent influence of effluent discharges. A similar variation was observed during the evening, although to a lesser extent. The early commencement of the tank sewer gravity discharges is a further indication of the inaccuracy of the system, but would be unlikely to impair water quality or aesthetic appearance unless it occurred under HW slack conditions.

Observations of the FSO during discharges under LW spring tide conditions indicated that only two of the five diffuser ports were in use, the other three being blocked by sediment. It is assumed that this is contrary to the original design specification, thus implying that the outfall is not achieving the desired initial dilution.

Observations made by the NRA TWIU staff in the vicinity of the fine screening plant did not indicate there to be an odour problem related to the plant.

The theoretical discharge regime is regarded as a realistic compromise and takes into account the sensitivity of the estuary under LW conditions and the improved dispersive characteristics during the tidal ebb. However, the previous points highlight marked inaccuracies in the time-keeping of the discharge control system relative to the local tidal regime. These discrepancies are arguably more noticeable in that they occurred under relatively low effluent flow conditions and shed doubts on the capability of the system to cope with higher effluent flows, not necessarily equivalent to storm conditions.

4. *PRE-SCHEME WATER QUALITY*

An extract from the River Pollution Survey of England and Wales (Reference 1) described the initial 2.5km stretch of the Torridge Estuary south of its confluence with the Taw Estuary as being of Class 2 quality, that is, 'of doubtful quality and needing improvement.' Further to this, a 3km stretch up-estuary from Bideford was described as Class 3, that is: 'of poor quality requiring improvement as a matter of some urgency.'

In 1980 the National Water Council proposed a new system of classification specifically for estuaries which was based on chemical, biological and aesthetic quality. This system placed the Torridge Estuary in Class A, described as good. This was despite the estuary being placed in the second category with regard to aesthetic quality, indicating that the area was aesthetically influenced by certain inputs (Reference 1).

Prior to the Torridge District Council enquiry into the then proposed fine screening plant at Bideford in 1985, formal inspections of the estuary and Instow beach were made. These inspections noted the presence of surface slicks and deposited solids on the water and along the estuary shores. At Instow beach evidence of sewage based solids, plastics and other materials was also noted (Reference 1).

Whilst the above statements are somewhat contradictory, they do highlight the aesthetic quality of the Torridge Estuary as being a consistent and noticeable problem.

More detailed surveys reviewing the water quality of the Torridge Estuary have been undertaken by/for the then SWWA.

The findings of water quality studies prior to 1985, conducted by the then SWWA, resulted in the conclusion that crude sewage discharges constituted one of a number of factors affecting the quality of the Torridge estuarine waters. Survey results indicated that the crude sewage discharges had little detrimental effect on chemical water quality, but that the effluent discharges did contribute the majority of faecal bacteria enumerated in the estuarine waters. Further to this it was observed that such discharges contributed the majority of gross solids and sanitary debris, leading to slight aesthetic problems in many areas and severe problems in a few places (Reference 1).

The largest survey into the physical, chemical and biological characteristics of the Torridge and Taw estuarine system was undertaken by Wimpol Ltd. between October 1987 and October 1989 for the then SWWA (Reference 2). The survey was completed prior to the commissioning of the Bideford fine screen plant and outfalls and the resultant re-routing of the Bideford discharges. As such, it represents the most comprehensive estimate of pre scheme environmental conditions in the Torridge Estuary.

Water quality data from the above survey, for the summer periods of 1988 and 1989, summarises the pre-scheme water quality and is presented in Figures 3.1 to 3.5 to support the statements presented in this section and to enable comparison with the post scheme water quality data collected by the NRA TWIU during the summer of 1991.

The data presented includes: Surface Water Acidity (pH), Figures 3.1a to d; Surface Water Dissolved Oxygen (DO), Figures 3.2a to d; Surface Water Total Oxidised Nitrogen (TON), Figures 3.3a to d; Surface Water Dissolved Ammonia, Figures 3.4a to d; Surface Water Faecal Coliform Counts, Figure 3.5a to d. Listings of the data are also presented in Appendix B. The Figures indicate spring and neap HW and LW tidal conditions but do not include mid-ebb or mid-flood data as no measurements were taken at these tidal states. The water quality data is limited to measurements taken in the surface layers of the estuary because it was felt that such data was more pertinent to the near-field and far-field influence of largely freshwater discharges into a saline environment and the resultant buoyant effluent slicks. However, it is likely that the far-field scenario would be influenced by vertical mixing processes. European Community (EC) Environmental Quality Standards (EQS's) relating to DO, pH and faecal coliform counts are presented in Table 3.1.

The physical survey highlighted the influence of both the tidal saline intrusion and riverine inputs on the physical mixing characteristics of the Torridge Estuary. These influences included: enhanced saline intrusion during spring tides; reduced saline intrusion under high river flow conditions; reduced stratification effects during low riverine input summer months; inverted saline/freshwater thermal differences between summer and winter seasons; the influence of riverine input on suspended sediment load and the existence of a turbidity maximum. Further to this, ebb flows were found to be largely controlled by bathymetry and the location of the main channel which altered frequently in the lower and middle reaches of the estuary.

The summer water quality surveys indicated that pH levels (Figures 3.1a to 3.1d), ranging from 7.5 to 8.6 were generally suitable for the passage of migratory fish (between 7.0 and 8.5), and always within the bathing water range (6.0 to 9.0). The highest values of 8.4 and greater were found to be associated with the more riverine sampling locations.

The summer D.O. concentrations (Figure 3.2a to 3.2d) were generally suitable for the passage of migratory fish, that is, greater than the minimum EQS level of 5.0mg/l O. However, during a period of very low river flow and warm weather in 1989, DO levels did fall below the EQS in the upper reaches of the Torridge Estuary, with a minimum recorded level of 4.5mg/l O.

Summer nutrient levels such as TON of up to 2mg/l N were generally found to be highest at upper estuary survey sites (Figures 3.3a to 3.3d), thus indicating the importance of the riverine inputs as the major nutrient sources due to the influence of agricultural run-off. However, summer dissolved ammonia levels (Figures 3.4a to 3.4d), although not high (less than 0.5mg/l N), were sometimes elevated in the Bideford area in association with main mid-estuary discharges.

Individual summer faecal coliform samples from the Torridge Estuary (Figures 3.5a to 3.5b) did not generally exceed the E.C. mandatory EQS limits for 95% of the values (2000/100ml faecal coliforms and 10000/100ml total coliforms) (Reference 2). However, during the course of the 1987 to 1989 study, values at the EC designated Instow bathing beach did exceed such limits. In addition estuarine samples collected throughout the two years also provided total and faecal coliform counts in exceedance of the limits, with *Salmonellae* and enterovirus also detected (Reference 2).

Winter and summer studies of the major estuarine pollutant inputs identified the riverine inputs as the major nutrient sources, whilst the Bideford effluent discharges were identified as the major sources of faecal coliform (Reference 2).

Fish studies indicated that salmon stocks were low but increasing. Sea trout stock were found to be low and in decline as a result of adverse water quality, although the problem was thought to be related in particular to incidents of farm pollution (Reference 2).

In terms of the sediment quality the Torridge Estuary was not regarded as contaminated but notable organic enrichment, in the vicinity of sewage outfalls, was evident. Benthic faunal communities were found to be sparsely populated in comparison to those of similar estuaries (Reference 2).

Aesthetic problems including sanitary debris and faecal matter were observed in the Torridge Estuary and along its shores including Instow bathing beach on numerous occasions (Reference 2).

The previous points and discussion of points from previous surveys indicate that the water quality problems of the Torridge Estuary, prior to the commissioning of the fine screening plant, were specifically associated with elevated microbiological levels and poor aesthetic appearance. The high natural sediment load and riverine nutrient inputs reduced the significance that effluent discharges might have had with regard to the chemical water quality. However, the influence of industrial waste possibly discharged through the SWWA system as trade effluent may have caused individual samples to indicate high levels of dissolved mercury and dissolved cadmium.

5. POST-SCHEME WATER QUALITY

The water quality of the Torridge Estuary subsequent to the commissioning of the Bideford fine screen plant and outfall was appraised by the NRA South West TWIU during the summer of 1991. Descriptions of survey operations, provided by the NRA, are presented in Appendix B.

Of the data collected, the results of tracer experiments have been presented in Figures 4.1 and 4.2, whilst only selected parameters from main channel surface locations has been presented in Figures 4.3 to 4.7. Listings of the data are also tabulated in Appendix C.

This data was regarded as being indicative of both near-field and far-field water quality conditions as influenced by an effluent discharge and the initial surface slick flowing within main channel constraints. However, it should be noted that in the far-field area of effluent plume influence, vertical mixing is usually attained and as such results should be regarded as indicative of conditions throughout depth as confirmed by near-bed sample data presented in Appendix C. The parameters presented correspond, where possible, to those chosen to represent pre-scheme conditions allowing comparison between the pre- and post-scheme water quality. An indication of surface water movement, as depicted using citrus fruit and fluorescein dye as qualitative tracers released from the FSO, was also obtained.

The data was collected on 7th June 1991 (neap tide), 14th August 1991 (spring tide) and 19th August 1991 (neap tide). All three surveys were conducted under conditions of relatively low river and effluent flows. Results of the observed landing points of the fruit and trajectories of the dye are presented in Figures 4.1 and 4.2 for 14th August 1991 (spring tide) and 19th August 1991 (neap tide) respectively. The water quality data presented includes: Surface Water Acidity (pH), Figures 4.3a to c; Surface Water Dissolved Oxygen (DO), Figures 4.4a to c; Surface Water Total Oxidised Nitrogen (TON), Figure 4.5; Surface Water Dissolved Ammonia, Figures 4.6a to c; Surface Water Faecal Coliform Counts, Figures 4.7a to c.

The physical data collected during the three surveys was generally typical of neap and spring summer estuarine conditions influenced by low river flows and seasonally high temperatures.

Ebb tide tracer experiments, undertaken using fluorescent dye and citrus fruit to indicate the fate of the main tank sewer ebb discharge, were of limited success but did indicate the possible movement of effluent based material as depicted in Figures 4.1 and 4.2. The influence of the citrus fruit was most notable during the spring tide release (Figure 4.1) where fruit landed on the southern extremity of the E.C. designated bathing beach at Instow. During the neap survey (Figure 4.2) the fruit landed on the eastern side of the estuary a short distance north from the FSO location. The movement of the dye, only released during the neap survey (Figure 4.2), indicated the ebb water movement to be strongly influenced by main channel bathymetry as identified in previous studies. The dye was also used to identify the location of the plume as an aid to sampling.

Turbidity and suspended solids measurements were within levels expected for the Torridge Estuary which is influenced by highly mobile bed material, resuspended during flood and ebb episodes. This situation is likely to be significant with respect to the silting up of the diffuser ports as mentioned in section 2. The suspended solids values measured, presented in Appendix C, ranged from 2.4 to 296mg/l during the spring tide and 3 to 157mg/l during the neap survey. There was little indication of organic enrichment of the suspended sediment in the vicinity of the outfall.

Measured pH and DO levels (Figures 4.3a to c and Figures 4.4 a to c) were, in general terms, acceptable for the passage of migratory fish. DO levels were measured as percentage saturation and as such cannot be directly related to the EQS regarding the passage of migratory fishery which is expressed in milligrams per litre oxygen (mg/l O). Nevertheless levels were consistently higher than 60% saturation. Further to this the lowest DO levels of 69% saturation were converted to milligrams per litre and found to be at worst 5.3mg/l O, 0.3mg/l O above the migratory fishery EQS of 5.0mg/l O.

During the survey of 19th August 1991 notably high DO and pH levels were measured generally increasing up estuary, with a maximum pH value of 8.7 and a peak DO of 187% saturation (12.9mg/l O). These values, observed during the ebb flow, were probably influenced by the effects of a phytoplankton bloom observed during the survey.

Nutrient levels in the form of dissolved ammonia and TON concentrations were generally acceptable, with dissolved ammonia generally less than 1mg/l N and TON less than 2mg/l N. The TON concentrations (Figure 4.5) were only sampled during the survey on 7th June 1991 but indicated the significance of the riverine input as the major dissolved nutrient source, with a general increase in levels up estuary. However, at the LW and mid-ebb tidal states there was some indication of TON enrichment in the vicinity of the FSO. Dissolved ammonia levels (Figures 4.6a to c) were, as stated, of generally low levels with little estuary wide variation. Concentrations were notably enhanced in the near vicinity of the FSO during all three surveys, with the highest levels of up to 2.5mg/l N typically measured within the discharge boil. However, the influence of the discharge was observed to diminish rapidly with distance up and down estuary during all three surveys.

The lateral (cross-estuary) area of influence of the FSO on dissolved ammonia concentrations was only investigated on 7th June 1991. The data collected (Tables C.1.a to C.1.d in Appendix

C) indicate that the localised elevation of amonia levels by the FSO, at its worst during periods of slack water, does not persist across the full width of the estuary on neap tides. No comparable data is available for spring tides. The data collected to date is insufficient to quantify the size of the dissolved ammonia "mixing zone" (i.e. area of EQS exceedance) resulting from the FSO.

Faecal coliform counts, obtained for the area during all three surveys, gave an indication of the area and degree of influence that the Bideford FSO had on the Torridge Estuary at the time of survey (Figures 4.7 a to c).

At LW the influence of the FSO is theoretically at its minimum with little or no discharge under normal operating conditions. The available data for the 7th June and 14th August 1991 (Figures 4.7a and 4.7b) generally confirm this. No significant increase in faecal coliform counts, normally associated with a LW discharge, was evident. This was further justified by additional data, obtained for the 14th August 1991 and presented in Appendix C (Table C.7), which showed the Torridge and Yeo riverine faecal coliform counts to be of a similar order to those measured throughout the estuary.

During the flood tide elevated coliform counts up-estuary from the discharge would be the expected scenario. This was generally found to be the case during the studies of 7th June and 14 August 1991 (Figures4.7a and 4.7b), with faecal coliform counts measured at site 11 (Little America) of 3300/100ml and 3900/100ml respectively: these values are in excess of the bathing water EQS limit (2000/100ml). On the 7th June 1991, a high faecal coliform count of 3100/100ml was also measured at site 12 (Pillmouth). The very high faecal coliform counts measured in the bottom water sample taken at this location (ie 21000/100ml) may be indicative of concentrated 'slugs' of effluent moving up-estuary as suggested by the associated salinity measurement of 15.6ppt. However, localised bacterial sources such as the River Yeo may also have contributed to this result.

At HW the area of influence of the FSO discharge, with regard to faecal coliform counts, was still found to be up-estuary from the discharge point (Figures 4.7a and 4.7b), with counts generally increasing up the estuary from the discharge point. This effect may be the result of other bacterial sources upstream of the FSO, but high faecal coliform counts measured in bottom samples at sites 12 and 13 on 7th June 1991 (2200 and 3800 no/100ml) were also associated with salinity measurements in excess of 25ppt. The high bacterial levels observed at these upper estuary sites at HW are thus likely to result from a combination of riverine bacterial sources and effluent from the FSO pushed upstream on the flood tide.

During the ebb flow the sampling surveys attempted to concentrate on the most significant discharge, that is the discharge of stored effluent from the tank sewer. Irregularities in the timing and quantity of this discharge made this difficult, but nevertheless the down-stream influence of the discharge was observed. Data from the survey undertaken on 7th June 1991 (Figure 4.7a) did not clearly highlight the influence of the main discharge. However, faecal coliform counts of 5100/100ml and 2400/100ml, in excess of the EQS bathing water limit, were detected at sites 7 and 6 respectively.

The ebb plume sampling exercise carried out on the 14th August 1991 under spring tide conditions successfully sampled the tank sewer discharge. However, the discharge records discussed in section 2 and presented in Figure 2.2 indicate that the quantity of effluent discharged was less than normal. The data collected, from the resultant effluent plume (Figure 4.7b), showed there to be high faecal coliform levels in excess of the bathing water EQS as far down estuary as site 5. Under 'normal' discharge conditions (ie a greater volume of effluent) influence of the FSO may extend somewhat further seawards and thus closer to the bathing beach at Instow.

Data obtained from the survey of the 19th August 1991 (Figure 4.7c) during neap tides provided the most realistic indication of the extent of influence of the tank sewer discharge. Faecal coliform counts in excess of the 2000/100ml EQS limit were measured in samples as far down the estuary as Appledore shipyard, with relatively high counts of 1900/100ml measured at Appledore slipway opposite Instow beach. However, the survey data also indicates that the west side of the estuary (Appledore) was more directly influenced than the east side (Instow), although shallow water depths impaired sampling on the eastern side of the channel.

No quantitative information on the aesthetic quality of the estuary was obtained by the TWIU. However, qualitative observations made by members of the NRA field team, during the surveys of the 14th and 19th August 1991, suggested a lack of sewage related debris.

The above discussion, based on presently available data, indicates that the water quality problems affecting the Torridge Estuary are primarily those associated with the microbiological loading caused by the major effluent discharge to the area, that is the Bideford FSO. The influence of the aforementioned discharge with regard to the nutrient and suspended solids loading to the estuary would appear to be of less significance in relation to the riverine inputs and natural suspended sediment load.

6. A COMPARISON OF PRE AND POST SCHEME WATER QUALITY

This section aims to provide a comparison between the water quality of the Torridge Estuary before and after the commissioning of the Bideford fine screen plant and outfalls in order to assess whether or not there have been any significant changes as a result of the introduction of the aforementioned system.

Historic water quality data for the Torridge Estuary has been presented in Figures 5.1 and 5.2. Figures 5.1a and b present mean surface water dissolved ammonia concentrations, whilst Figures 5.2a and b present mean surface faecal coliform counts. Further comparisons can be made by reference to the numerous Figures presented as part of sections 3 and 4 which have been produced using similar formats and scales to ease cross-referencing. Mean total and faecal coliform counts for the EC designated bathing beach at Instow, covering the last four years, have been presented in Figure 5.3. Data presented in Figures 5.1 to 5.3 are tabulated in Appendix D. It should be noted that in comparing the Figures from sections 3 and 4 only the data referring to the HW and LW tidal states can be realistically compared.

pH levels were slightly higher during the 1991 (7.8 to 8.7) surveys than during the surveys undertaken in 1988 and 1989 (7.5 to 8.6). However, whether or not such a change could be attributed to the commissioning of the Bideford fine screen plant and outfalls or other influences such as phytoplankton activity cannot be substantiated. Despite the slight increase, the pH levels remained within the EQS range for bathing waters (6.0 to 9.0) and generally remained within the range required for the passage of migratory fish (7.0 to 8.5).

Dissolved oxygen (DO) levels were measured in milligrams per litre of oxygen in 1988 and 1989, whilst the 1991 data was measured as percentage saturation. However the 1991 levels did not indicate any problems with regard to low DO levels, with a minimum converted level of 5.3mg/l O comparable with minimum values from the 1988 and 1989 data. In fact the opposite was observed with high levels of up to 182% saturation (12.6mg/l O) associated with observations of phytoplankton activity.

Only limited total oxidised nitrogen (TON) data was obtained from the 1991 surveys (Figure 4.5). However, the available data was similar in terms of general levels and inter-site variations to that obtained in the 1988 and 1989 (Figures 3.3a to d), with levels generally increasing up the estuary showing the riverine inputs to be significant. Whilst there was a localised increase in TON in the near vicinity of the FSO discharge, the FSO did not appear to influence TON levels in the estuary as a whole under HW conditions. The LW TON levels were primarily influenced by the riverine inputs.

Surface dissolved ammonia levels generally less than 1mg/l N, measured during the 1991 surveys (Figures 4.6a to c), were similar to those measured in 1988 and 1989 (Figures 3.4a to d). The elevated levels of dissolved ammonia in the vicinity of the discharge did not notably cause an increase or decrease in levels further away from the outfall at HW. However, the lack of any LW discharge did not result in a notable reduction in dissolved ammonia levels either. Some mid-ebb samples did indicate the influence of the FSO but these could not be compared to previous survey data. With reference to the historic mean dissolved ammonia concentrations (Figures 5.1a and 5.1b), levels would seem to have decreased from those measured in 1982. However, since then, ammonia concentrations have not shown any notable change, with the only notable influence of the Bideford FSO being at the discharge point.

Surface faecal coliform counts obtained from samples taken at HW and LW during the 1991 surveys (Figures 4.7a to c) were similar to those obtained from the surveys undertaken during 1988 and 1989 (Figures 3.5a to d). There were no significant increases in the 1991 HW counts other than at the discharge point itself. Equally no notable decreases in the LW counts were noted despite the lack of effluent being discharged. The 1991 data indicates that the Bideford fine screen outfall influences mid-ebb and mid-flood faecal coliform counts, but such effects cannot be gauged with respect to the 1988 and 1989 data. In terms of the historic mean surface faecal coliform counts (Figures 5.2a and 5.2b) the general situation would seem to have improved over the years 1982, 1984 and 1985. However, there was little noteworthy difference between the 1987-1989 data and the 1991 data other than the peak measured in the FSO discharge boil. This indicates that, based on presently available data, the commissioning of the Bideford fine screen plant and outfall has done little to alter the microbiological water quality of the estuary, other than perhaps worsen the situation in the immediate vicinity of the outfall and improve the situation in the areas around the previous outfalls.

The microbiological bathing water quality of Instow beach, presented in Figure 5.3 would appeared to have improved between 1988 and 1989 in terms of both mean total and faecal counts. Between 1989 and 1991 mean total coliform counts increased from 1529/100ml to 3534/100ml, although this is thought to be as much a facet of natural variability as the result of the influence of domestic effluent discharges. Mean faecal coliform counts did not show a significant increase or decrease between 1989 and 1991, again intimating that the commissioning of the FSO has had little or no effect on microbiological water quality.

The aesthetic quality of the Torridge Estuary would be the most likely area to have shown some improvement subsequent to the commissioning of the FSO. Initial indications from the qualitative information provided by the NRA TWIU are that the aesthetic quality of the estuary has improved, although a more detailed study of this aspect in particular would be required to fully substantiate this.

In general terms there appears to have been little change in the water quality of the Torridge Estuary since the 1987-1989 study. The re-routing of the Bideford discharges through the fine screen plant and outfall has certainly moved the area of immediate influence on the estuary closer to the EC designated bathing beach at Instow. Despite this, presently available data does not indicate any notable change in the water quality off Instow beach. Similarly, the improvement of the discharge regime, notably to prevent discharges during sensitive LW periods, has resulted in no notable change in water quality.

7. REFERENCES

1. CA JENKINS (1985). Torridge District Council Inquiry into an Appeal by South West Water Authority regarding the Proposed Sewage Fine Screening Plant at Bideford and into an Application by the Authority for Consent to Discharge Fine Screened Sewage to the Torridge Estuary at Bideford (and documents referred to therein).

2. SOUTH WEST WATER (1987 to 1989). Taw - Torridge Environmental Survey and Mathematical Modelling. Reports B, F, J, K, L and M.

TABLES

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Table 2.1: Bideford Outfalls Re-routed to the Fine Screen Plant and Outfall

Outfall Name	Position N.G.R.	Discharge Type	Date of 1st flow through the Fine Screen Plant
Bideford, south of bridge	453 261	Storm	Dec-89
Bideford, south of bridge	454 262	Storm	Dec-89
Orchard Hill	456 281	Crude/Storm	23-Oct-90
Bridgeland Street	455 268	Crude	23-Oct-91
Victoria Park, coarse screened	456 272	Crude/Storm	24-Oct-91
East-the-Water, south of bridge	455 262	Storm	Dec-90
East-the Water	455 260	Crude	3-Dec-90

Table 2.2: A Comparison Between the Theoretical and Actual Discharge Regime for 14-AUG-91 (Spring Tide)

Discharge Regime	Discharge Regime Start Time (HW+/-)		Variation (mins)
	Theoretical	Actual	(+ = late,- = early)
Tank sewer filling, no discharge to the estuary.	HW+5:00	HW-5:19	158+
Tank sewer contents retained, other flows pumped to the estuary.	HW-4:00	HW-3:48	12+
Tank sewer discharging by gravity, other flows pumped to the estuary.	HW+2:00	HW+1:51	9-
Tank sewer filling, no discharge to the estuary.	HW+5:00	HW+5:44	44+
Tank sewer contents retained, other flows pumped to the estuary.	HW-4:00	HW-3:53	7+
Tank sewer discharging by gravity, other flows pumped to the estuary.	HW+2:00	HW+2:32	32+

Bideford Fine Screen Outfall - Post Scheme Appraisal

Table 2.3: A Comparison Between the Theoretical and Actual Discharge Regime for 19-AUG-91 (Neap Tide)

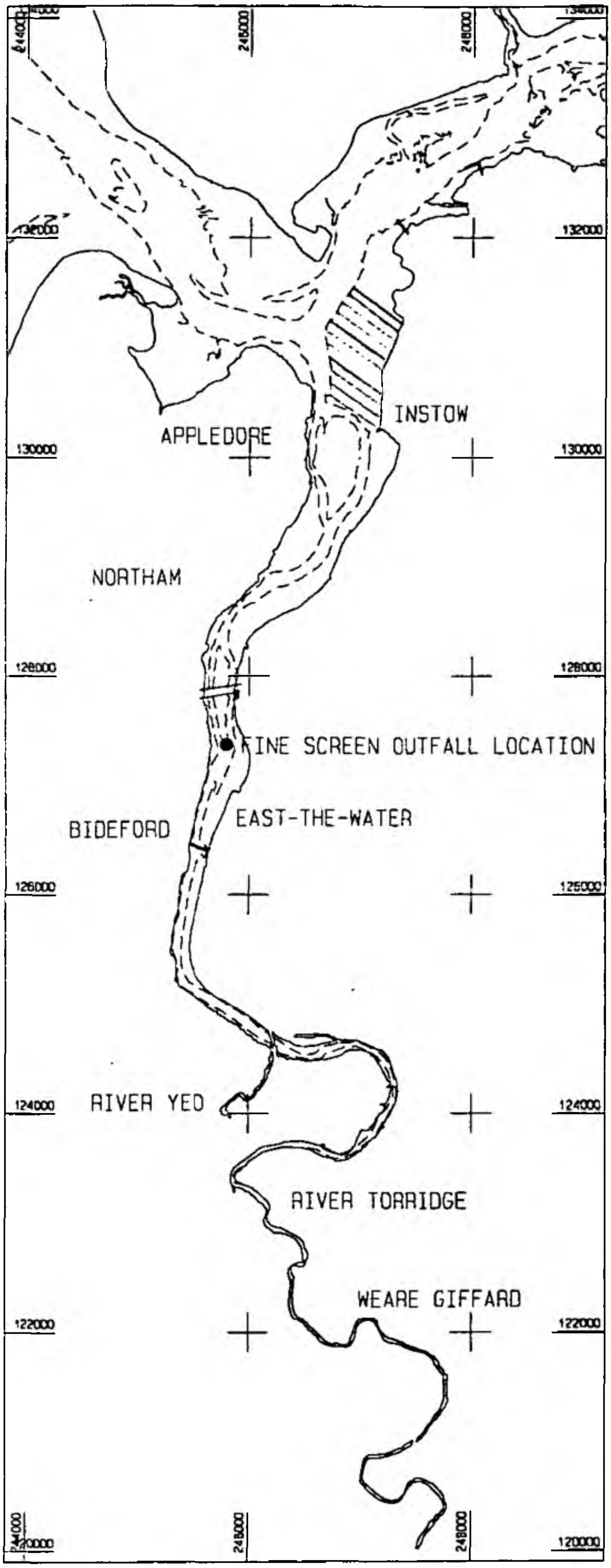
Discharge Regime	Discharge Regime Start Time (HW+/-)		Variation (mins) (+ =late,- =early)
	Theoretical	Actual	
Tank sewer discharging by gravity, other flows pumped to the estuary.	HW+2:00	HW+1:27	33-
Tank sewer filling, no discharge to the estuary.	HW+5:00	HW+5:52	52+
Tank sewer contents retained, other flows pumped to the estuary.	HW-4:00	HW-4:42	42-
Tank sewer discharging by gravity, other flows pumped to the estuary.	HW+2:00	HW+0:56	66-
Tank sewer filling, no discharge to the estuary.	HW+5:00	HW+4:29	31-
Tank sewer contents retained, other flows pumped to the estuary.	HW-4:00	HW-5:03	63-

Table 3.1: Environmental Quality Objectives and Standards (EQO's and EQS's) for Selected Water Quality Determinands in Estuarine Waters

Determinand	EQO	EQS	Statistic
Acidity (pH)	Migratory Fishery	7.0 to 8.5	Range for 95% of samples
Acidity	Bathing waters	6.0 to 9.0	
Dissolved Oxygen	Migratory Fishery	5.0 mg/l	Minimum low for 95% of samples
Unionised Ammonia	Migratory Fishery	0.021 mg/l	Maximum annual arithmetic mean
Faecal Coliforms	Bathing Waters	2000/100ml	95% compliance in n-1 samples if n> 20 samples
Total Coliforms	Bathing Waters	10000/100ml	95% compliance in n-1 samples if n> 20 samples
Salmonella	Bathing Waters	0 in 1 litre	
Enterovirus	Bathing Waters	0 pfu in10 litres	

FIGURES

LIST OF FIGURES



N

METRES
0 500 2500
SCALE 1: 60000

BIDEFORD FINE SCREEN OUTFALL POST SCHEME APPRAISAL

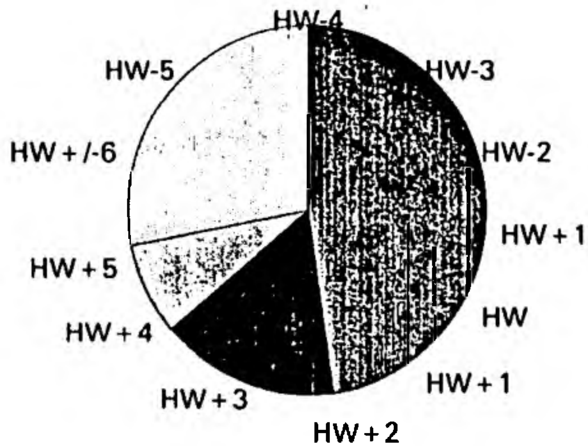
FRONTISPIECE

THE TORRIDGE ESTUARY

NOTES
THE SHADED AREA SIGNIFIES AN
E.C. DESIGNATED BATHING BEACH

REFERENCE NO:	RPOZ 5169
FIGURE NO:	1.1
DATE PLOTTED:	2-JUL-92

WIMPEY ENVIRONMENTAL

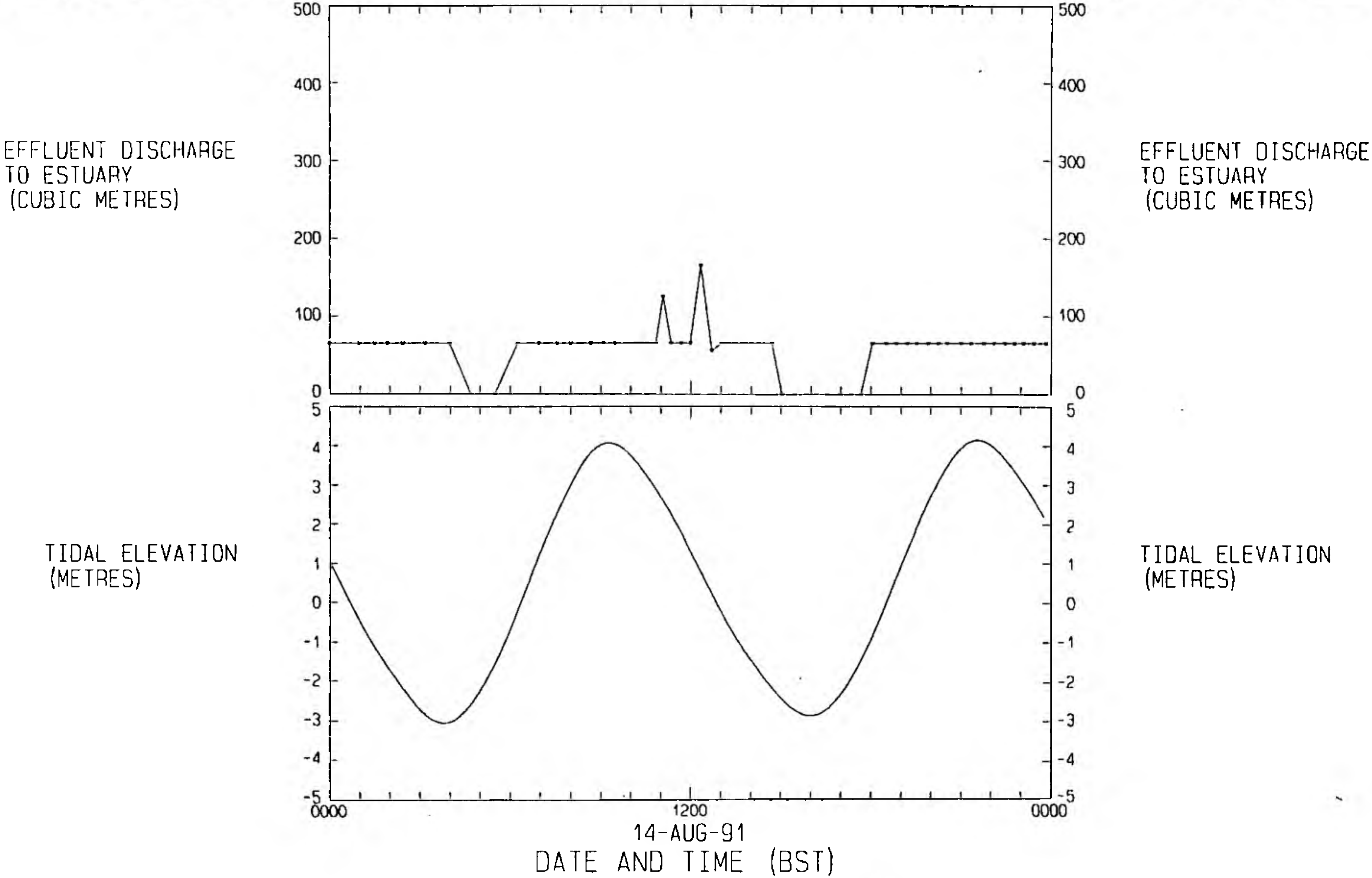


FLOW PATTERN 1: ALL FLOW TO ESTUARY, TANK SEWER CONTENTS RETAINED.	FLOW PATTERN 2: TANK SEWER DISCHARGING BY GRAVITY, INCOMING FLOW DISCHARGED TO ESTUARY.	FLOW PATTERN 3: TANK SEWER DISCHARGING TO STORM SUMP, OTHER FLOW DISCHARGED TO ESTUARY.	FLOW PATTERN 4: TANK SEWER FILLING. FLOW<200 L/SEC TO TANK SEWER. FLOW>200 L/SEC DISCHARGED TO ESTUARY.

Bideford Fine Screen Outfall
Post Scheme Appraisal

THEORETICAL DISCHARGE REGIME

FIGURE 2.1
WIMPEY
ENVIRONMENTAL

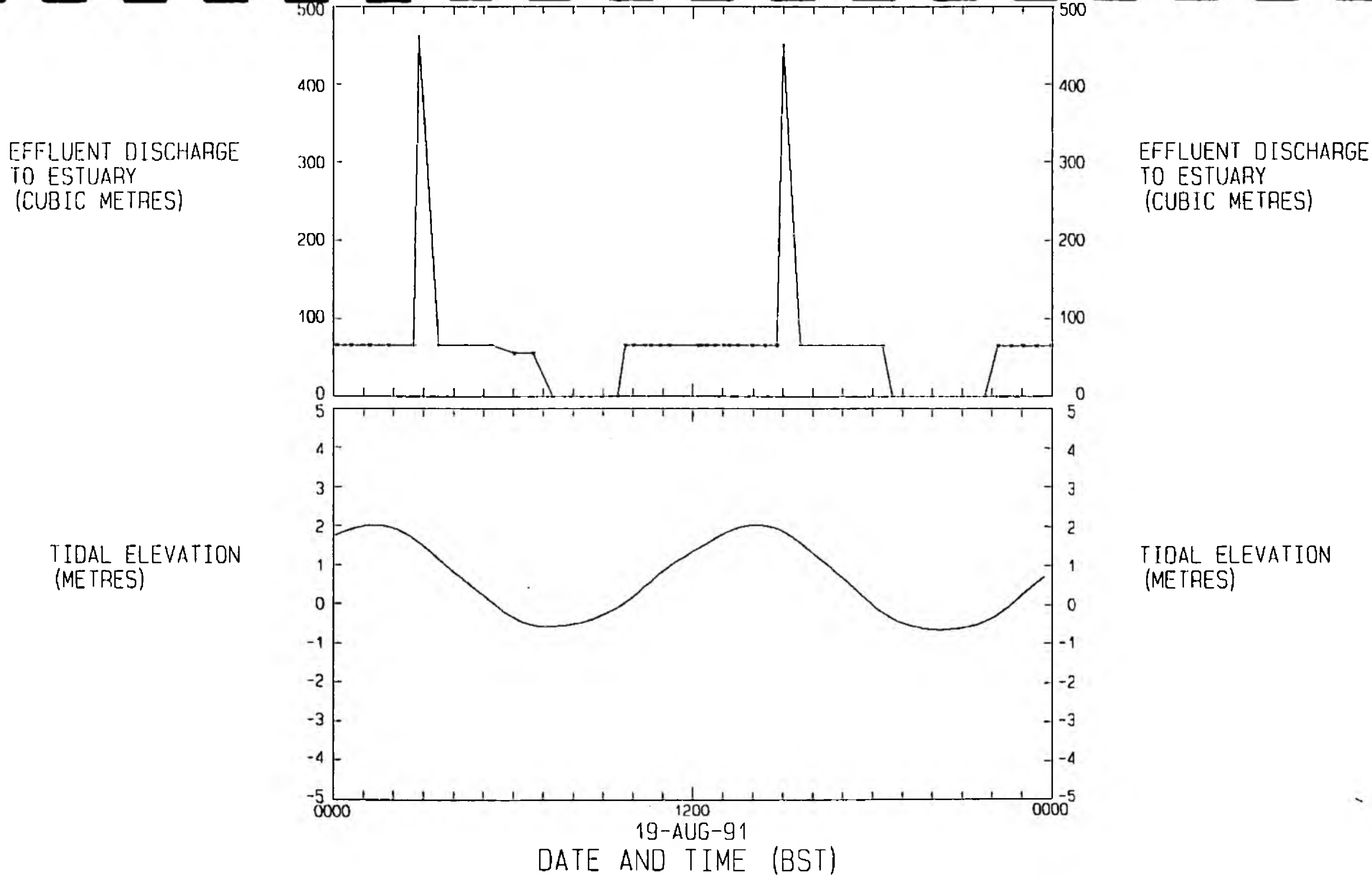


NOTES:

EACH POINT ON THE EFFLUENT DISCHARGE TRACE REPRESENTS THE TIME AT WHICH A DISCRETE DISCHARGE COMMENCED AND THE TOTAL VOLUME OF EFFLUENT DISCHARGED. THE LINES BETWEEN THE POINTS DO NOT REPRESENT LINEAR CHANGES IN FLOW RATES.

THE TIDAL CURVE WAS GENERATED FROM TIDAL PREDICTIONS FOR APPLEDORE.

BIDEFORD FINE SCREEN OUTFALL POST SCHEME APPRAISAL OUTFALL DISCHARGE CHARECTERISTICS SPRING TIDE		
WIMPEY ENVIRONMENTAL	REF. NO	RP07 5169
	FIGURE NO	2 2

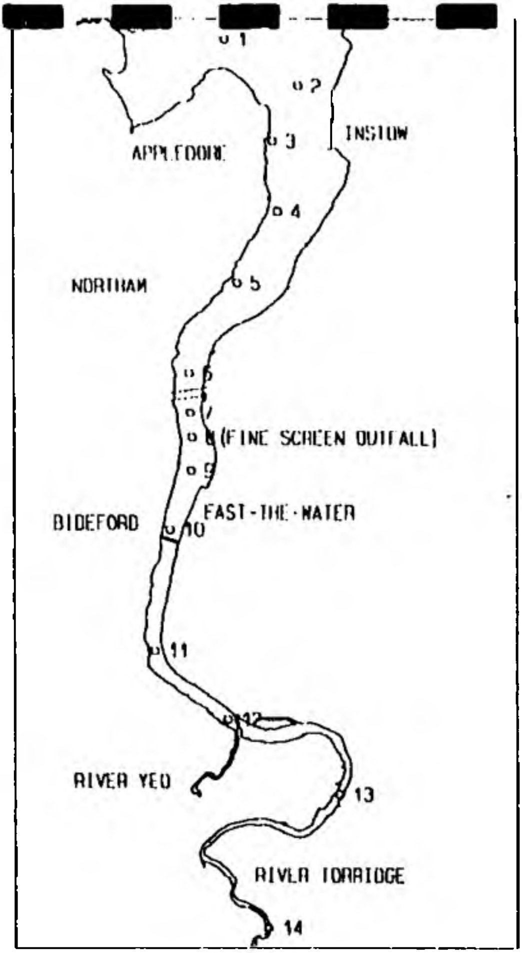


NOTES:

EACH POINT ON THE EFFLUENT DISCHARGE TRACE REPRESENTS THE TIME AT WHICH A DISCRETE DISCHARGE COMMENCED AND THE TOTAL VOLUME OF EFFLUENT DISCHARGED. THE LINES BETWEEN THE POINTS DO NOT REPRESENT LINEAR CHANGES IN FLOW RATES.

THE TIDAL CURVE WAS GENERATED FROM TIDAL PREDICTIONS FOR APPLEDORE.

BIDEFORD FINE SCREEN OUTFALL POST SCHEME APPRAISAL OUTFALL DISCHARGE CHARECTERISTICS NEAP TIDE	
WIMPEY ENVIRONMENTAL	REF. NO RPOZ 5169 FIGURE NO: 2.3



Low Water (pH)

Mid-Flood

High Water (pH)

Mid-Ebb

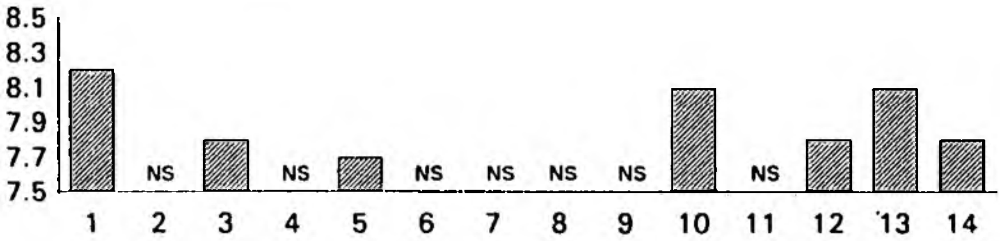
Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Spring Tide Water Quality
(30-JUL to 01 AUG-88)

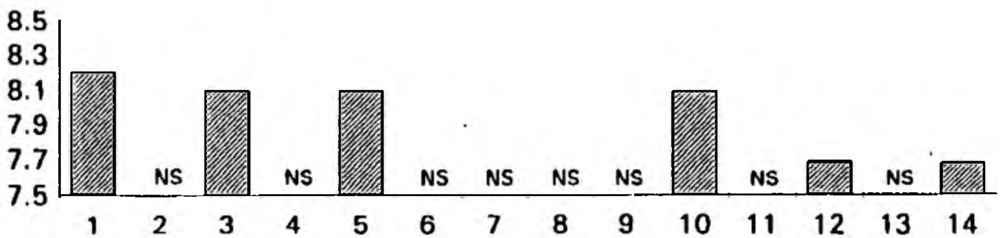
SURFACE WATER ACIDITY (pH)

NS = Site Not Sampled

FIGURE 3.1a

WIMPEY
ENVIRONMENTAL





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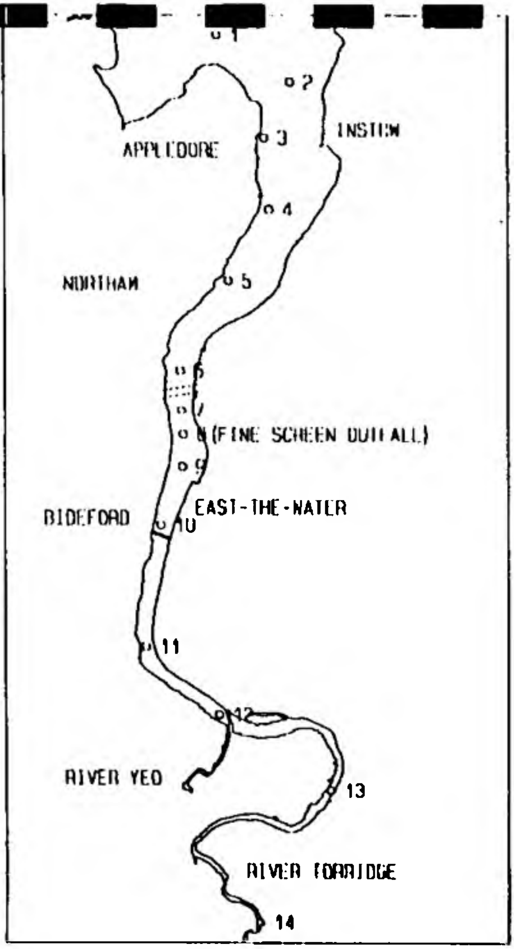


Low Water (pH)

Mid-Flood

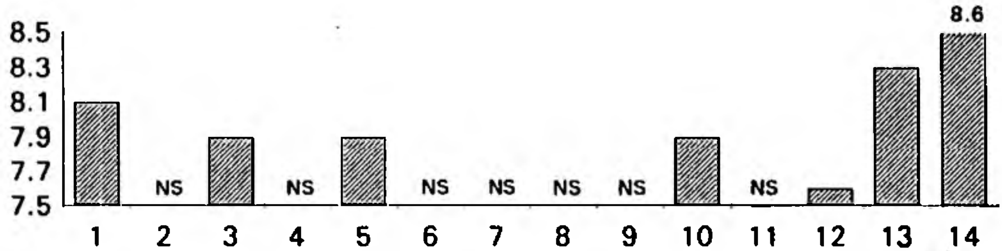
High Water (pH)

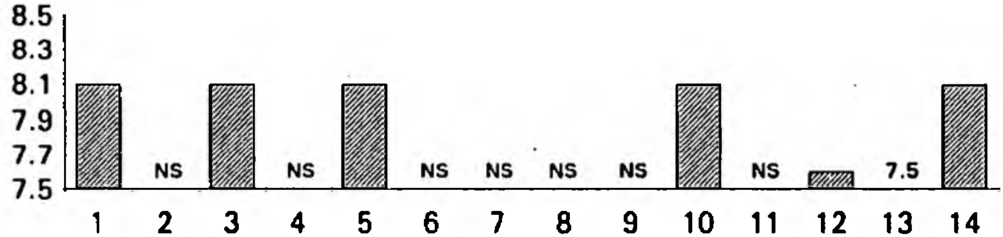
Mid-Ebb

Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Neap Tide Water Quality
(06 to 08-AUG-88)
SURFACE WATER ACIDITY (pH)

NS = Site Not Sampled
8.6 = Value Higher Than Conventional Scale
7.5 = Value at the Minimum of Conventional Scale

FIGURE 3.1b
WIMPEY
ENVIRONMENTAL





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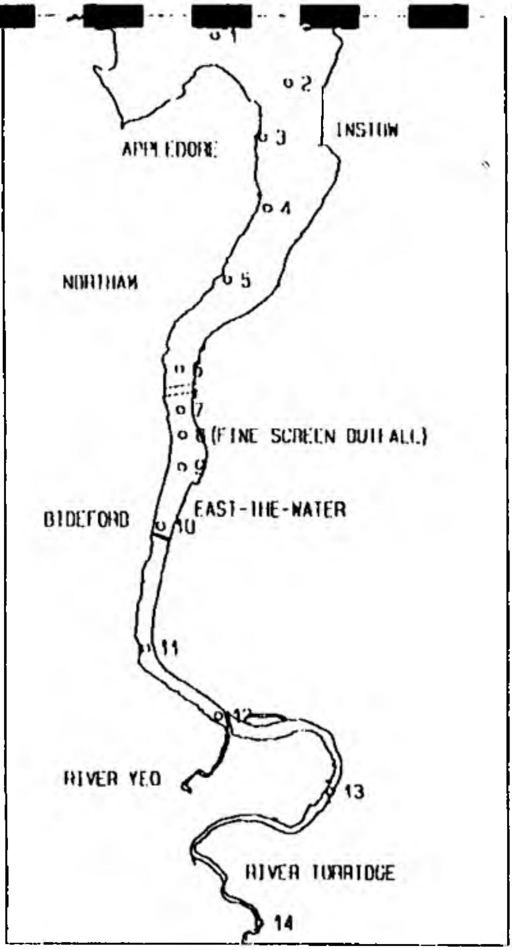


Low Water (pH)

Mid-Flood

High Water (pH)

Mid-Ebb

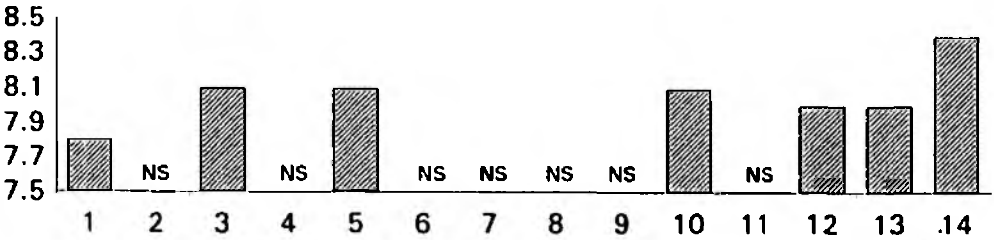
Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Spring Tide Water Quality
(19 to 21-JUL-89)
SURFACE WATER ACIDITY (pH)

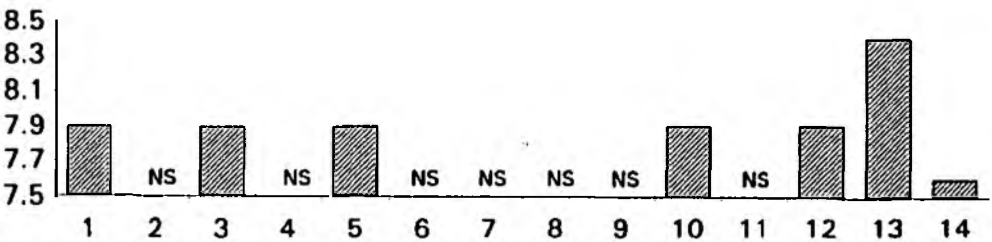
NS = Site Not Sampled

FIGURE 3.1c

WIMPEY

ENVIRONMENTAL





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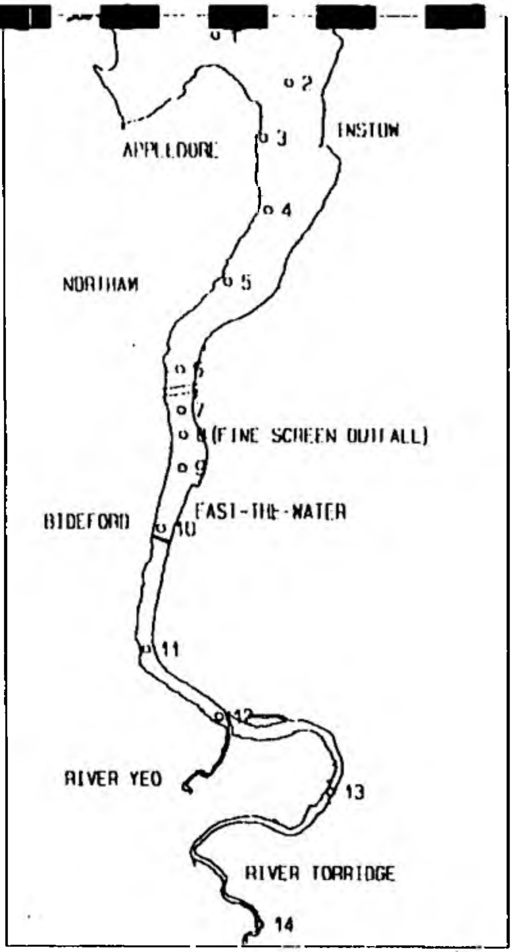


Low Water (pH)

Mid-Flood

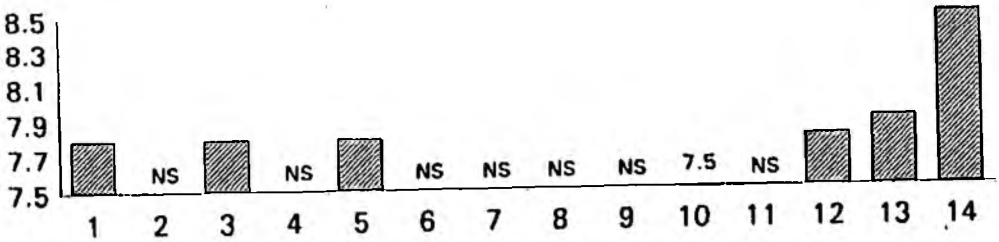
High Water (pH)

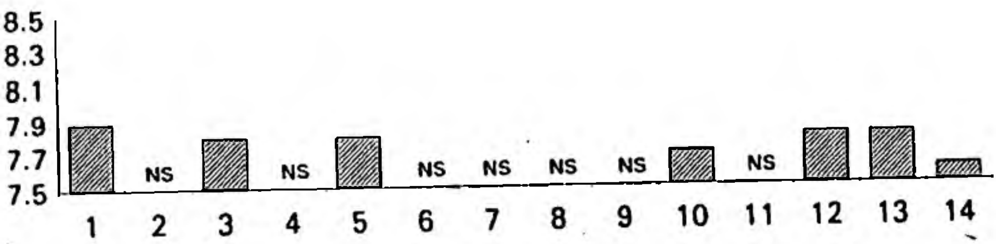
Mid-Ebb

Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Neap Tide Water Quality
(26 to 28-JUL-89)
SURFACE WATER ACIDITY (pH)

NS = Site Not Sampled
7.5 = Value Lower Than Conventional Scale

FIGURE 3.1d
WIMPEY
ENVIRONMENTAL





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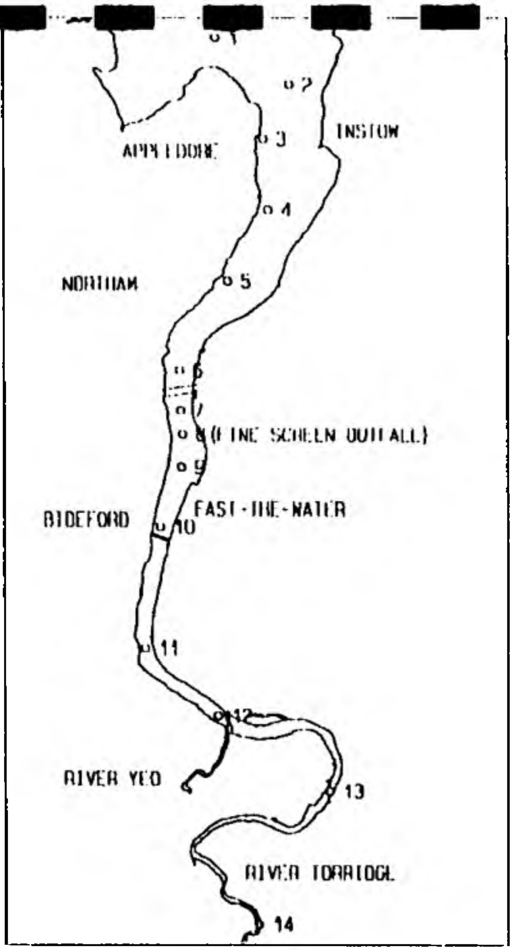


Low Water
(mg/l O)

Mid-Flood

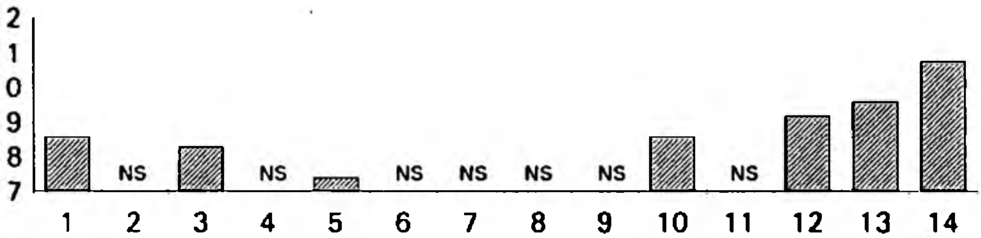
High Water
(mg/l O)

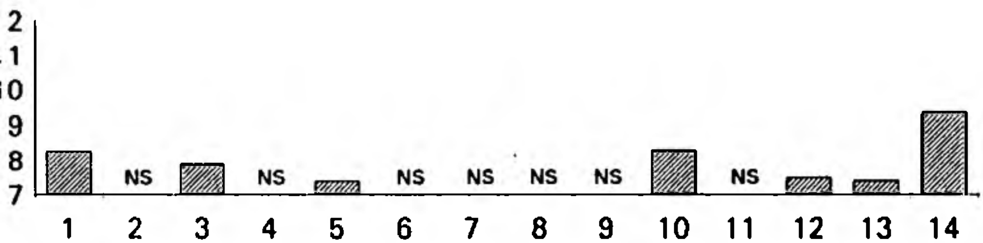
Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Spring Tide Water Quality
(30-JUL to 01-AUG-88)
SURFACE WATER DISSOLVED OXYGEN

NS = Site Not Sampled

Mid-Ebb

FIGURE 3.2a
WIMPEY
ENVIRONMENTAL





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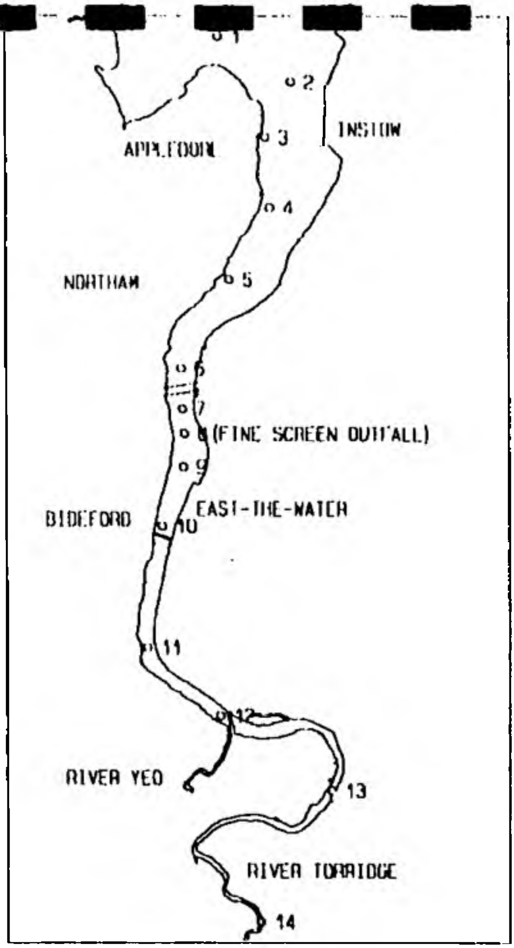


Low Water
(mg/l O)

12
11
10
9
8
7

Mid-Flood

High Water
(mg/l O)

12
11
10
9
8
7

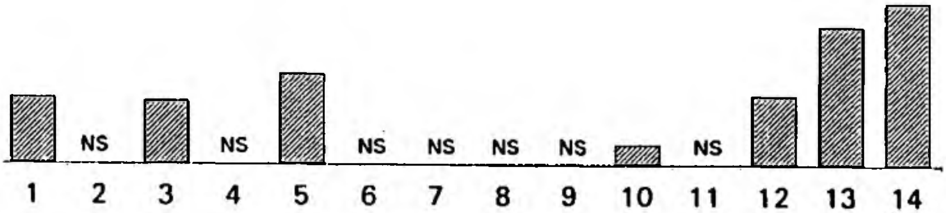
Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Neap Tide Water Quality
(06 to 08-AUG-88)
SURFACE WATER DISSOLVED OXYGEN

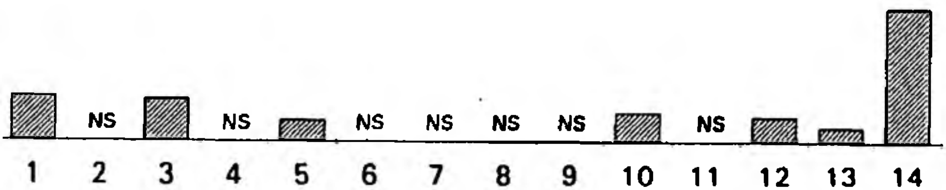
NS = Site Not Sampled

Mid-Ebb

FIGURE 3.2b

WIMPEY
ENVIRONMENTAL





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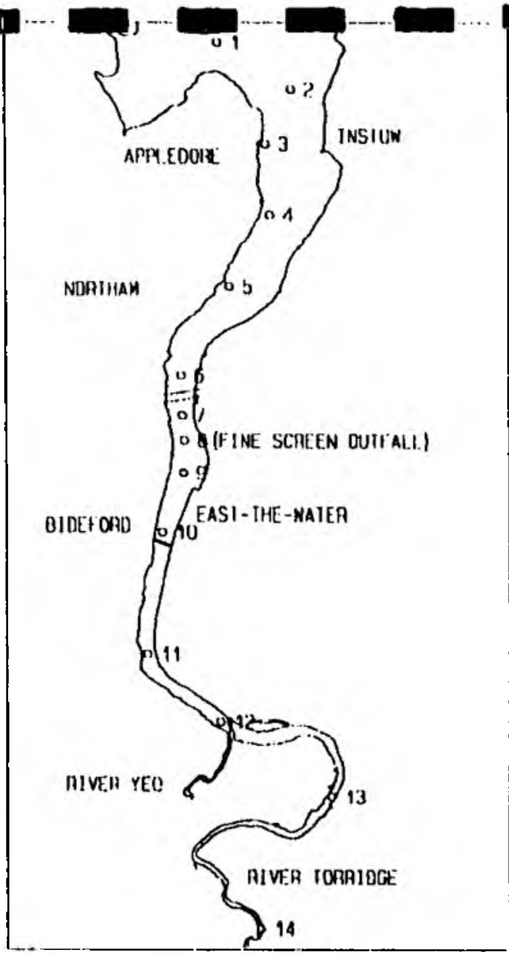


Low Water (mg/l O)

Mid-Flood

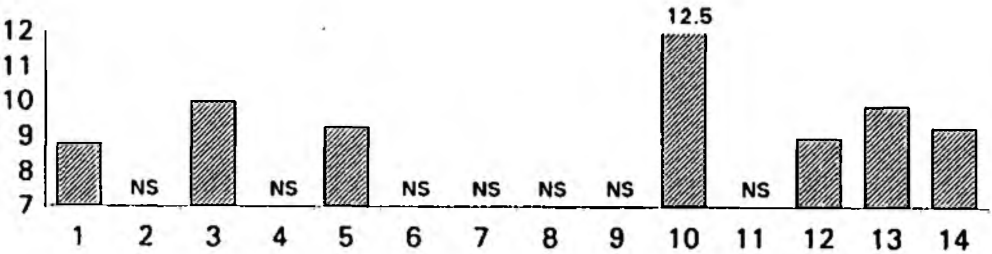
High Water (mg/l O)

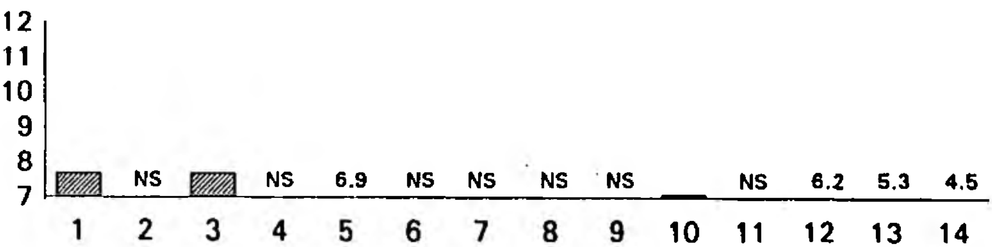
Mid-Ebb

Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Spring Tide Water Quality
(19 to 21-JUL-89)
SURFACE WATER DISSOLVED OXYGEN

NS = Site Not Sampled
12.5 = Value Higher Than Conventional Scale
6.9 = Value Lower Than Conventional Scale

FIGURE 3.2c
WIMPEY
ENVIRONMENTAL





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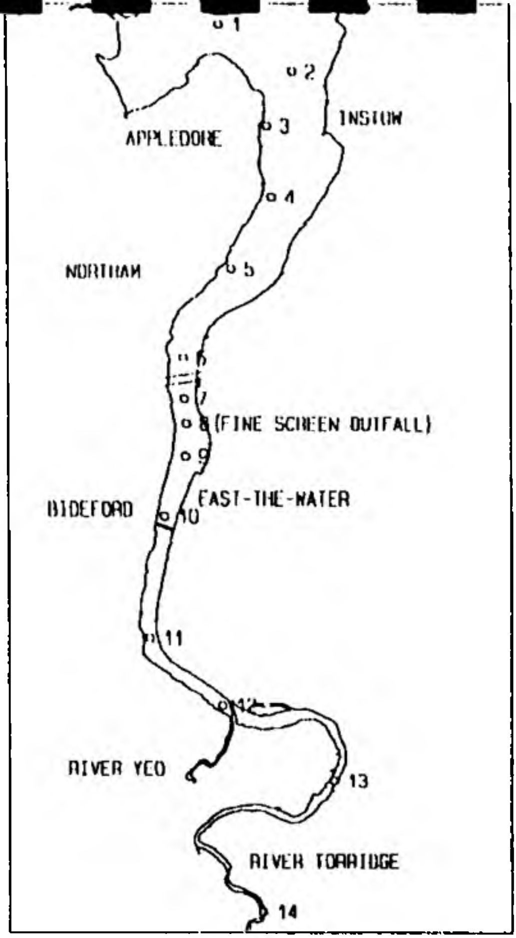


Low Water (mg/l O)

Mid-Flood

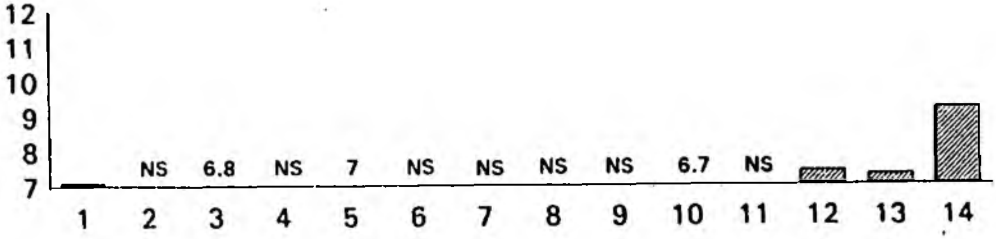
High Water (mg/l O)

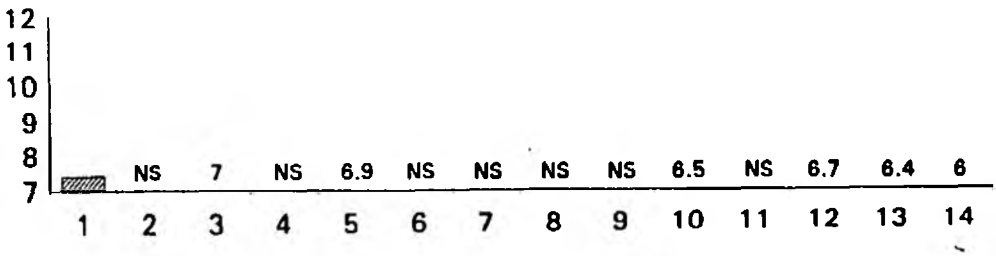
Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Neap Tide Water Quality
(26 to 28-JUL-89)
SURFACE WATER DISSOLVED OXYGEN

NS = Site Not Sampled
6.9 = Value Lower Than Conventional Scale

Mid-Ebb

FIGURE 3.2d
WIMPEY
ENVIRONMENTAL





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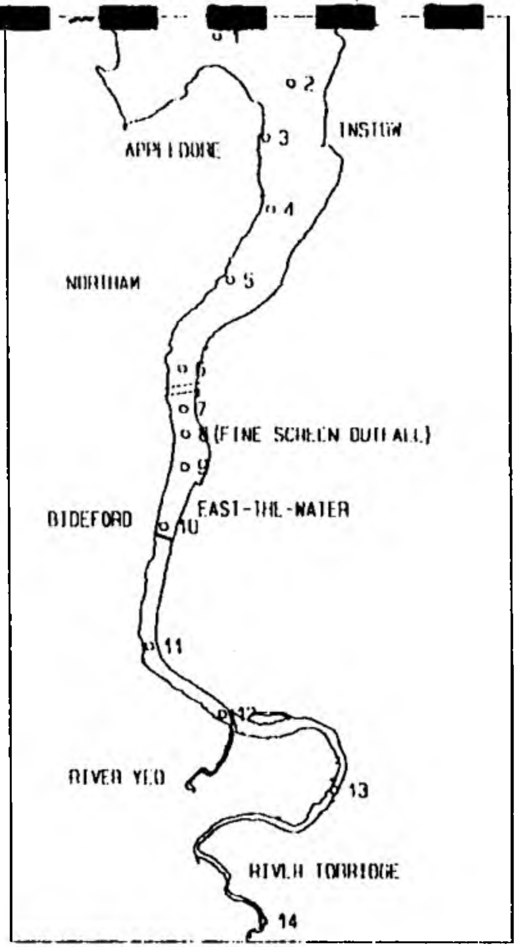


Low Water (mg/l N)

2
1.5
1
0.5
0

Mid-Flood

High Water (mg/l N)

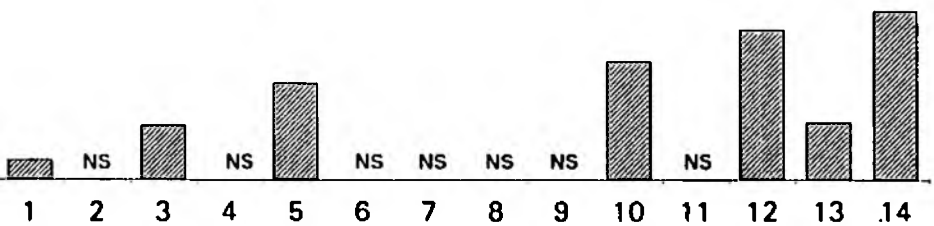
2
1.5
1
0.5
0

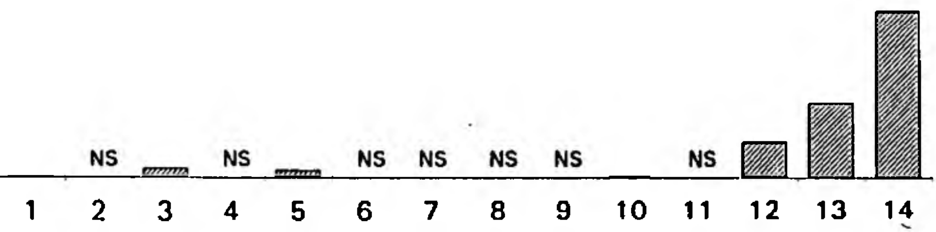
Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Spring Tide Water Quality
(30-JUL to 01- AUG-88)
SURFACE WATER TOTAL OXIDISED NITROGEN

NS = Site Not Sampled

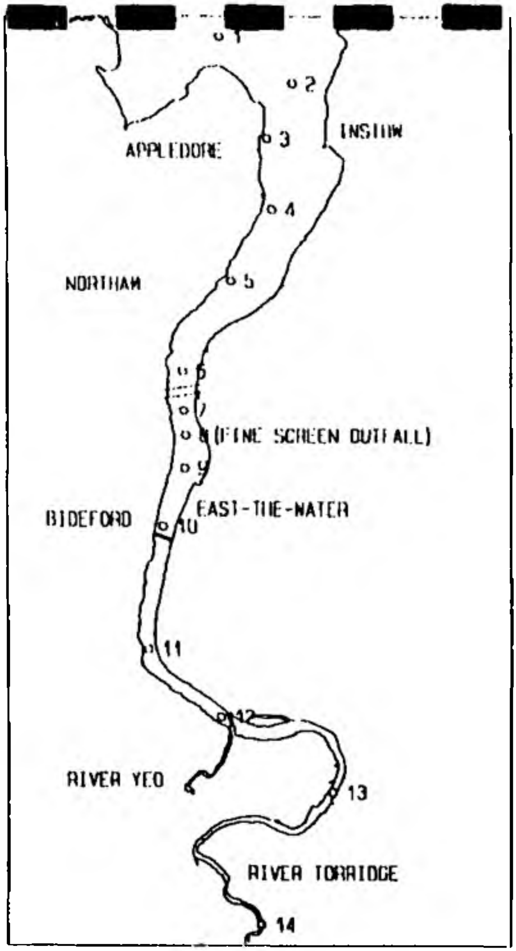
Mid-Ebb

FIGURE 3.3a
WIMPEY
ENVIRONMENTAL





Sample Sites



Low Water
(mg/l N)

Mid-Flood

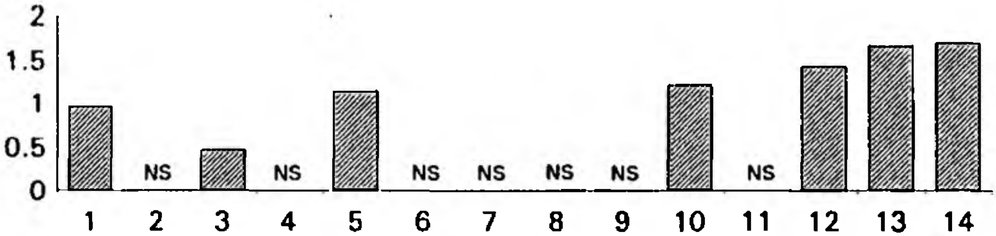
High Water
(mg/l N)

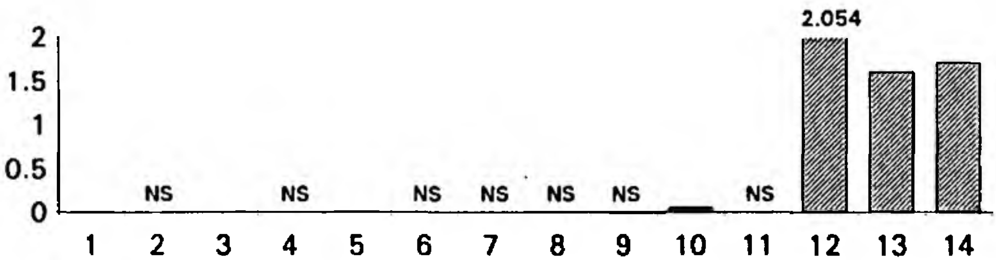
Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Neap Tide Water Quality
(06 to 08-AUG-88)
SURFACE WATER TOTAL OXIDISED NITROGEN

NS = Site Not Sampled
2.054 = Value Higher Than Conventional Scale

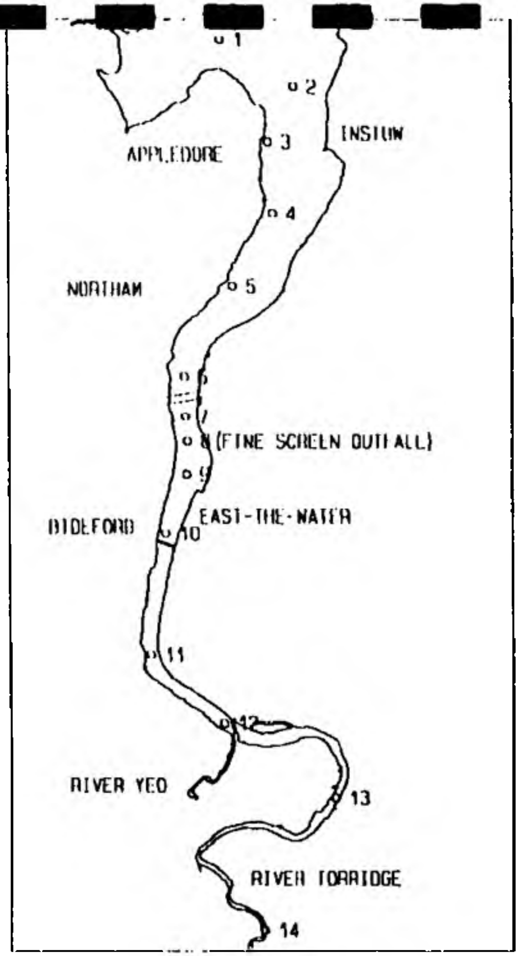
Mid-Ebb

FIGURE 3.3b
WIMPEY
ENVIRONMENTAL





Sample Sites



Low Water (mg/l N)

2
1.5
1
0.5
0

Mid-Flood

High Water (mg/l N)

2
1.5
1
0.5
0

Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Spring Tide Water Quality
(19 to 21-JUL-89)
SURFACE WATER TOTAL OXIDISED NITROGEN

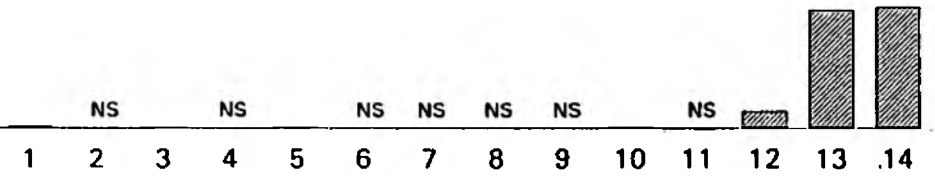
NS = Site Not Sampled

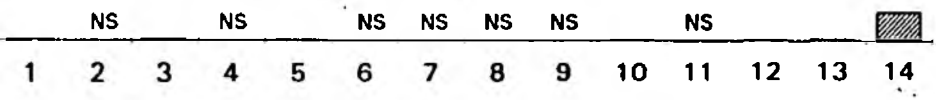
Mid-Ebb

FIGURE 3.3c

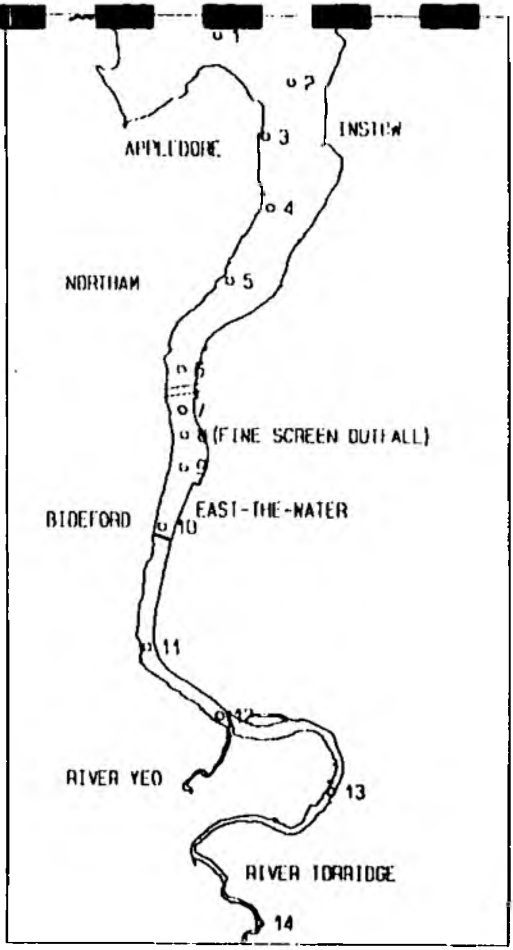
WIMPEY

ENVIRONMENTAL





Sample Sites



Low Water (mg/l N)

2
1.5
1
0.5
0

Mid-Flood

High Water (mg/l N)

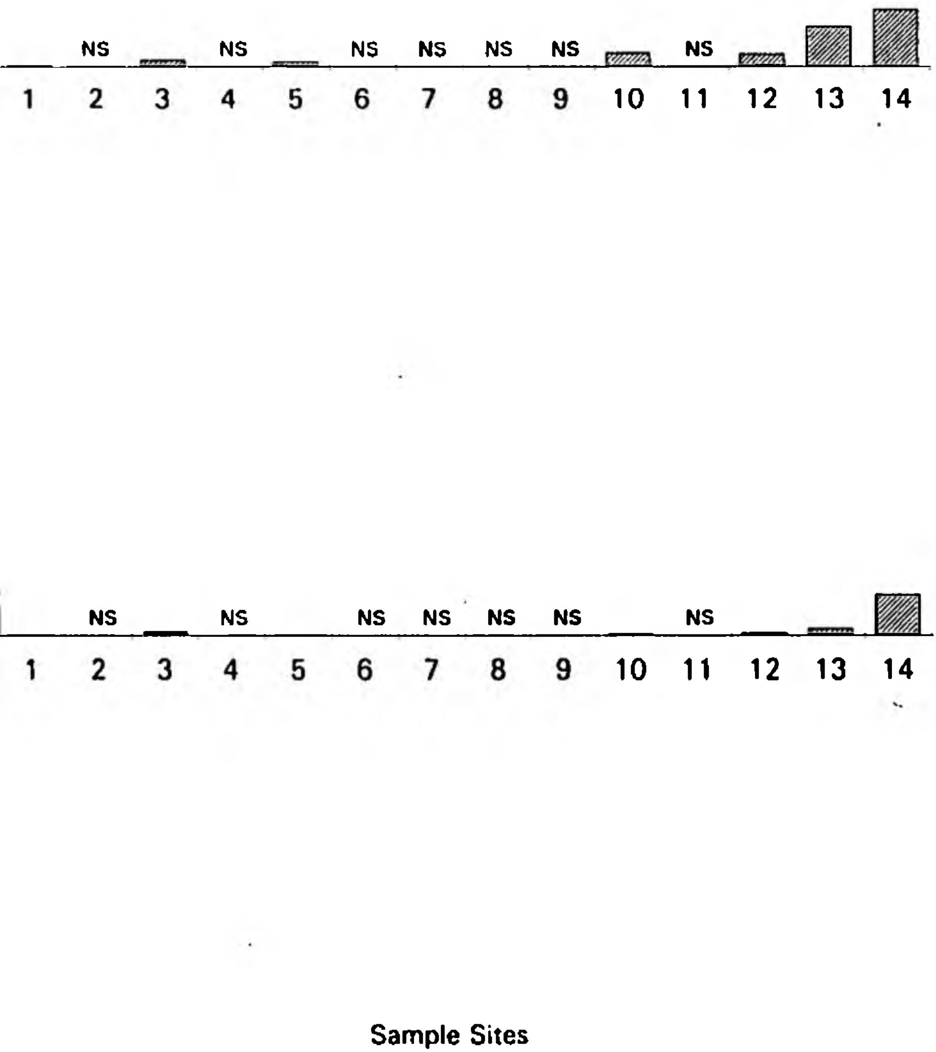
2
1.5
1
0.5
0

Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Spring Tide Water Quality
(26 to 28-JUL-89)
SURFACE WATER TOTAL OXIDISED NITROGEN

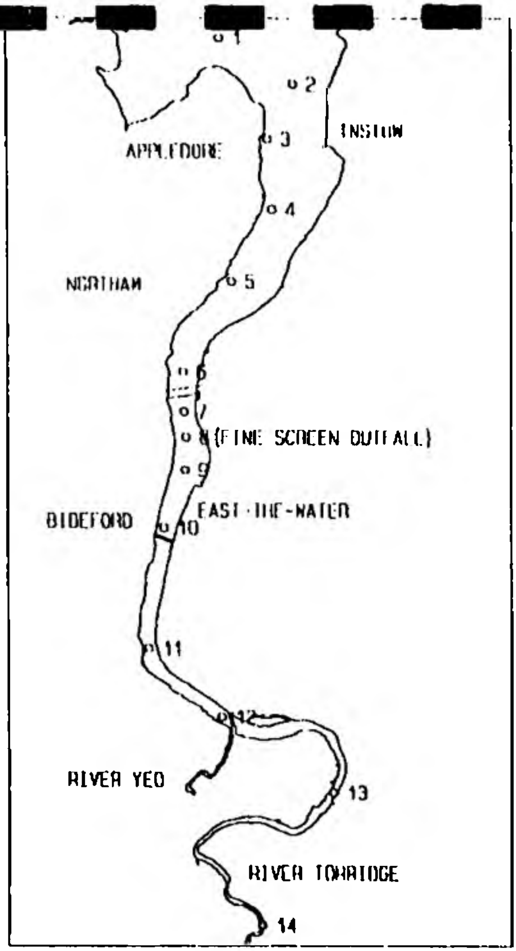
NS = Site Not Sampled

Mid-Ebb

FIGURE 3.3d
WIMPEY
ENVIRONMENTAL



NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Sample Sites



Low Water (mg/l N)

1
0.8
0.6
0.4
0.2
0

Mid-Flood

High Water (mg/l N)

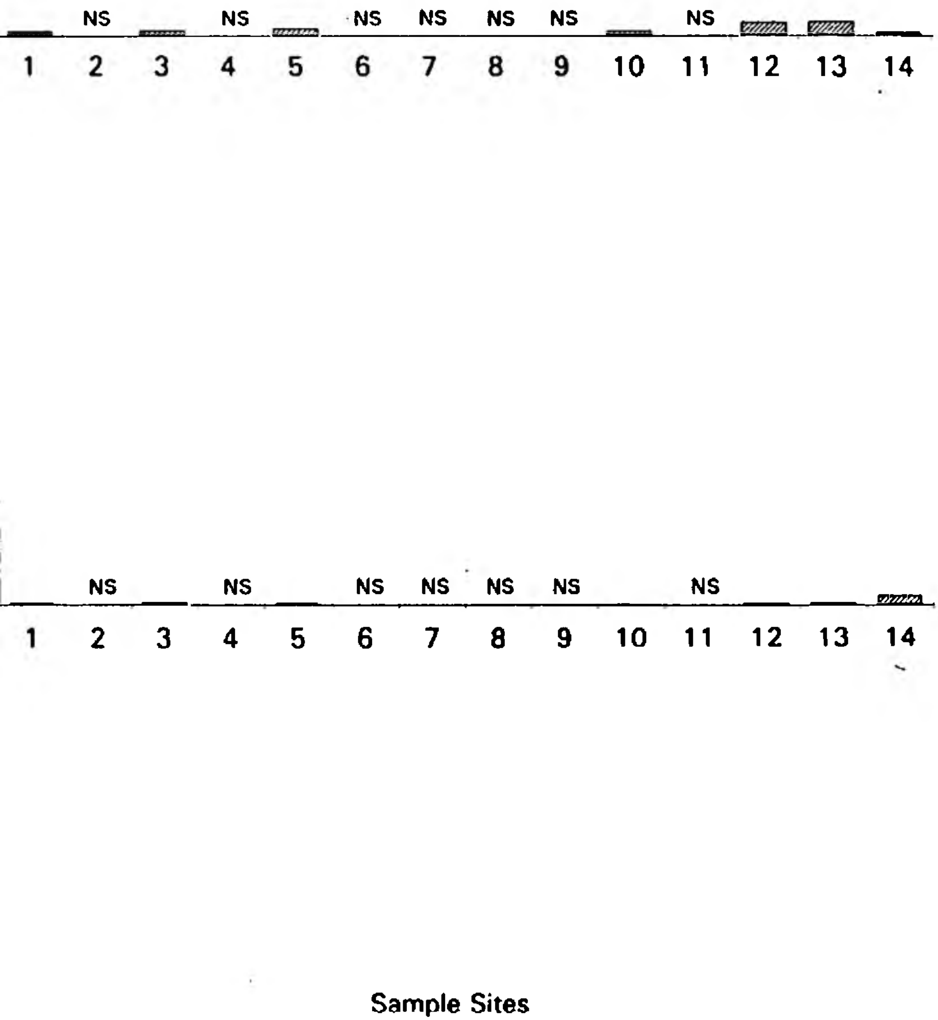
1
0.8
0.6
0.4
0.2
0

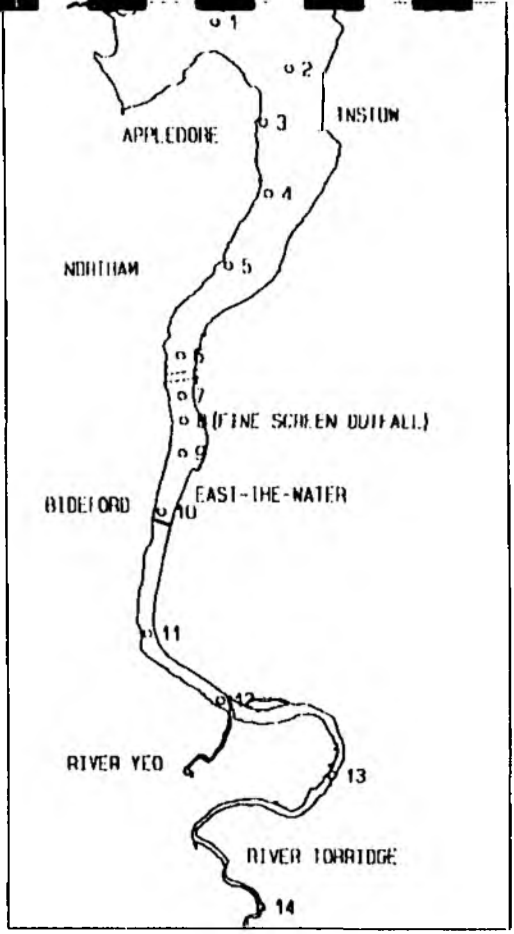
Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Spring Tide Water Quality
(30-JUL to 01-AUG-88)
SURFACE WATER DISSOLVED AMMONIA

NS = Site Not Sampled

Mid-Ebb

FIGURE 3.4a
WIMPEY
ENVIRONMENTAL


NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Sample Sites



Low Water (mg/l N)

1
0.8
0.6
0.4
0.2
0

Mid-Flood

High Water (mg/l N)

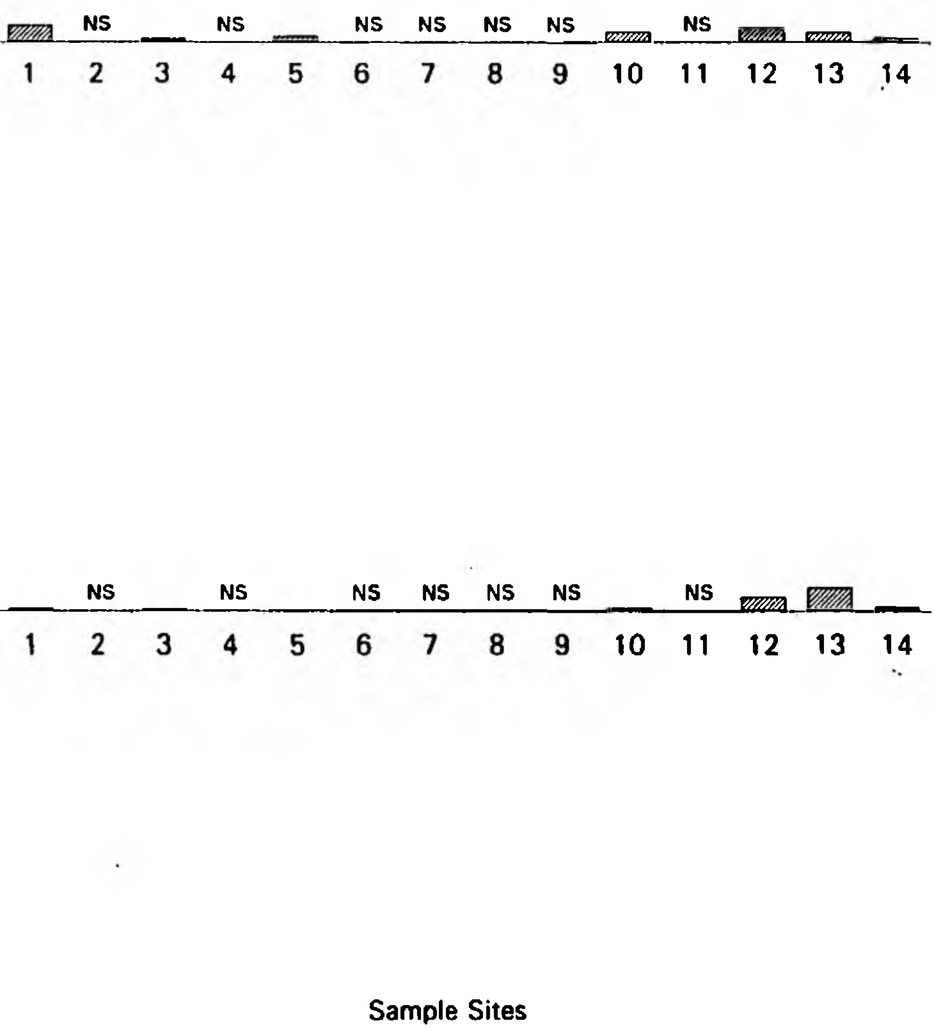
1
0.8
0.6
0.4
0.2
0

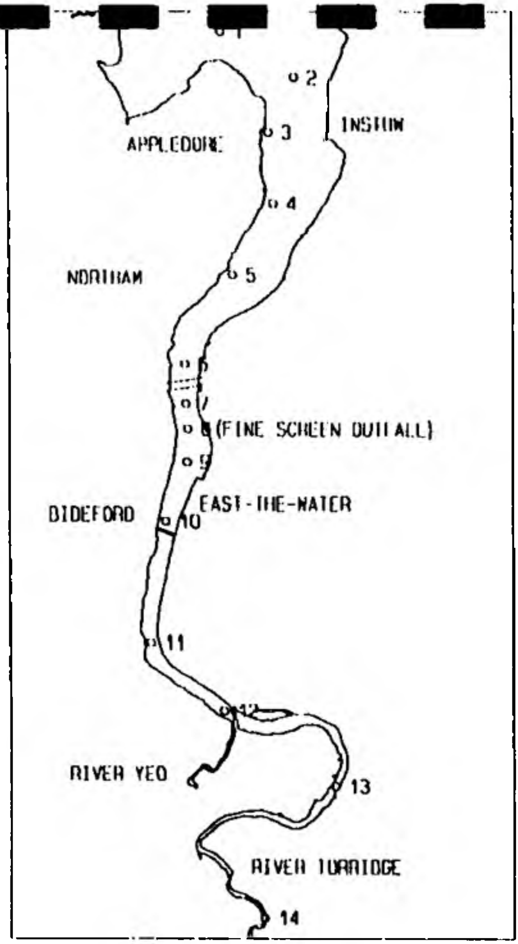
Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Neap Tide Water Quality
(06 to 08-AUG-88)
SURFACE WATER DISSOLVED AMMONIA

NS = Site Not Sampled

Mid-Ebb

FIGURE 3.4b
WIMPEY
ENVIRONMENTAL


NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Sample Sites



Low Water (mg/l N)

1
0.8
0.6
0.4
0.2
0

Mid-Flood

High Water (mg/l N)

1
0.8
0.6
0.4
0.2
0

Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Spring Tide Water Quality
(19 to 21-JUL-89)

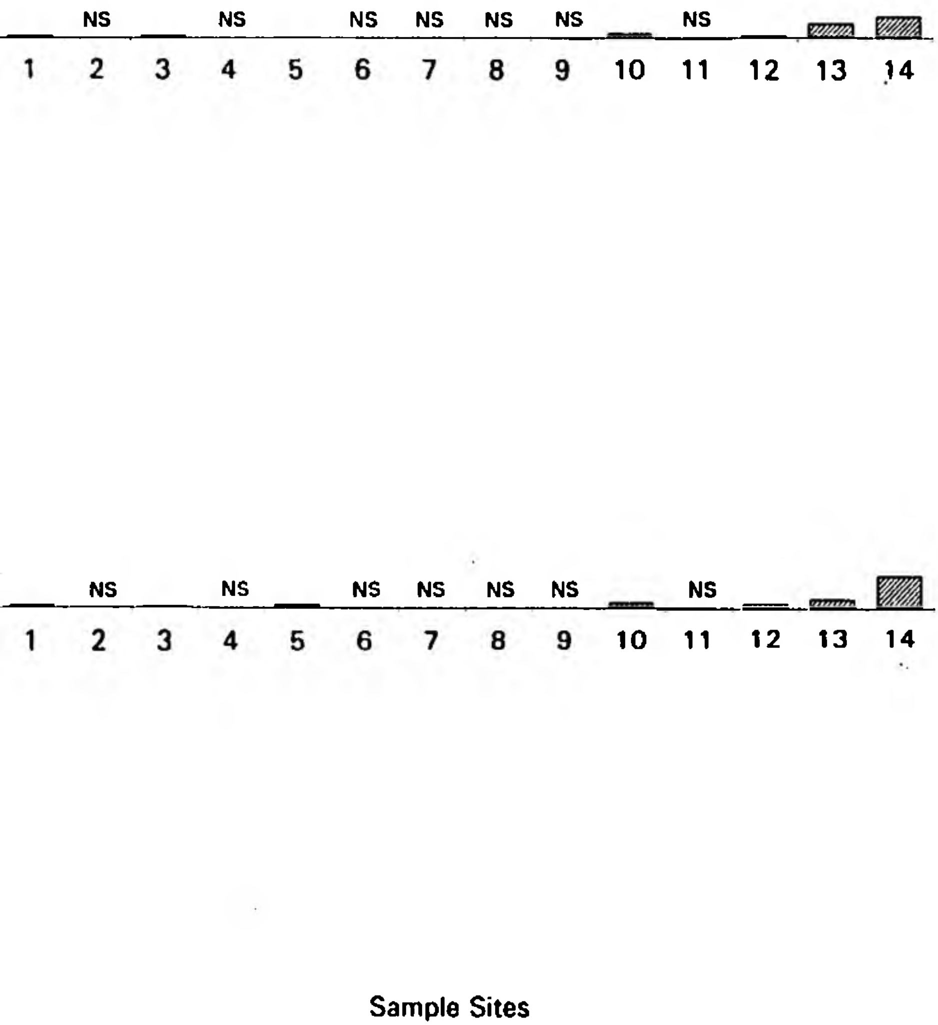
SURFACE WATER DISSOLVED AMMONIA

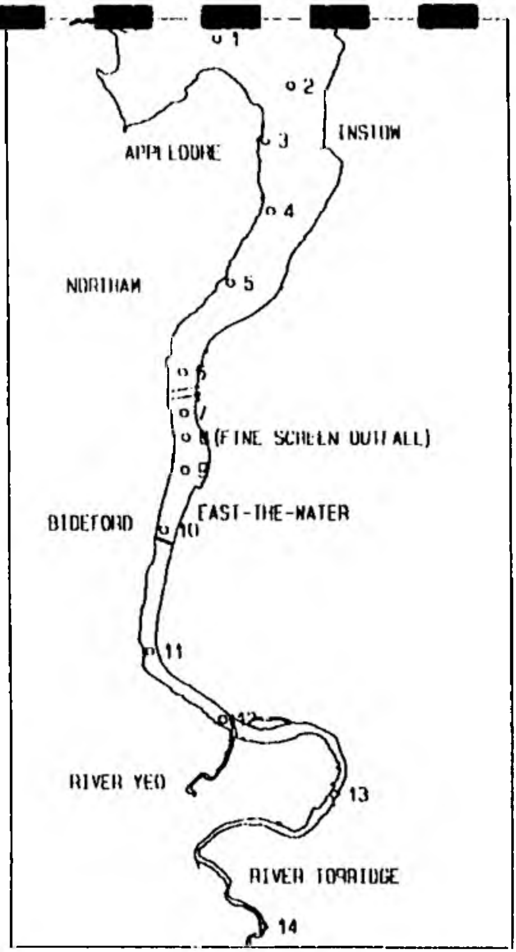
NS = Site Not Sampled

Mid-Ebb

FIGURE 3.4c

WIMPEY
ENVIRONMENTAL


NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Sample Sites



Low Water
(mg/l N)

Mid-Flood

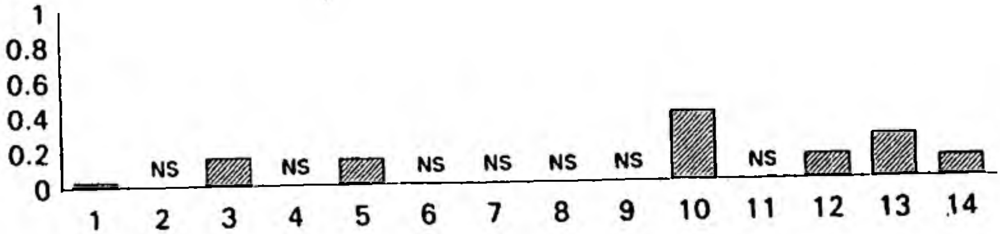
High Water
(mg/l N)

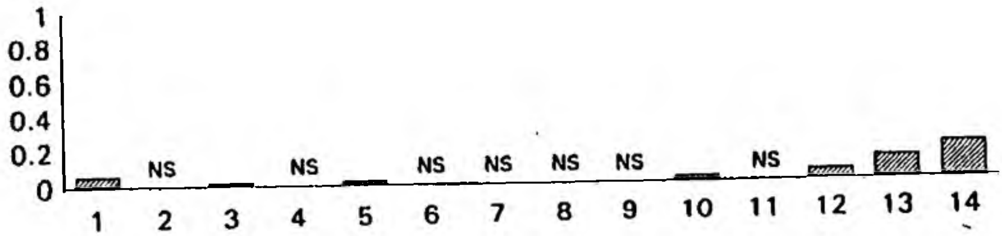
Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Neap Tide Water Quality
(26 to 28-JUL-89)
SURFACE WATER DISSOLVED AMMONIA

NS = Site Not Sampled

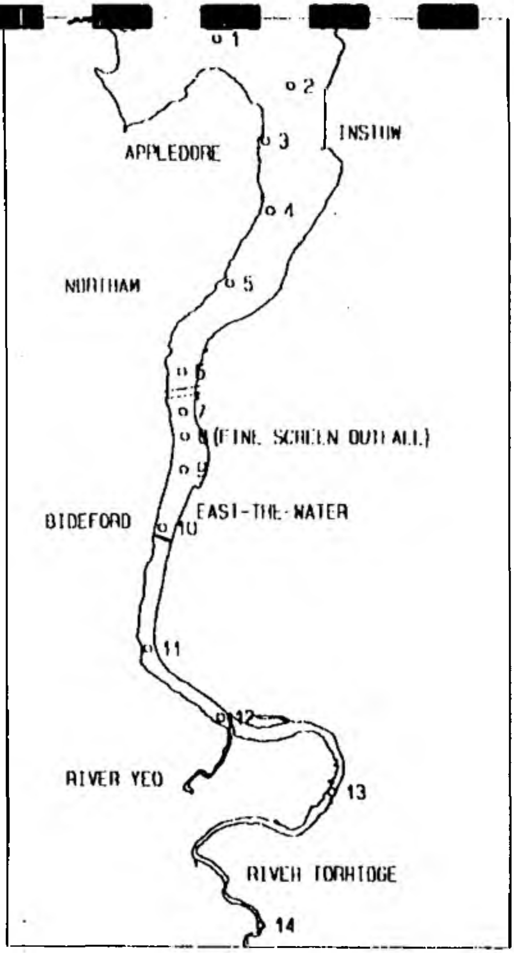
Mid-Ebb

FIGURE 3.4d
WIMPEY
ENVIRONMENTAL





Sample Sites



Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Spring Tide Water Quality
(30-JUL to 01-AUG-88)
SURFACE WATER FAECAL COLIFORM COUNTS

NS = Site Not Sampled
0 = No Faecal Coliforms Detected

Low Water
(No./100ml)

1000000
100000
10000
1000
100
10
1

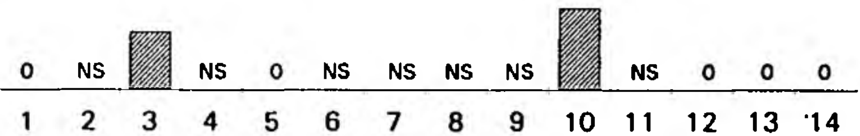
Mid-Flood

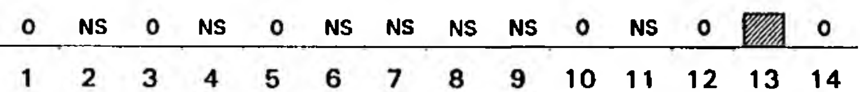
High Water
(No./100ml)

1000000
100000
10000
1000
100
10
1

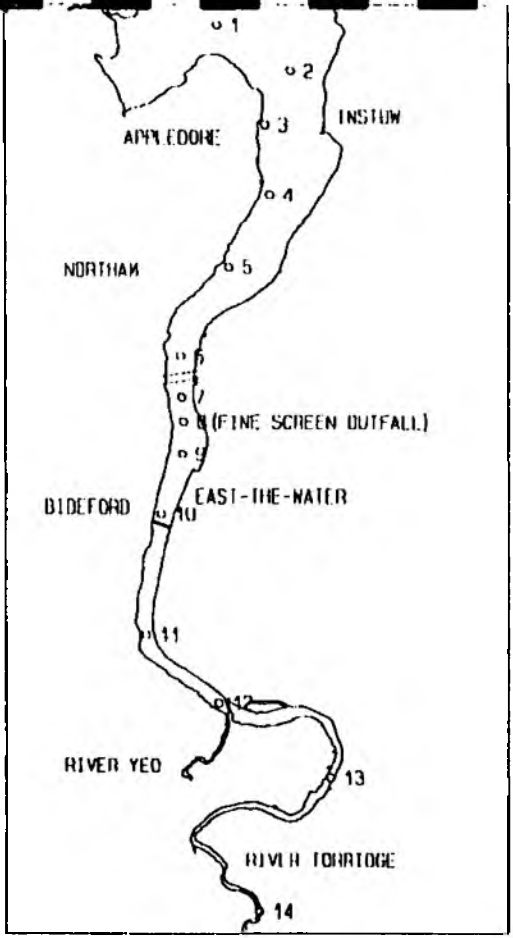
Mid-Ebb

FIGURE 3.5a
WIMPEY
ENVIRONMENTAL





Sample Sites



Low Water
(No./100ml)

Mid-Flood

High Water
(No./100ml)

Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Neap Tide Water Quality
(06 to 08-AUG-88)

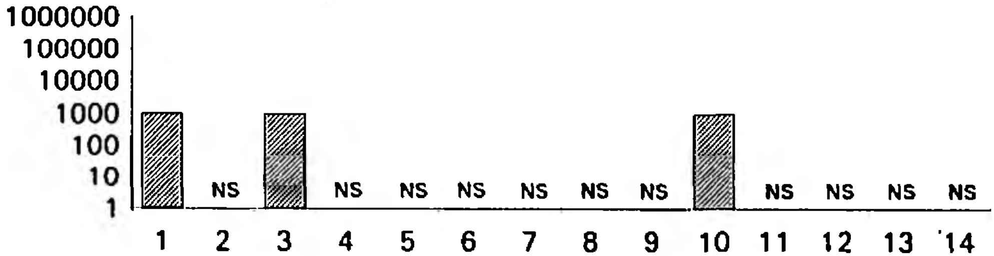
SURFACE WATER FAECAL COLIFORM COUNTS

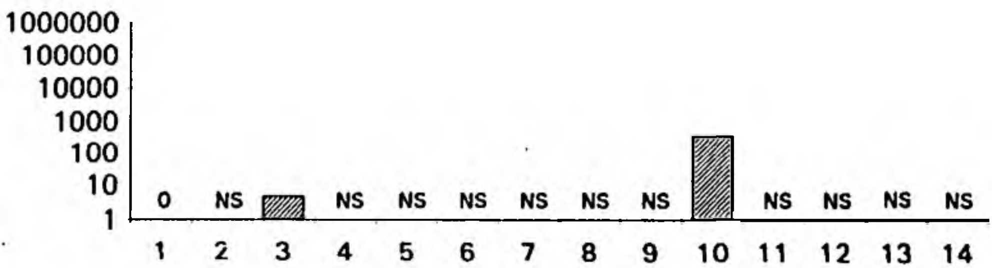
NS = Site Not Sampled
0 = No Faecal Coliforms Detected

Mid-Ebb

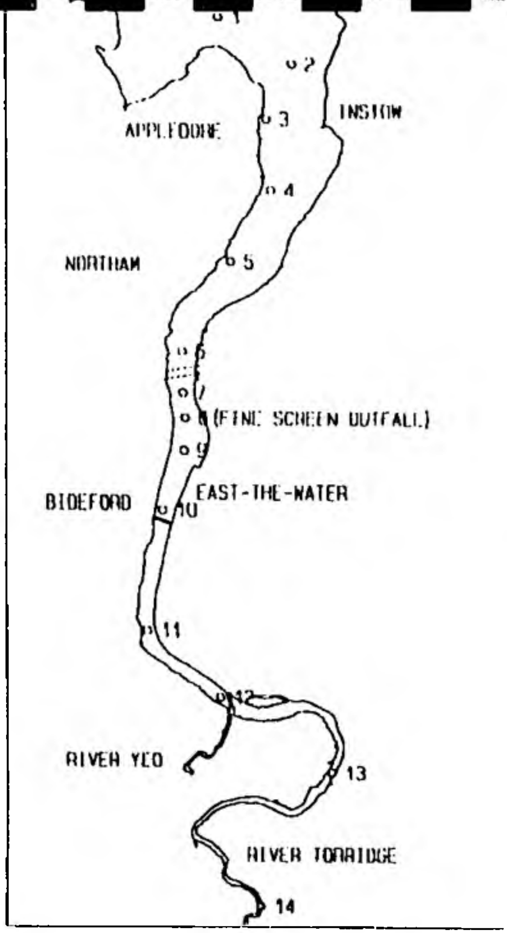
FIGURE 3.5b

WIMPEY
ENVIRONMENTAL





Sample Sites



Low Water
(No./100ml)

Mid-Flood

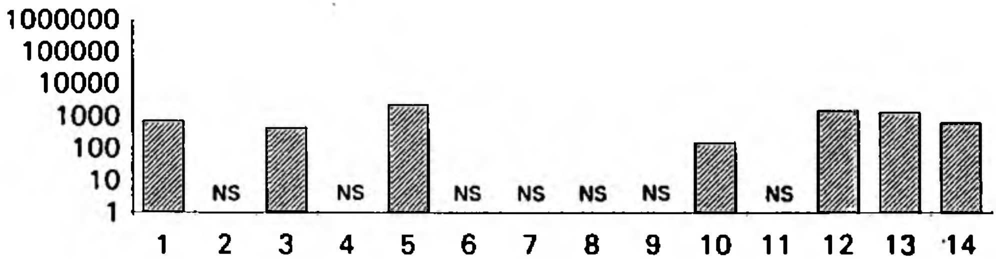
High Water
(No./100ml)

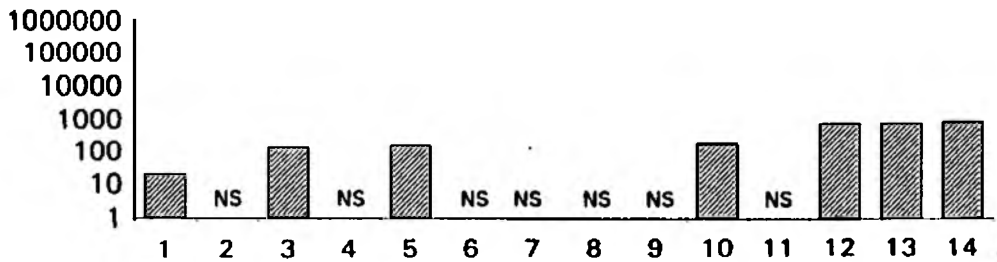
Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Spring Tide Water Quality
(19 to 21-JUL-89)
SURFACE WATER FAECAL COLFORM COUNTS

NS = Site Not Sampled

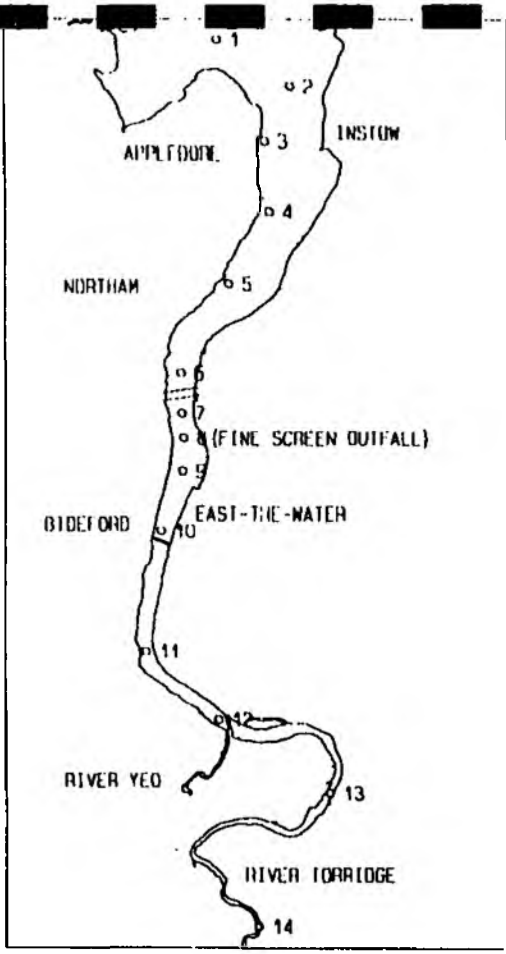
Mid-Ebb

FIGURE 3.5c
WIMPEY
ENVIRONMENTAL





Sample Sites



Low Water
(No./100ml)

Mid-Flood

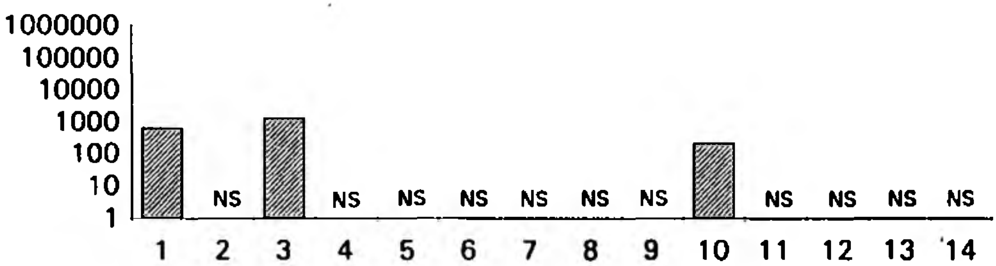
High Water
(No./100ml)

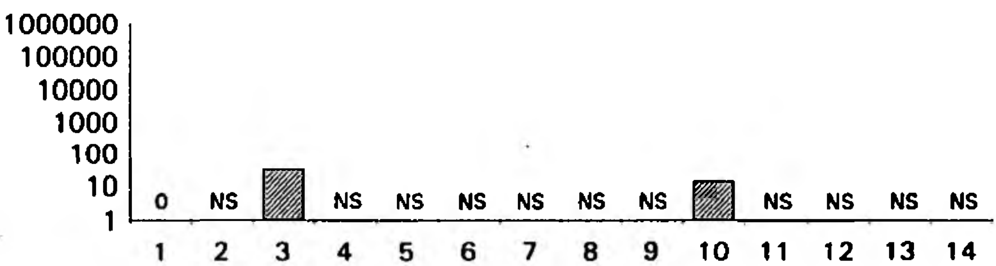
Mid-Ebb

Bideford Fine Screen Outfall
Post Scheme Appraisal
Pre-scheme Neap Tide Water Quality
(26 to 28-JUL-89)
SURFACE WATER FAECAL COLIFORM COUNTS

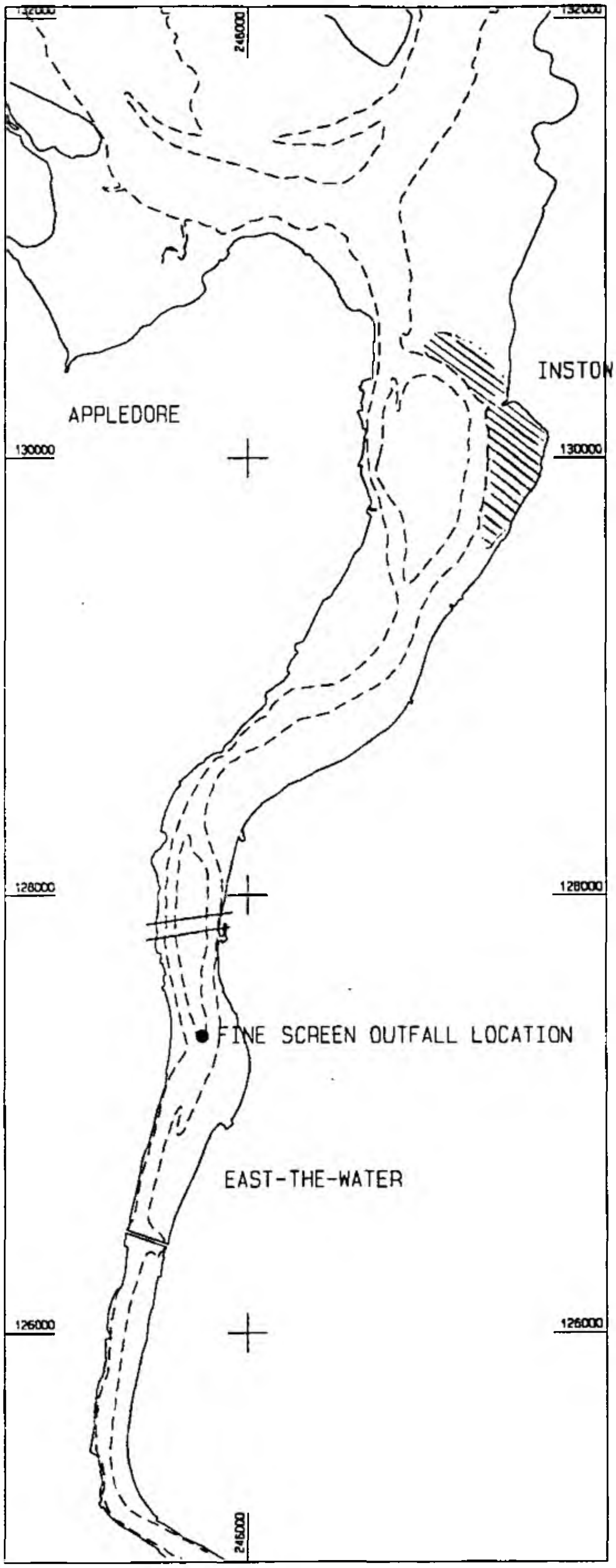
NS = Site Not Sampled
0 = No faecal Coliforms Detected

FIGURE 3.5d
WIMPEY
ENVIRONMENTAL





Sample Sites



N

METRES

0 500 1500

SCALE 1: 30000

BIDEFORD FINE SCREEN OUTFALL POST SCHEME APPRAISAL

SPRING TIDE QUALITATIVE TRACER EXERCISE
FROM BIDEFORD FINE SCREEN OUTFALL
14-AUG-91

HW: 09.30 BST
LW: 15.52 BST APPLEDORE
HW: 21.48 BST

TIDAL RANGE = 7.2m

EBB RELEASE COMMENCED
AT HW+2.50
FLOOD RELEASE COMMENCED
AT HW-2.75

NOTES

FOR THE EBB RELEASE ONLY CITRUS FRUIT AND A 0.5m DROGUE WERE RELEASED.

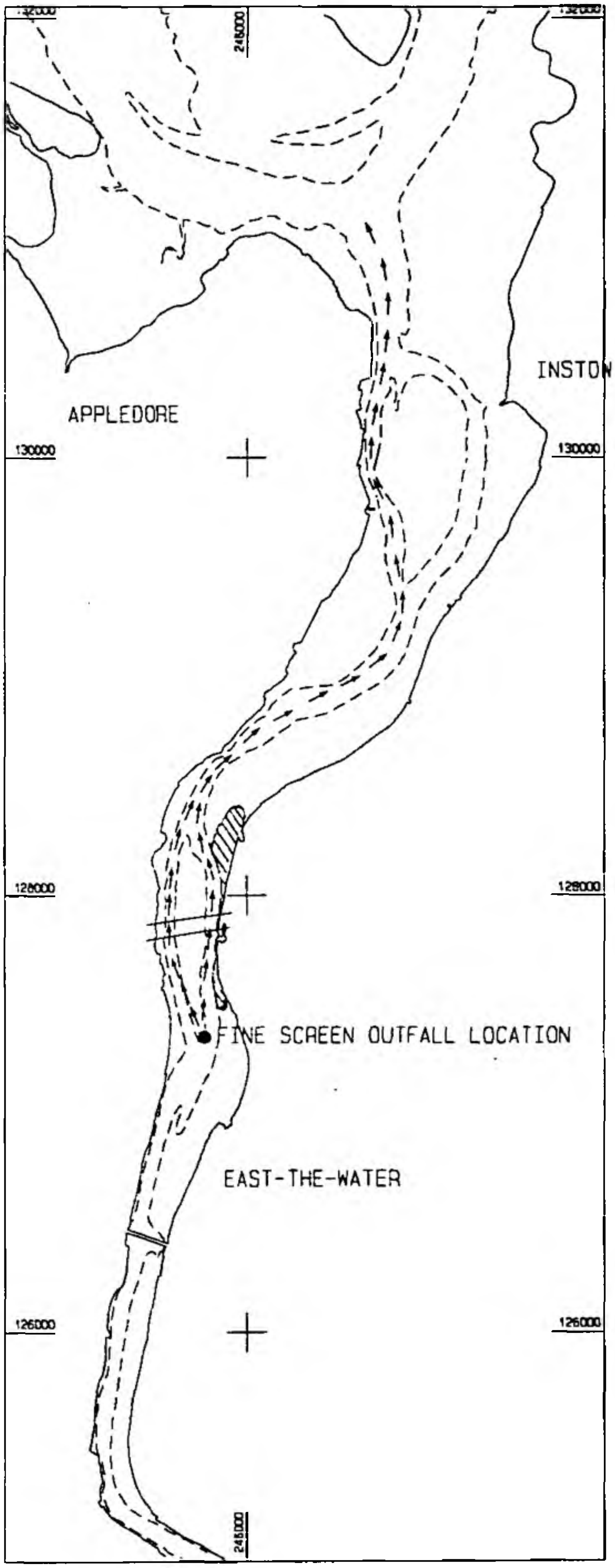
ALL THE FRUIT FOLLOWED THE MAIN CHANNEL AS THE TIDE DROPPED.

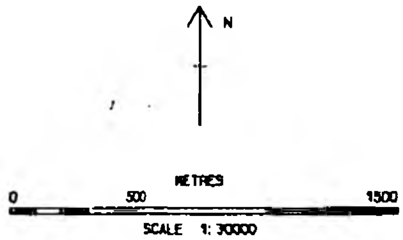
THE SHADED AREA HIGHLIGHTS THE AREA OF IMPACT OF THE FRUIT ON THE SHORE.

FOR A SIMILAR FLOOD RELEASE ALL THE FRUIT WERE LOST UP-ESTUARY.

REFERENCE NO:	RPOZ 5169
FIGURE NO.	4.1
DATE PLOTTED:	2-JUL-92

WIMPEY ENVIRONMENTAL





BIDEFORD FINE SCREEN OUTFALL POST SCHEME APPRAISAL

NEAP TIDE QUALITATIVE TRACER EXERCISE
FROM BIDEFORD FINE SCREEN OUTFALL
19-AUG-91

LW: 07.01 BST
HW: 13.45 BST APPLEDORE
LW: 19.00 BST

TIDAL RANGE = 3m

EBB RELEASE COMMENCED
AT HW+1.75

NOTES

ONLY THE EBB TIDE WAS STUDIED, WITH THE RELEASE OF CITRUS FRUIT, FLUORESCEIN DYE AND A 0.5m DROGUE.

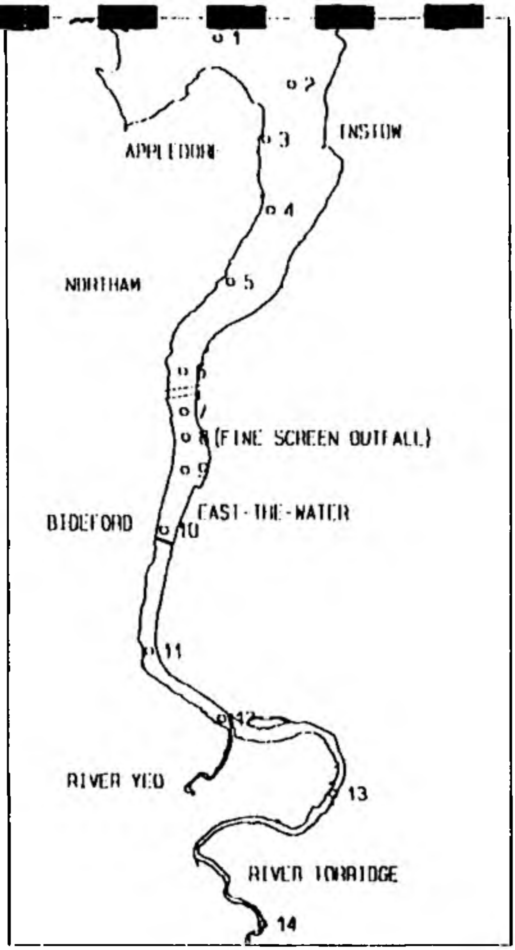
ARROWS (—→) SHOW THE MOVEMENT OF THE FLUORESCEIN DYE.

THE SHADED AREA HIGHLIGHTS THE AREA OF IMPACT OF FRUIT ON THE SHORE.

THERE WAS NO FLOOD TIDE RELEASE.

REFERENCE NO:	RPOZ 5169
FIGURE NO:	4.2
DATE PLOTTED:	2-JUL-92

WIMPEY
ENVIRONMENTAL



Bideford Fine Screen Outfall
Post Scheme Appraisal
Neap Tide Water Quality (07-JUN-91)

SURFACE WATER ACIDITY (pH)

NS = Site Not Sampled

FIGURE 4.3a
WIMPEY
ENVIRONMENTAL

Low Water (pH)

8.50
8.30
8.10
7.90
7.70
7.50

Mid-Flood (pH)

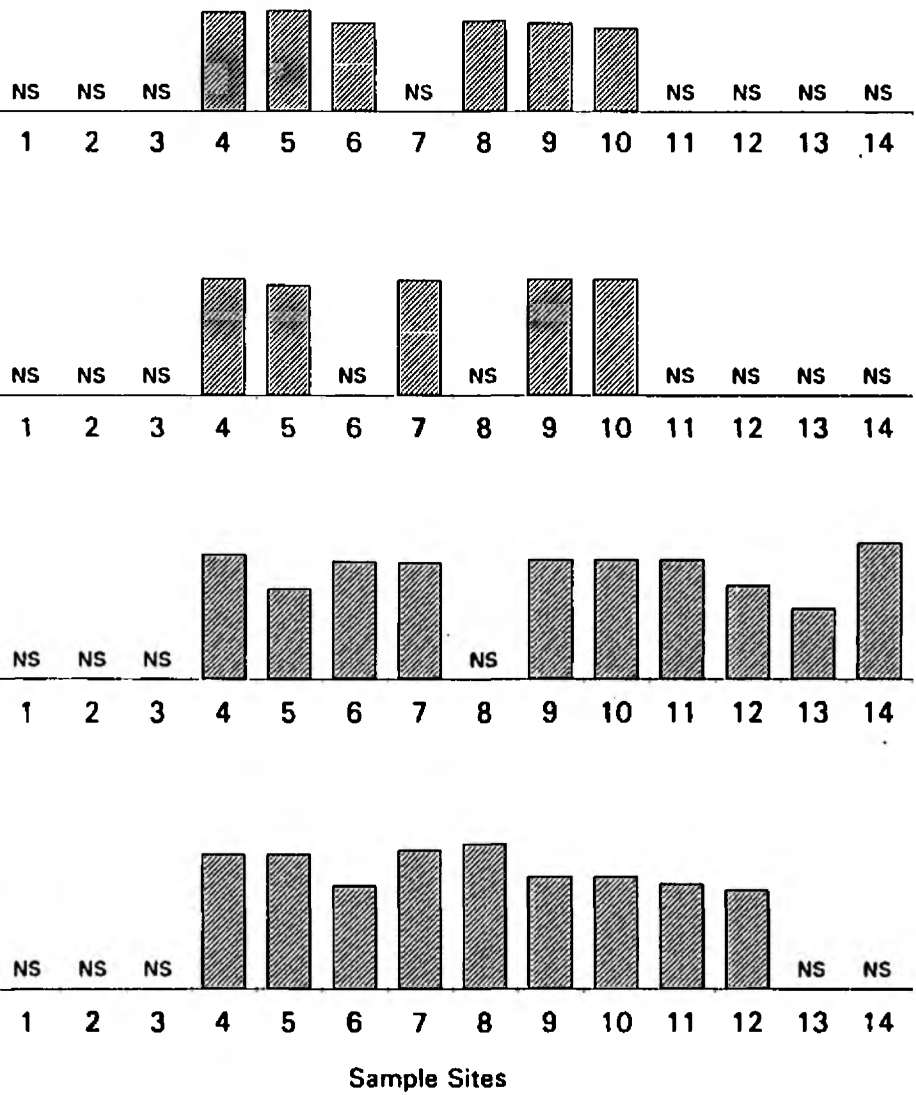
8.50
8.30
8.10
7.90
7.70
7.50

High Water (pH)

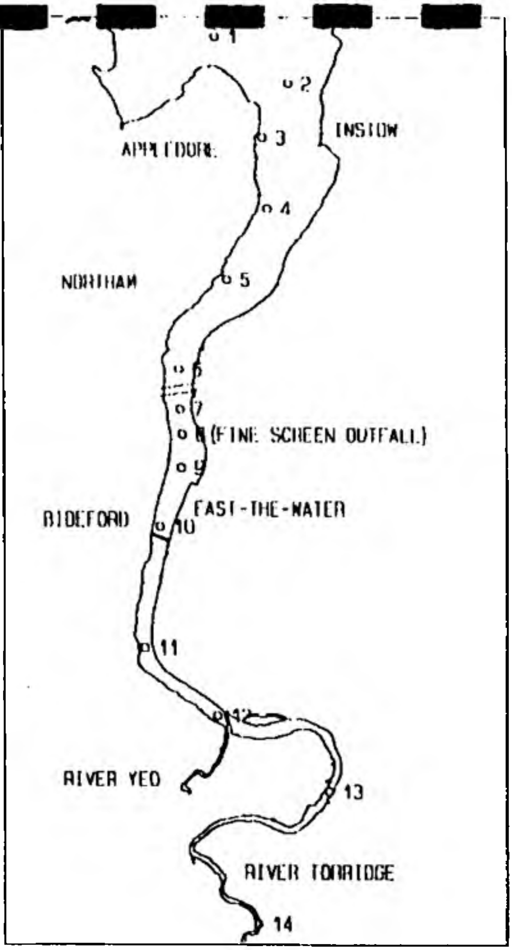
8.50
8.30
8.10
7.90
7.70
7.50

Mid-Ebb (pH)

8.50
8.30
8.10
7.90
7.70
7.50



NS NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Sample Sites

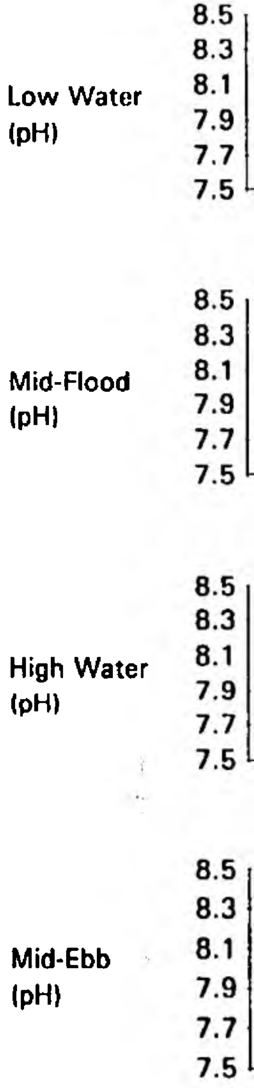


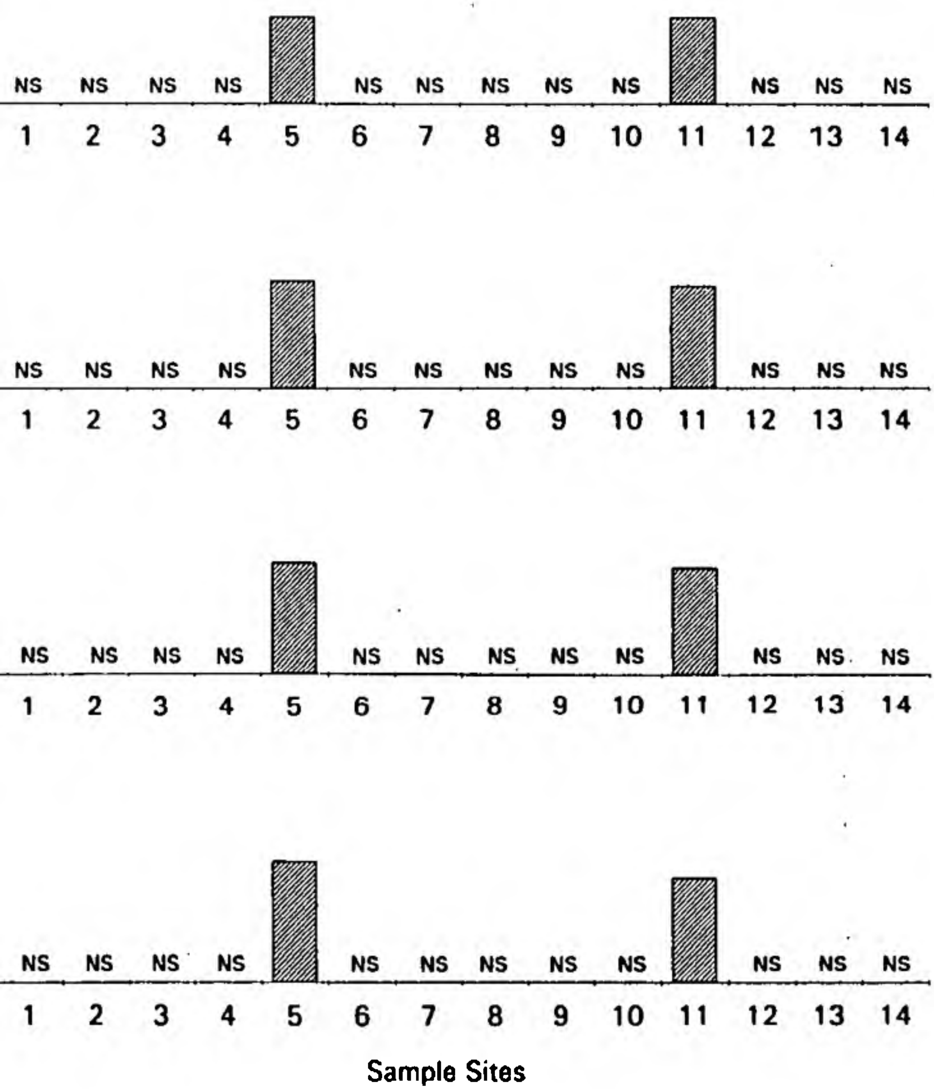
Bideford Fine Screen Outfall
Post Scheme Appraisal
Spring Tide Water Quality (14-AUG-91)

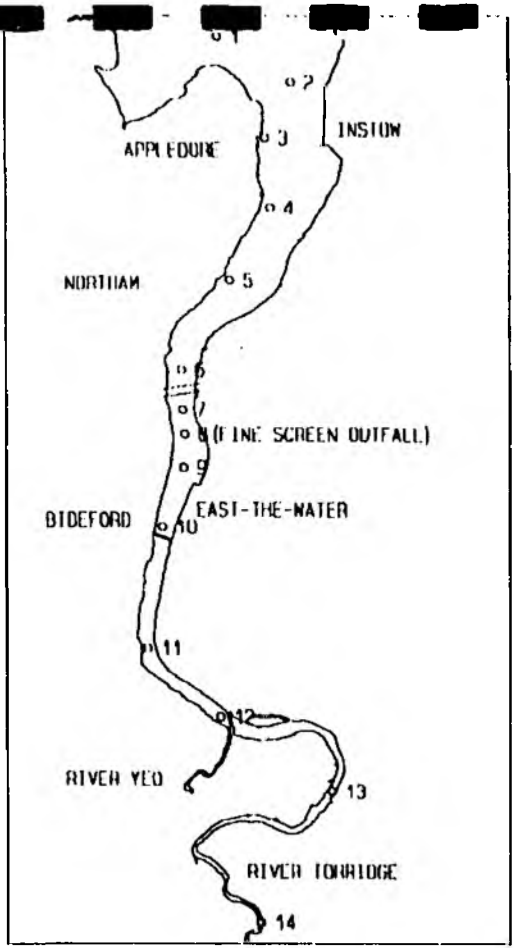
SURFACE WATER ACIDITY (pH)

NS = Site Not Sampled

FIGURE 4.3b
WIMPEY
ENVIRONMENTAL




NS NS NS NS NS NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Sample Sites



Low Water

Mid-Flood

High Water

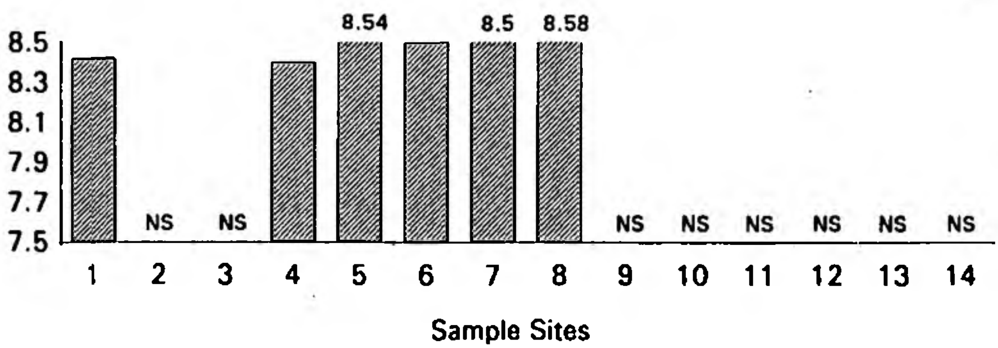
Bideford Fine Screen Outfall
Post Scheme Appraisal
Neap Tide Water Quality (19-AUG-91)

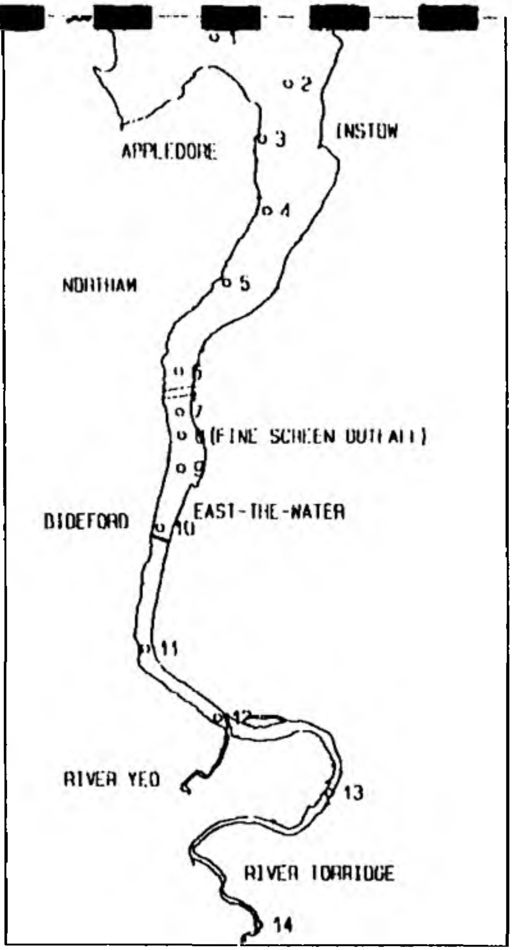
SURFACE WATER ACIDITY (pH)

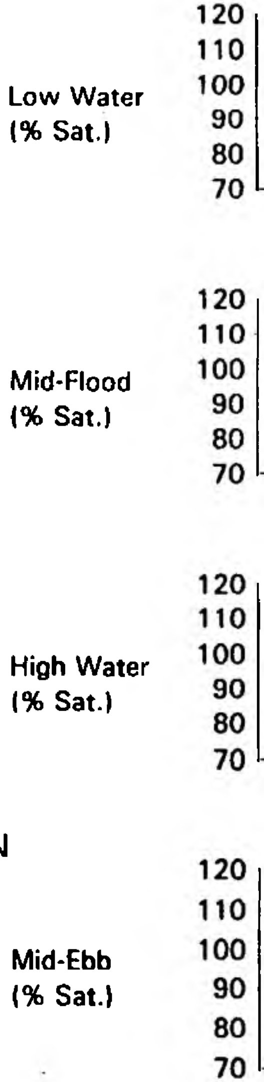
NS = Site Not Sampled
8.5 = Value Higher Than Conventional Scale

Mid-Ebb
(pH)

FIGURE 4.3c
WIMPEY
ENVIRONMENTAL


8.54
8.5
8.58
8.5
8.3
8.1
7.9
7.7
7.5
NS
NS
NS
NS
NS
NS
NS
NS
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Sample Sites



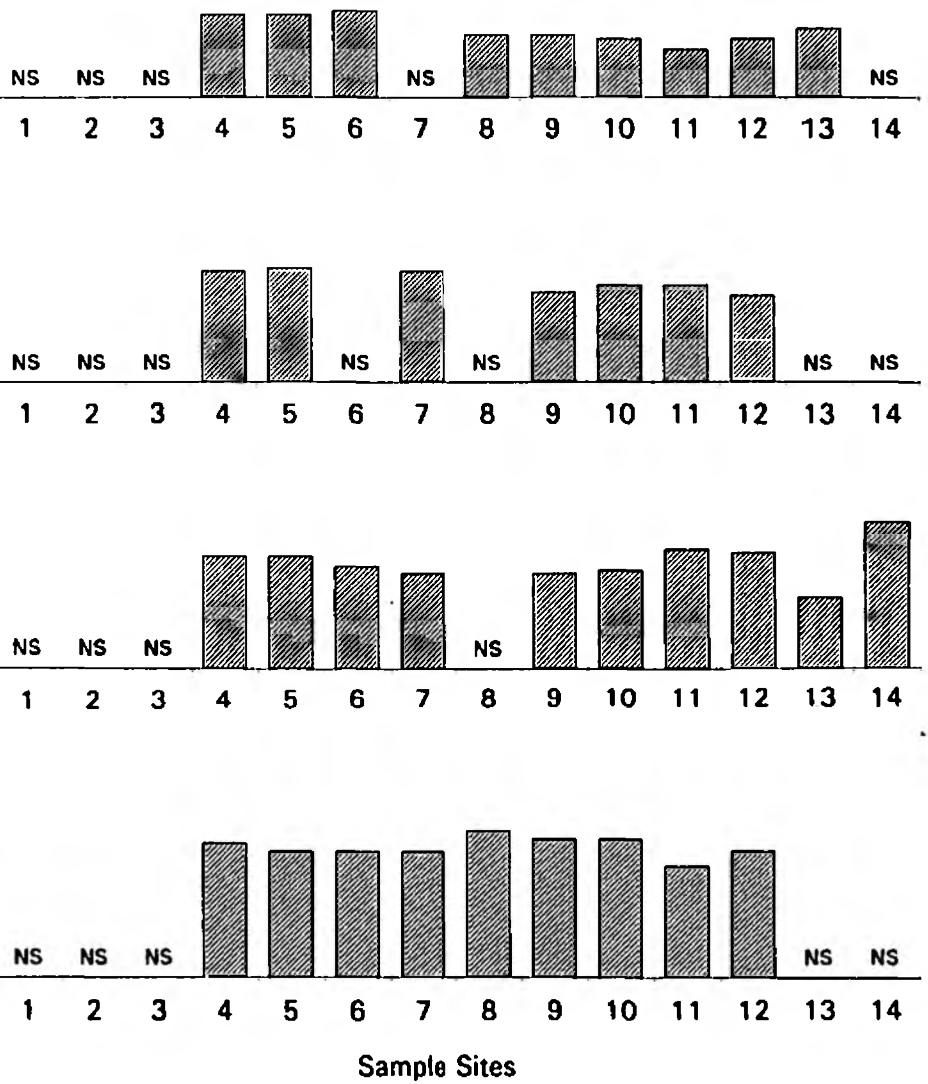


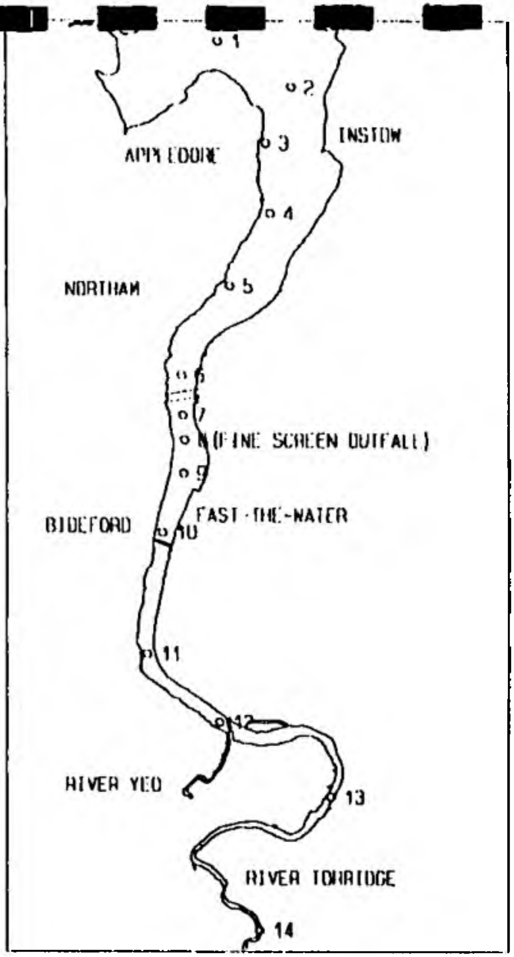
Bideford Fine Screen Outfall
Post Scheme Appraisal
Neap Tide Water Quality (07-JUN-91)

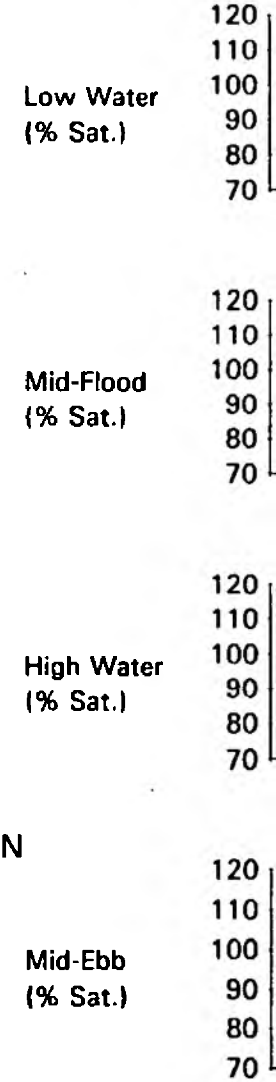
SURFACE WATER DISSOLVED OXYGEN

NS = Site Not Sampled

FIGURE 4.4a
WIMPEY
ENVIRONMENTAL


NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Sample Sites



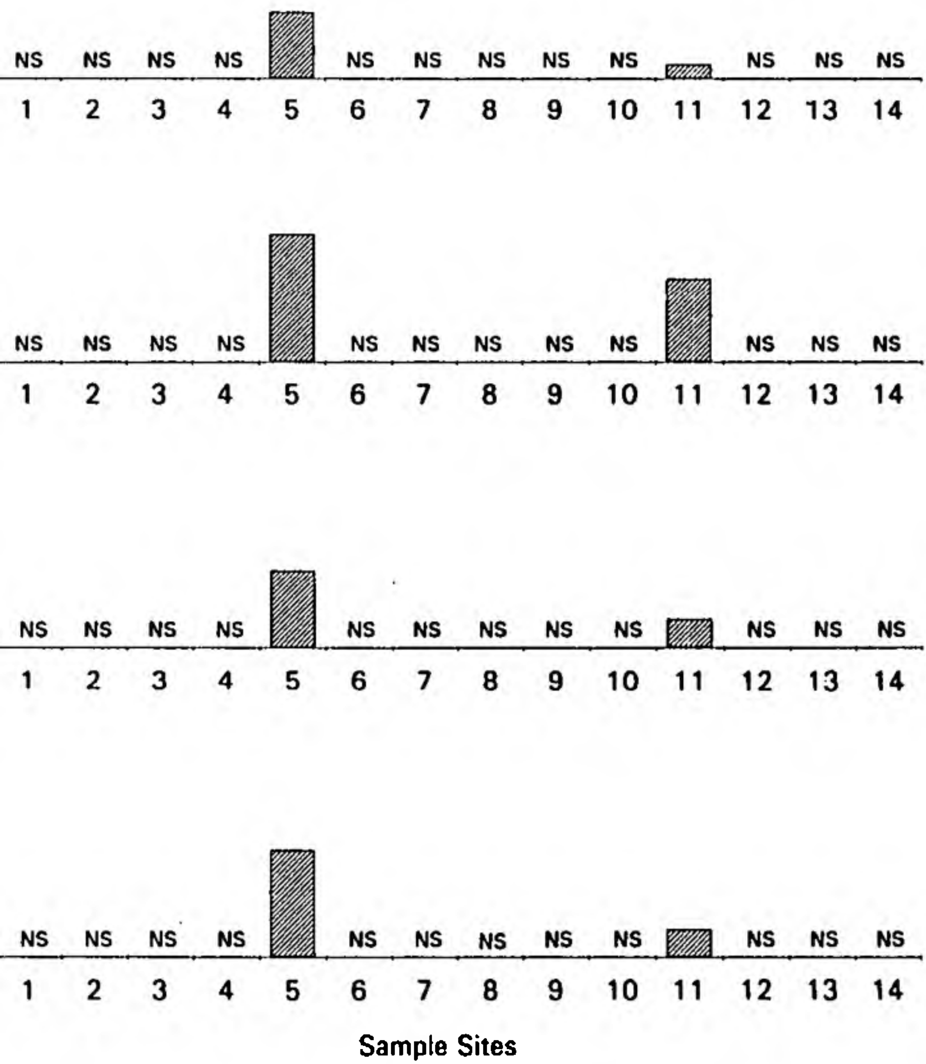


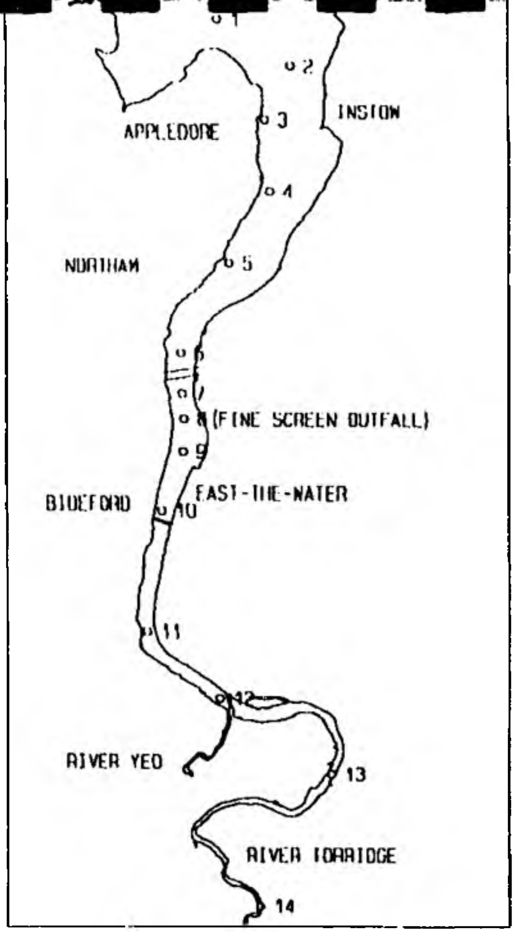
Bideford Fine Screen Outfall
Post Scheme Appraisal
Spring Tide Water Quality (14-AUG-91)

SURFACE WATER DISSOLVED OXYGEN

NS = Site Not Sampled

FIGURE 4.4b
WIMPEY
ENVIRONMENTAL


NS NS NS NS NS NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Sample Sites



Low Water

Mid-Flood

High Water

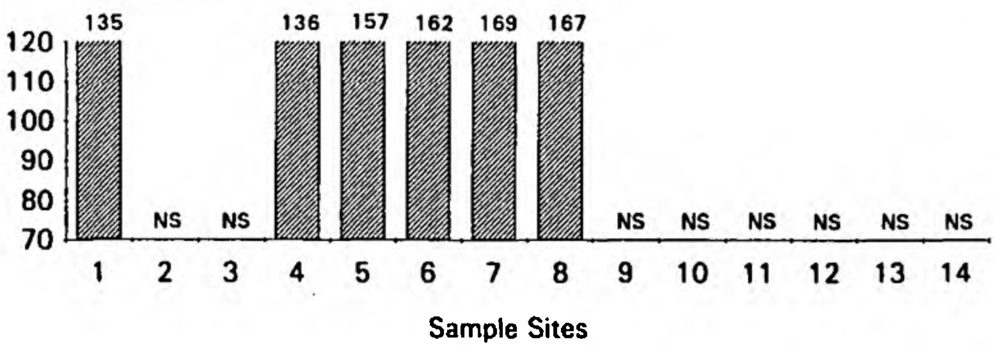
Bideford Fine Screen Outfall
Post Scheme Appraisal
Neap Tide Water Quality (19-AUG-91)

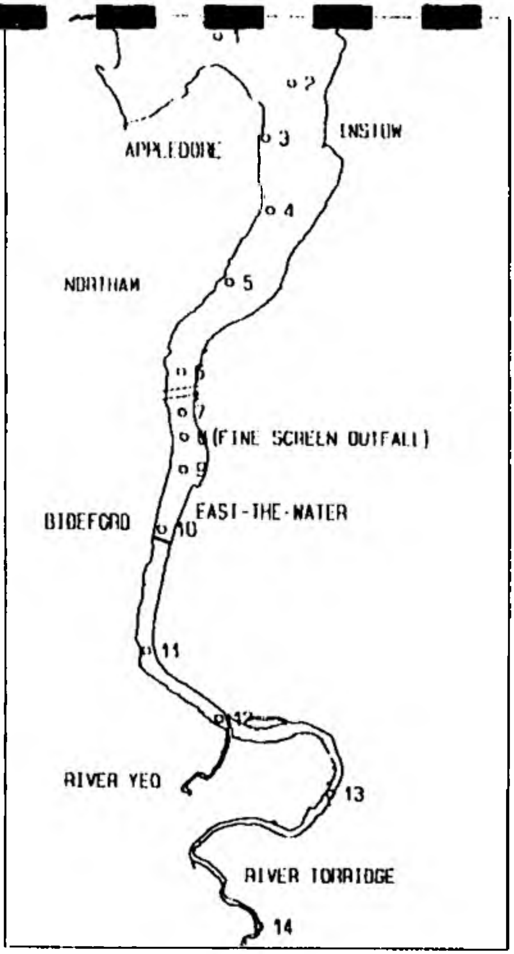
SURFACE WATER DISSOLVED OXYGEN

NS = Site Not Sampled
135 = Value Higher Than Conventional Scale

Mid-Ebb
(% Sat.)

FIGURE 4.4c
WIMPEY
ENVIRONMENTAL


135
136
157
162
169
167
120
110
100
90
80
70
NS
NS
NS
NS
NS
NS
NS
NS
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Sample Sites



Bideford Fine Screen Outfall
Post Scheme Appraisal
Neap Tide Water Quality (07-JUN-91)

SURFACE WATER TOTAL OXIDISED NITROGEN

NS = Site Not Sampled

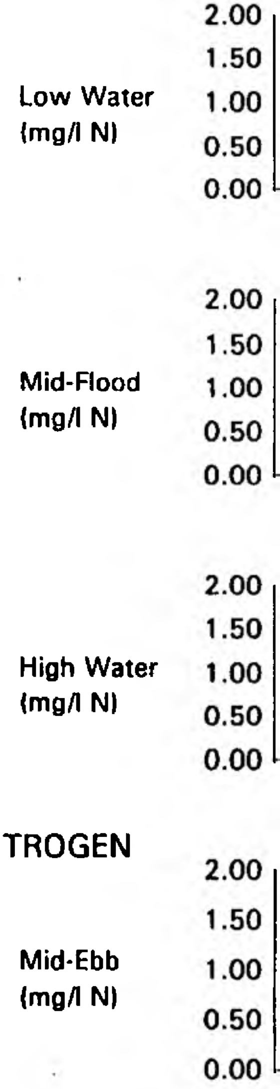
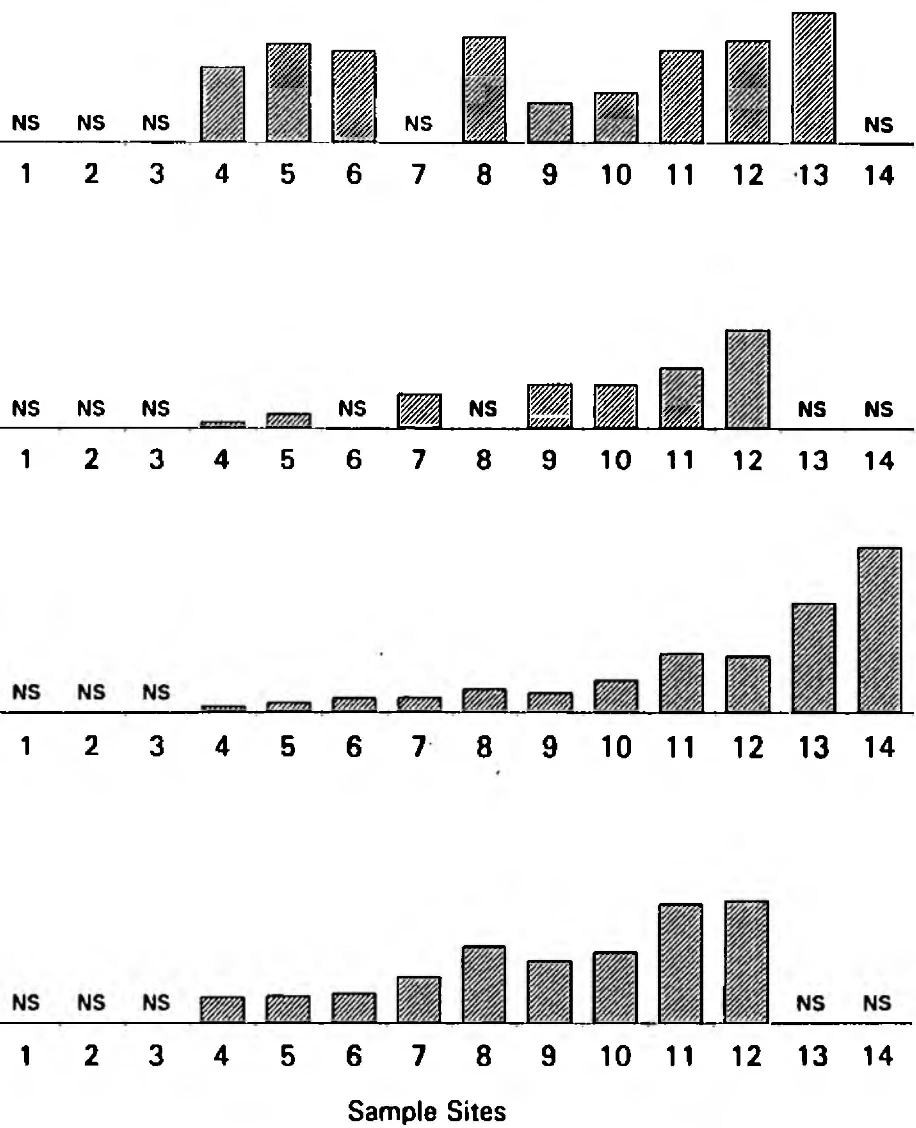
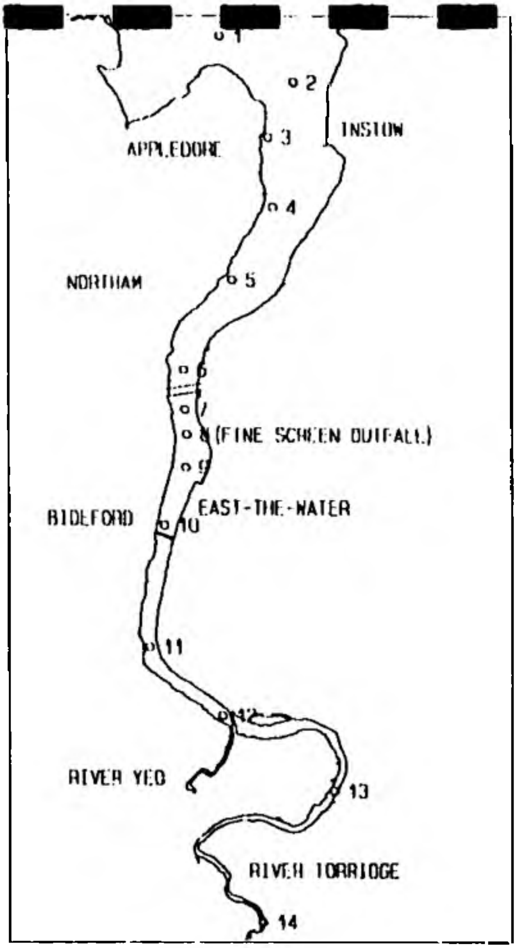
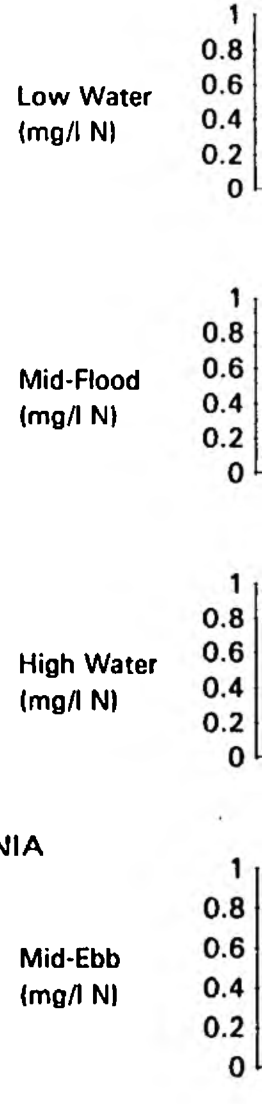


FIGURE 4.5

WIMPEY
ENVIRONMENTAL


NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Sample Sites





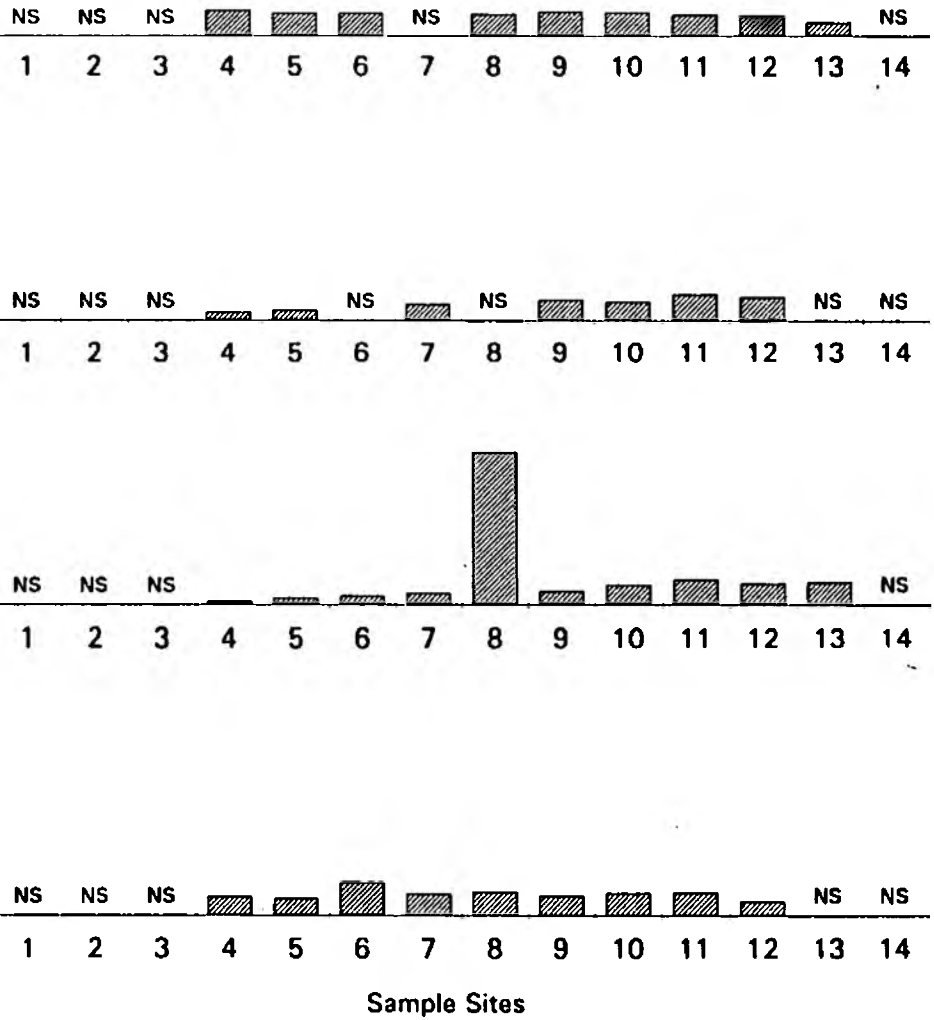
Bideford Fine Screen Outfall
Post Scheme Appraisal
Neap Tide Water Quality (07-JUN-91)

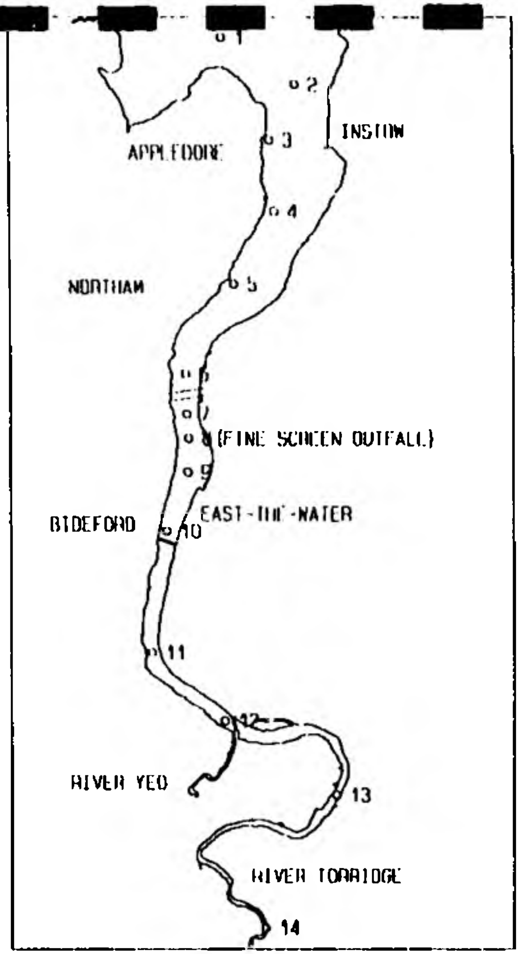
SURFACE WATER DISSOLVED AMMONIA

NS = Site Not Sampled

FIGURE 4.6a

WIMPEY
ENVIRONMENTAL


NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Sample Sites



Low Water (mg/l N) 1 0.8 0.6 0.4 0.2 0

Mid-Flood (mg/l N) 1 0.8 0.6 0.4 0.2 0

High Water (mg/l N) 1 0.8 0.6 0.4 0.2 0

Bideford Fine Screen Outfall
Post Scheme Appraisal
Spring Tide Water Quality (14-AUG-91)

SURFACE WATER DISSOLVED AMMONIA

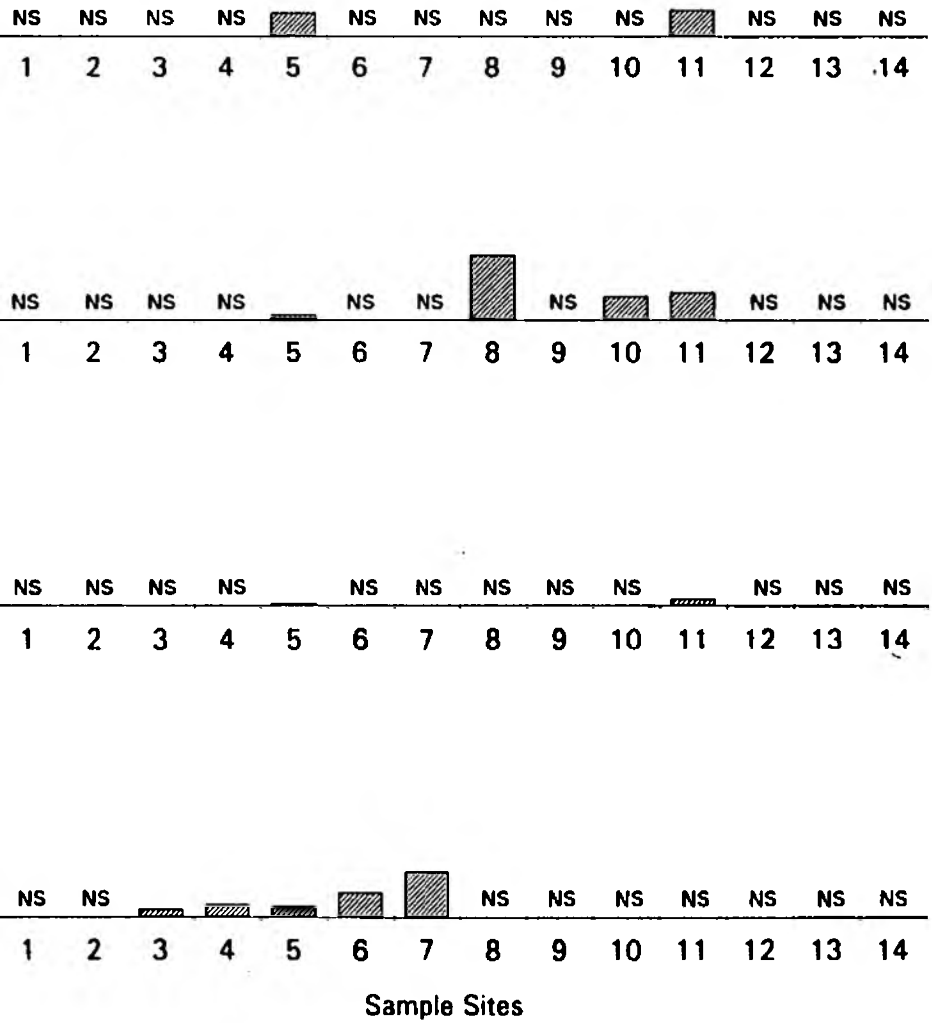
NS = Site Not Sampled

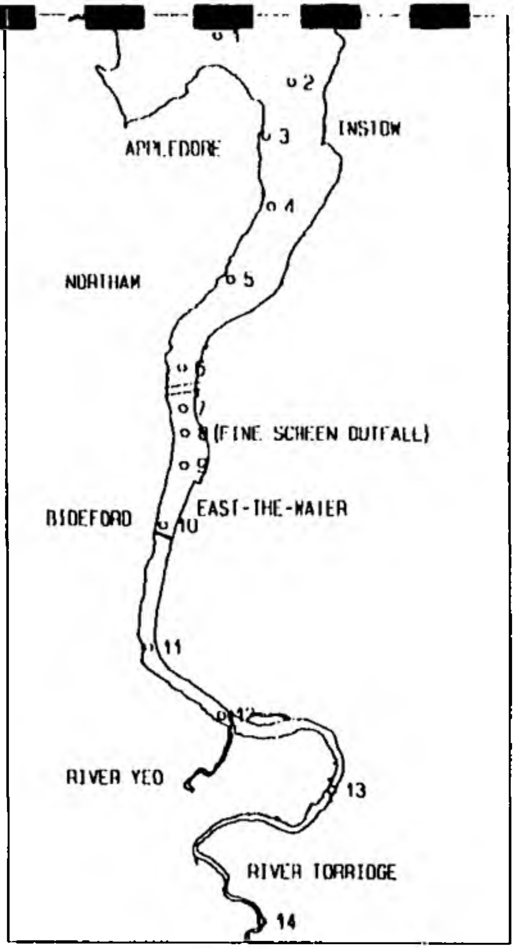
Mid-Ebb (mg/l N) 1 0.8 0.6 0.4 0.2 0

FIGURE 4.6b

WIMPEY

ENVIRONMENTAL


NS NS NS NS NS NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Sample Sites



Low Water

Mid-Flood

High Water

Bideford Fine Screen Outfall
Post Scheme Appraisal
Neap Tide Water Quality (19-AUG-91)

SURFACE WATER DISSOLVED AMMONIA

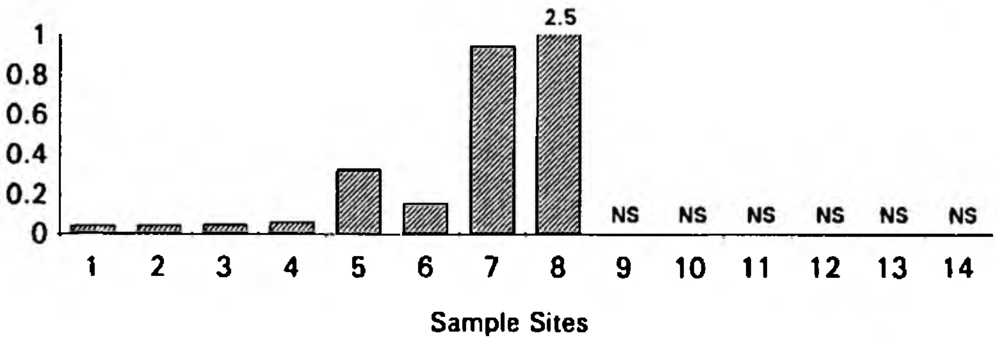
NS = Site Not Sampled
2.5 = Value Higher Than Conventional Scale

Mid-Ebb
(mg/l N)

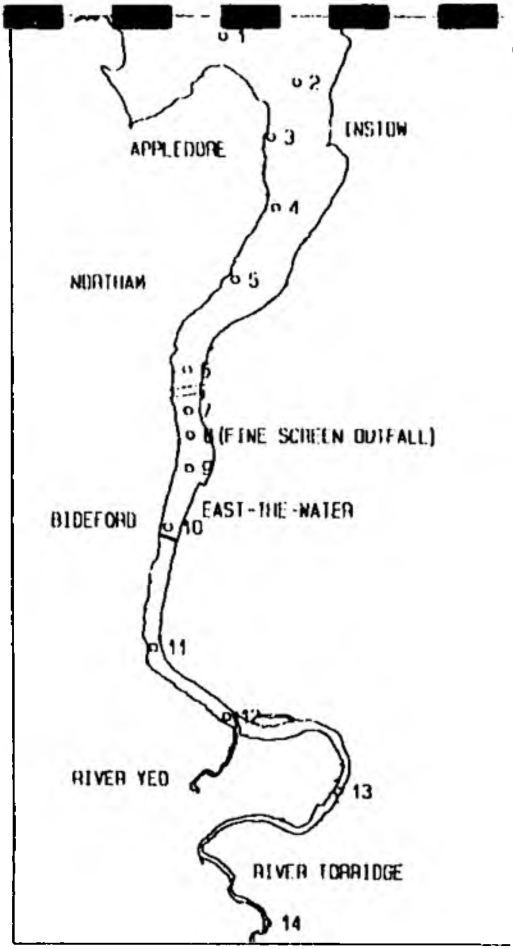
FIGURE 4.6c

WIMPEY

ENVIRONMENTAL



2.5
1
0.8
0.6
0.4
0.2
0
NS
NS
NS
NS
NS
NS
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Sample Sites



Low Water
(No./100ml)

Mid-Flood
(No./100ml)

High Water
(No./100ml)

Bideford Fine Screen Outfall
Post Scheme Appraisal
Neap Tide Water Quality (07-JUN-91)

SURFACE WATER FAECAL COLIFORM COUNTS

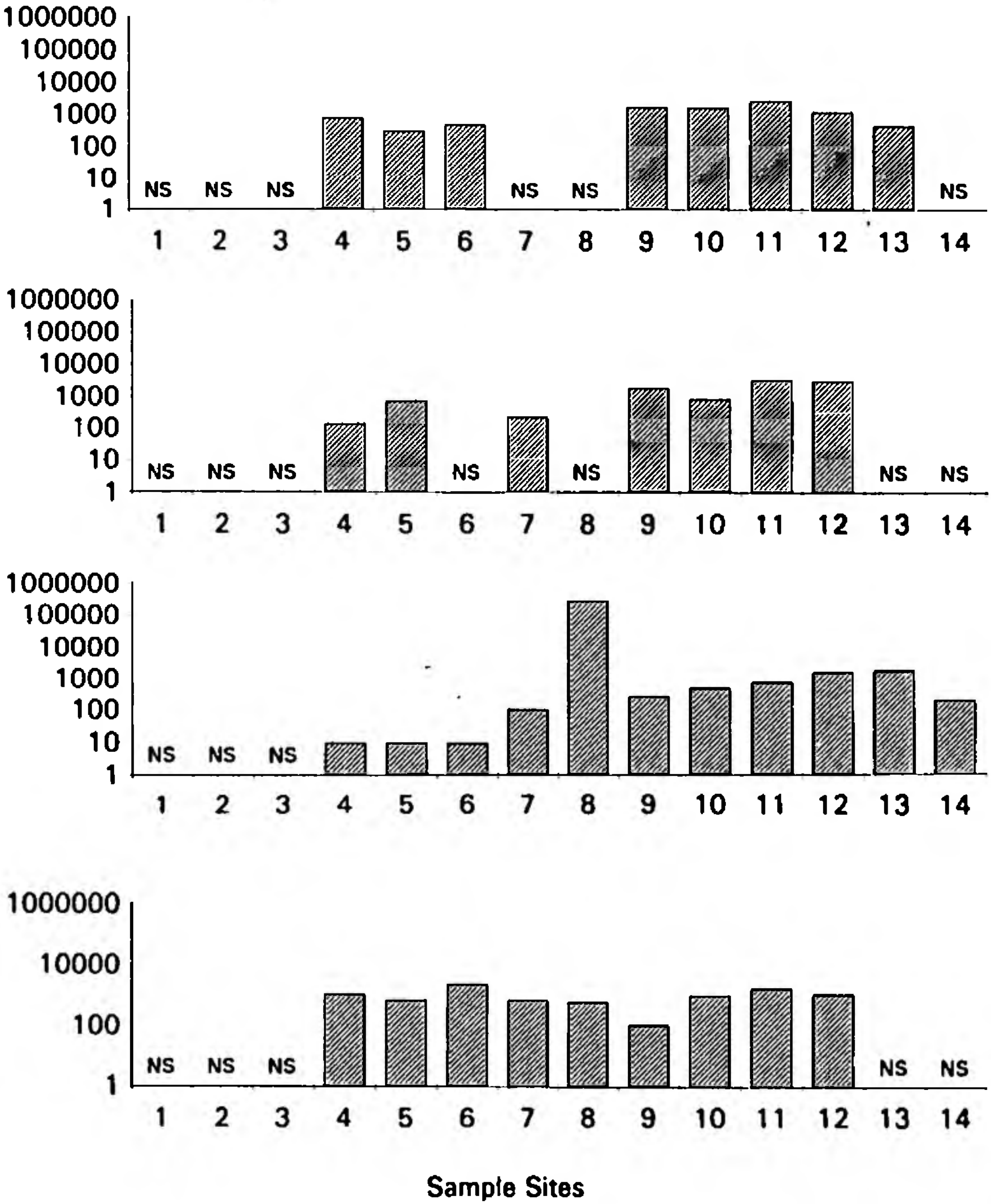
NS = Site Not Sampled
The E.C. Bathing Water E.Q.S. for
Faecal Coliforms is 2000/100ml

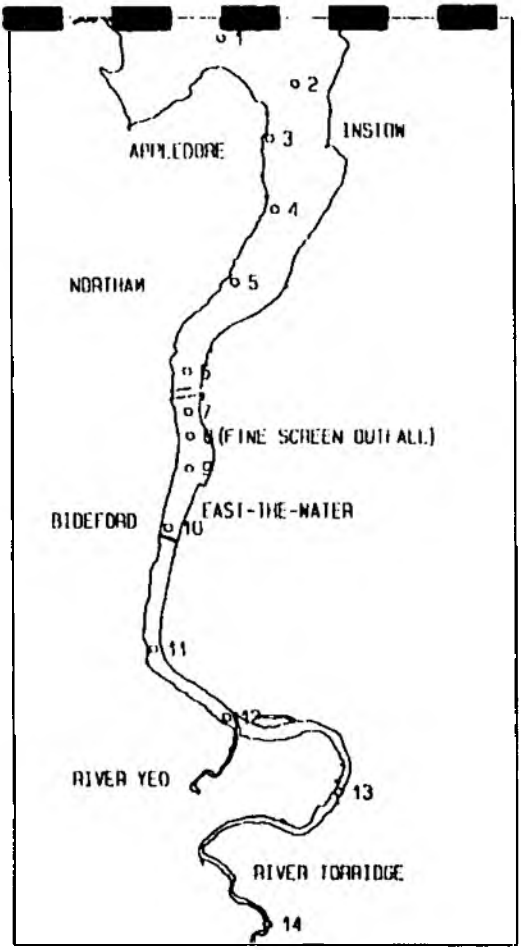
Mid-Ebb
(No./100ml)

FIGURE 4.7a

WIMPEY

ENVIRONMENTAL


1000000
100000
10000
1000
100
10
1
NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Sample Sites



Low Water
(No./100ml)

Mid-Flood
(No./100ml)

High Water
(No./100ml)

Bideford Fine Screen Outfall
Post Scheme Appraisal
Spring Tide Water Quality (14-AUG-91)

SURFACE WATER FAECAL COLIFORM COUNTS

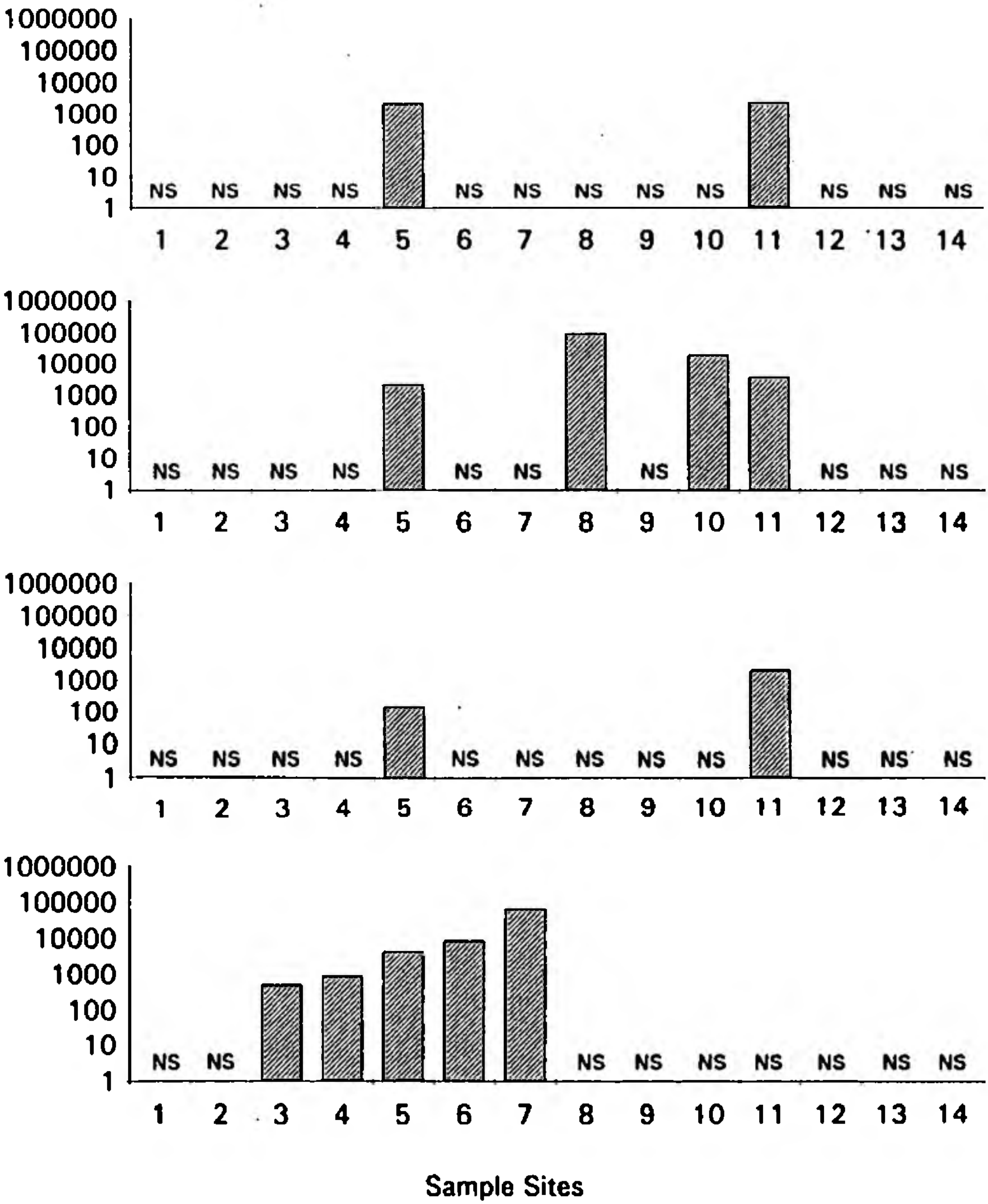
NS = Site Not Sampled

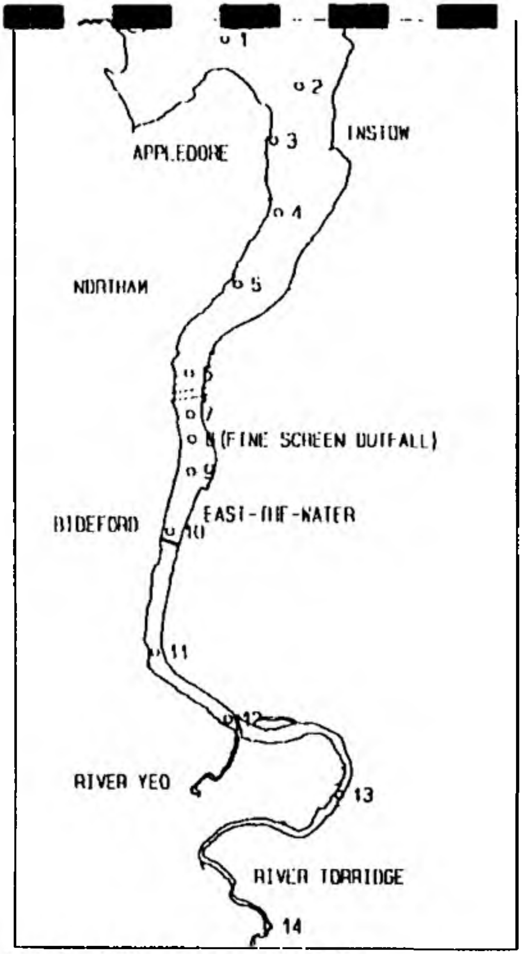
Mid-Ebb
(No./100ml)

FIGURE 4.7b

WIMPEY

ENVIRONMENTAL


1000000
100000
10000
1000
100
10
1
NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Sample Sites



Low Water

Mid-Flood

High Water

Bideford Fine Screen Outfall
Post Scheme Appraisal
Neap Tide Water Quality (19-AUG-91)

SURFACE WATER FAECAL COLIFORM COUNTS

NS = Site Not Sampled

Mid-Ebb
(No./100ml)

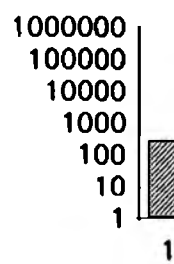
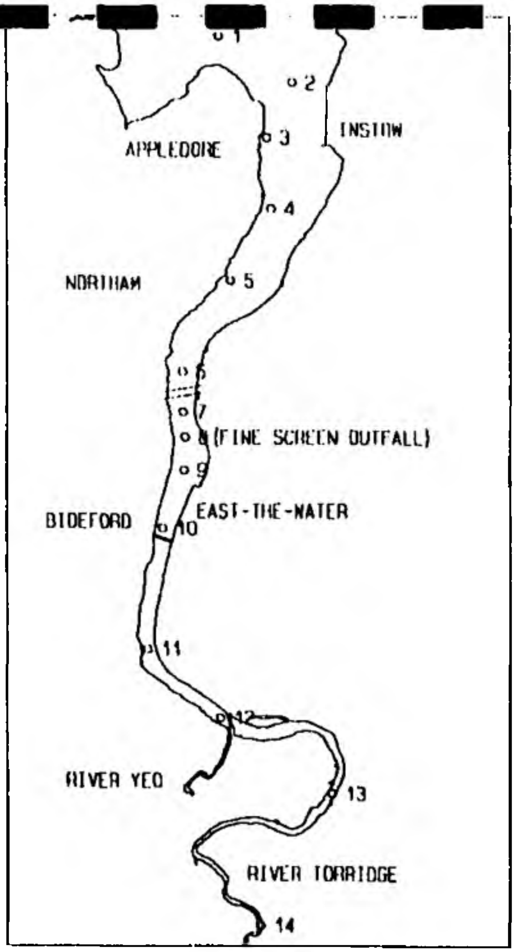


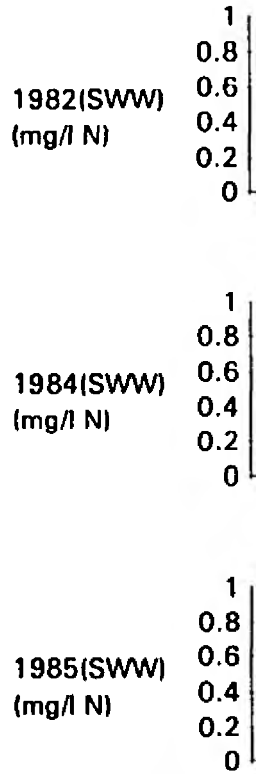
FIGURE 4.7c

WIMPEY

ENVIRONMENTAL


NS NS NS NS NS NS
2 3 4 5 6 7 8 9 10 11 12 13 14
Sample Sites



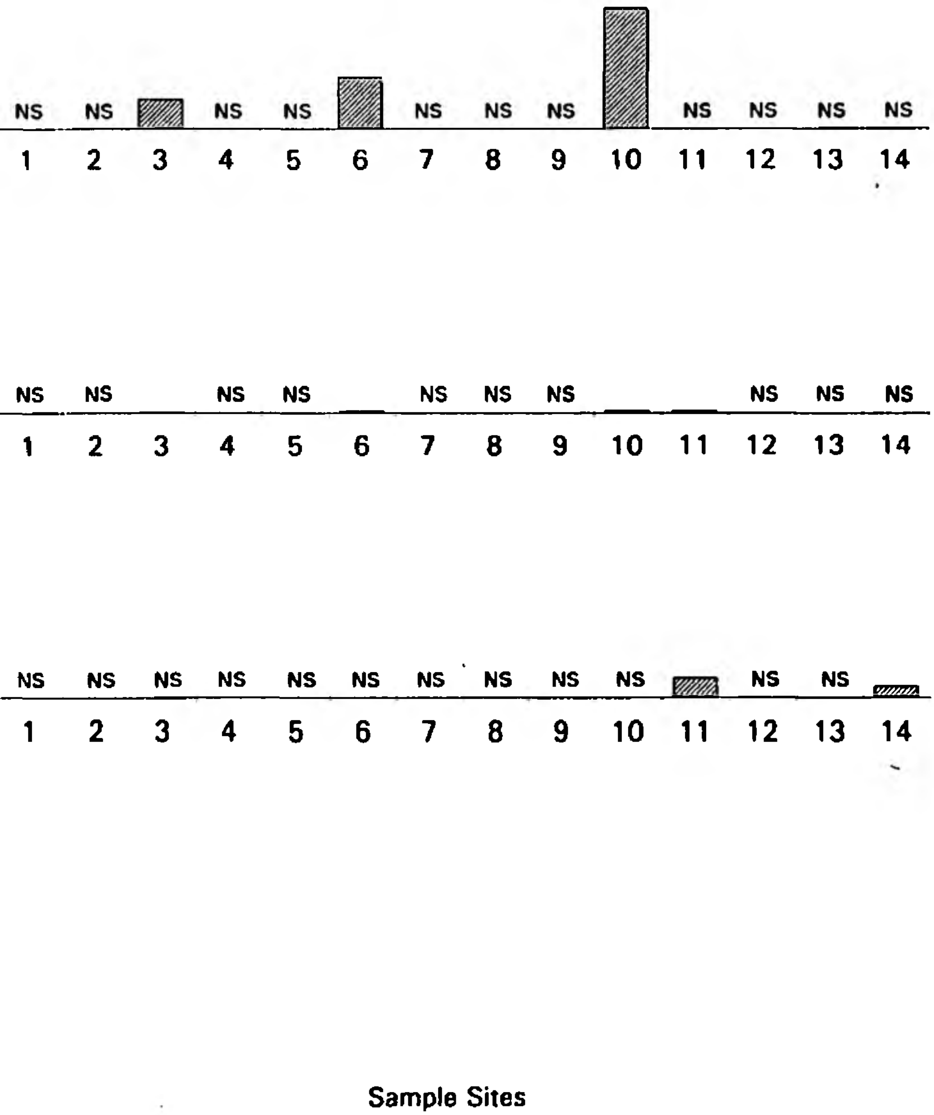


Bideford Fine Screen Outfall
Post Scheme Appraisal
Historic Water Quality

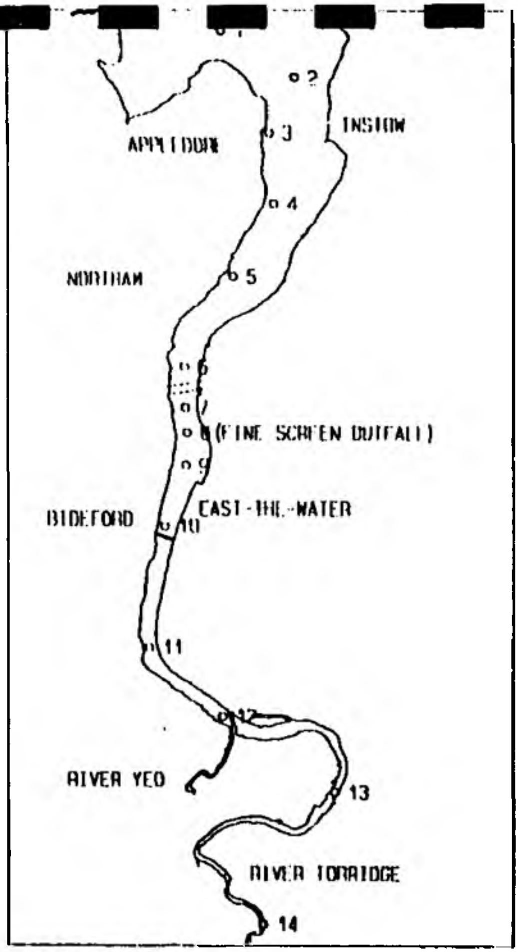
SURFACE WATER DISSOLVED AMMONIA

NS = Site Not Sampled

FIGURE 5.1a
WIMPEY
ENVIRONMENTAL



NS NS NS NS NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Sample Sites



1987-1989
(WIMPOL)
(mg/l N)

1
0.8
0.6
0.4
0.2
0

1991 (NRA)
(Neaps)
(mg/l N)

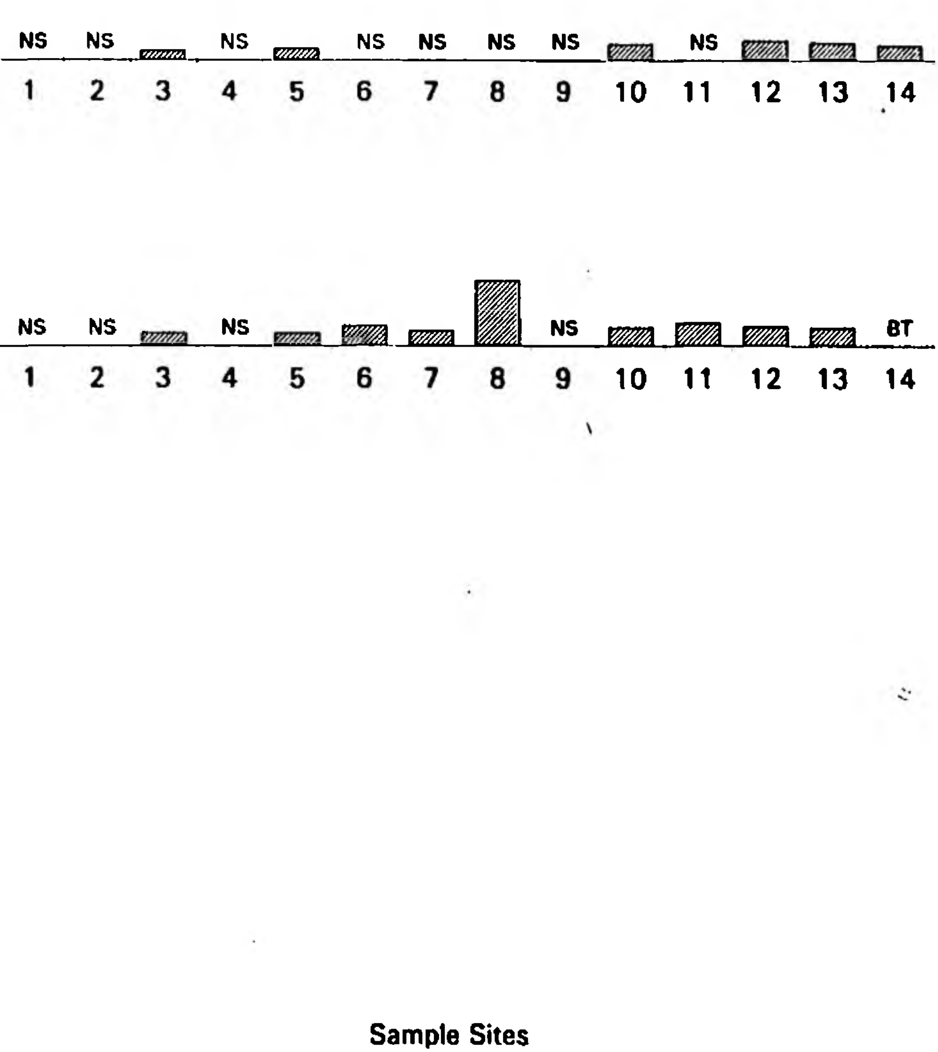
1
0.8
0.6
0.4
0.2
0

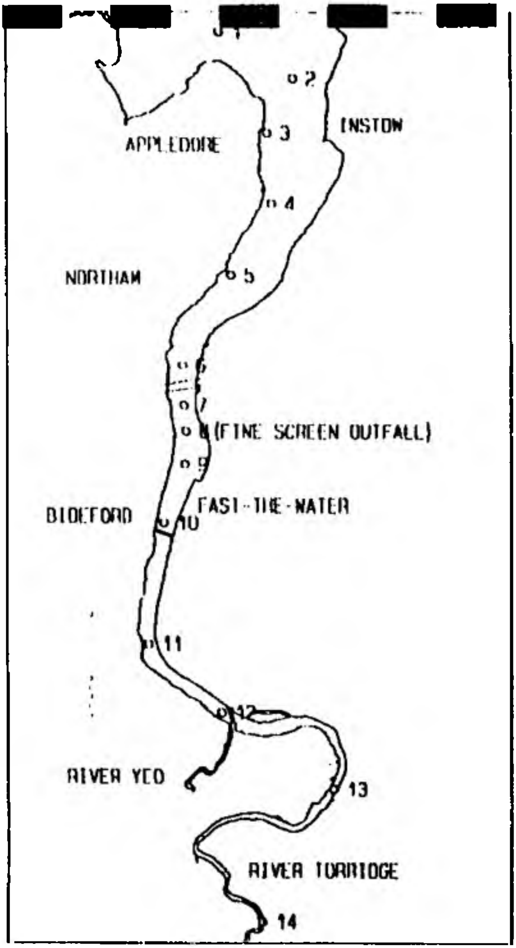
Bideford Fine Screen Outfall
Post Scheme Appraisal
Historic Water Quality

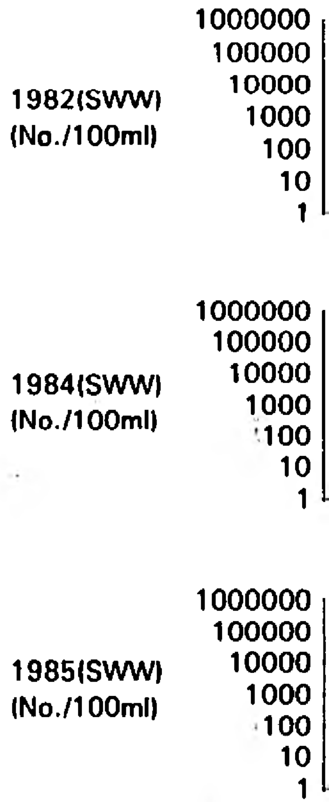
SURFACE WATER DISSOLVED AMMONIA

NS = Site Not Sampled
BT = Below Detection Threshold

FIGURE 5.1b
WIMPEY
ENVIRONMENTAL


NS NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS BT
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Sample Sites





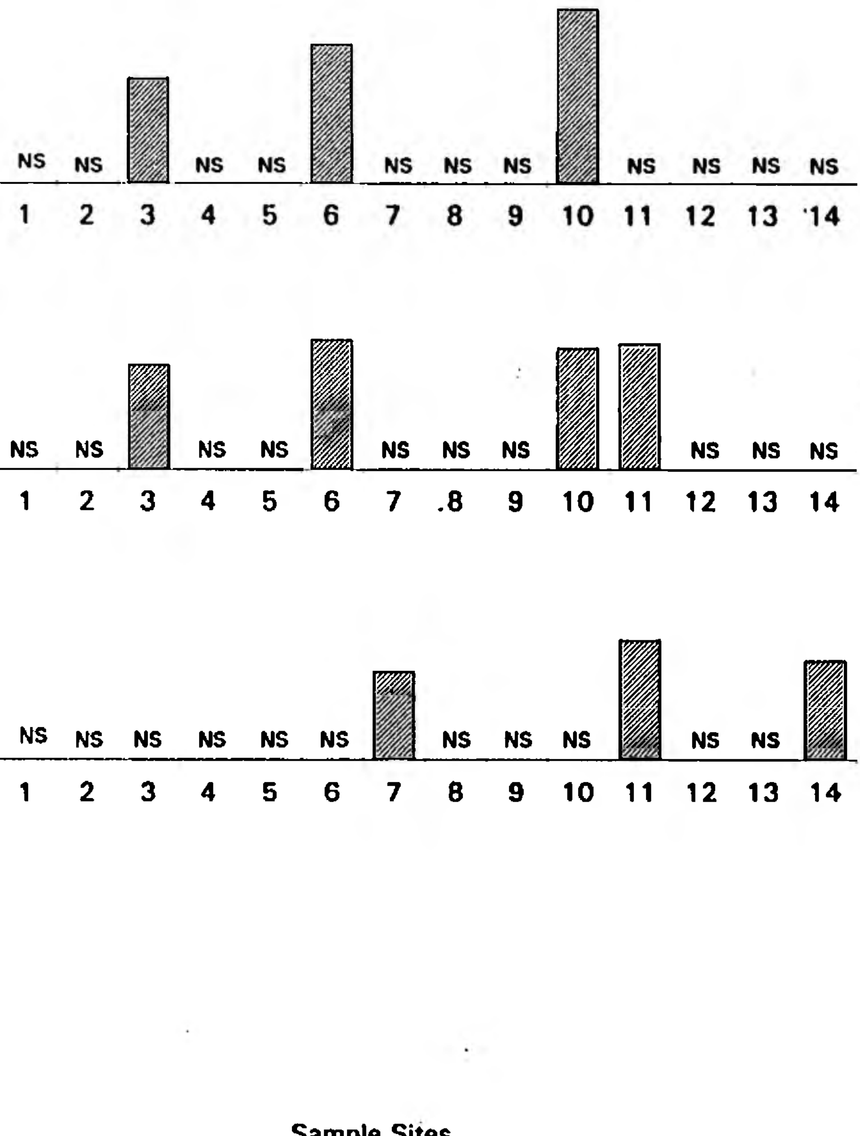
Bideford Fine Screen Outfall
Post Scheme Appraisal
Historic Water Quality

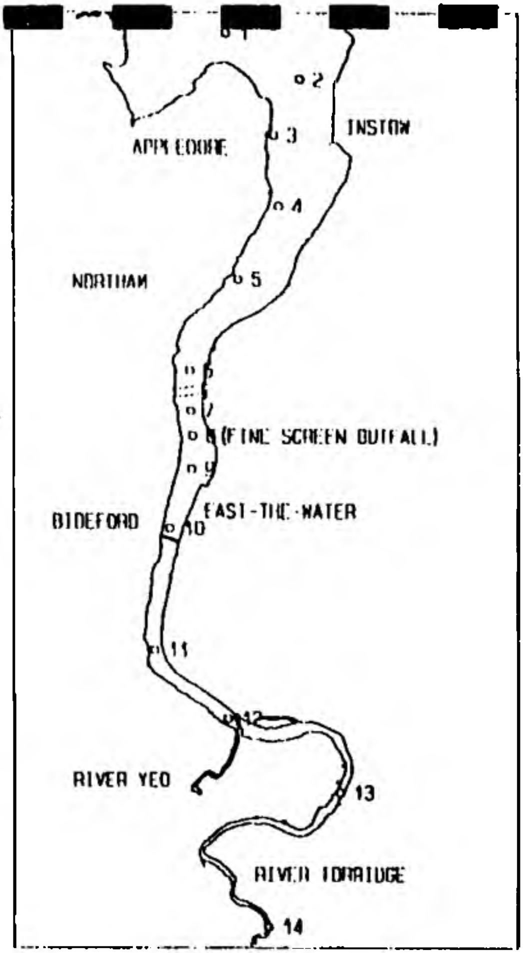
SURFACE WATER FAECAL COLIFORM COUNTS

NS = Site Not Sampled

FIGURE 5.2a

WIMPEY
ENVIRONMENTAL


NS NS NS NS NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NS NS NS NS NS NS NS NS NS NS NS
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Sample Sites



1987-1989
(WIMPOL)
(No./100ml)

1000000
100000
10000
1000
100
10
1

1991(NRA)
(Neaps)
(No./100ml)

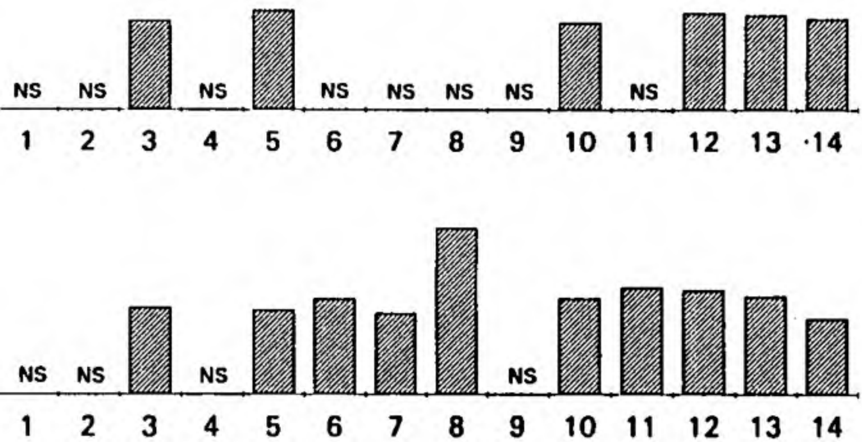
1000000
100000
10000
1000
100
10
1

Bideford Fine Screen Outfall
Post Scheme Appraisal
Historic Water Quality

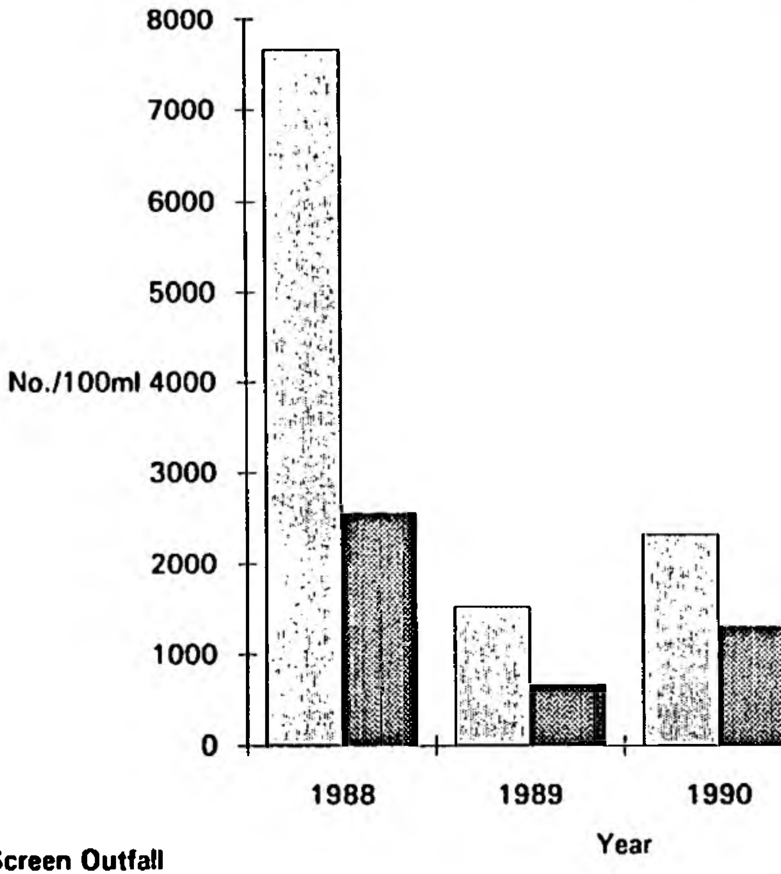
SURFACE WATER FAECAL COLIFORM COUNTS

NS = Site Not Sampled

FIGURE 5.2b
WIMPEY
ENVIRONMENTAL



Sample Sites



Bideford Fine Screen Outfall
Post Scheme Appraisal
Historic Water quality

MEAN COLIFORM COUNTS FOR INSTOW BEACH (1988-1991)

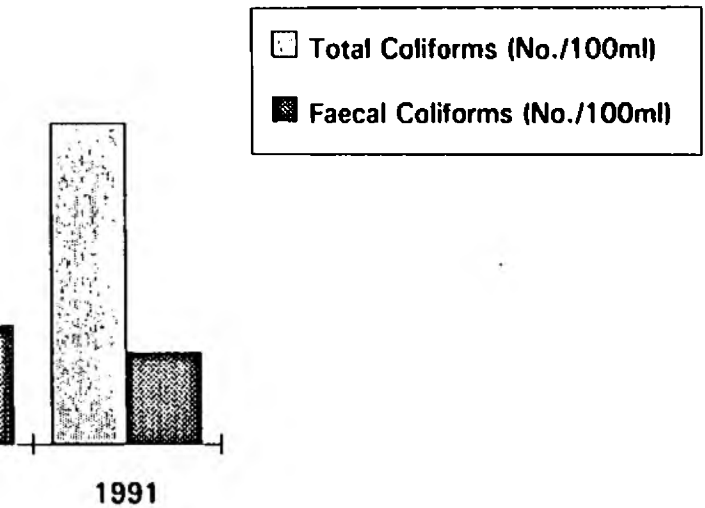
The E.C. Environmental Quality Standard for Total Coliforms is 10000/100ml

The E.C. Environmental Quality Standard for Faecal Coliforms is 2000/100ml

FIGURE 5.3

WIMPEY

ENVIRONMENTAL



Total Coliforms (No./100ml)
Faecal Coliforms (No./100ml)
1991

APPENDICES

APPENDICES

Appendix A Pre-scheme Water Quality Data

Appendix B - NRA South West Tidal Waters Investigation Unit Survey Notes

Appendix C - Bideford Fine Screen Outfall Post-scheme Appraisal Data

Appendix D - Historic Water Quality Data

APPENDIX A

Pre-scheme Water Quality Data

APPENDIX A

Pre-scheme Water Quality Data

Bideford Fine Screen Outfall - Post Scheme Appraisal

Table A.1a: Pre-Scheme Water Quality Data - Spring Tide Low Water (30-JUL to 01-AUG-88)

Wimpol Site	NRA Site No.	T/M/B	D.O. (mg/l O)	pH	T.O.N. (mg/l N)	NH4 (mg/l N)	Faecal Coliforms (No./100ml)
Z-South	1	T	8.6	8.2	0.237	0.033	0
A-West	3	T	8.3	7.8	0.633	0.034	60
B-West	5	T	7.4	7.7	1.118	0.047	0
C	10	T	8.6	8.1	1.361	0.033	325
D	12	T	9.2	7.8	1.725	0.079	0
E	13	T	9.6	8.1	0.658	0.085	0
F	14	T	10.8	7.8	1.938	0.019	0

Bideford Fine Screen Outfall - Post Scheme Appraisal

Table A.1b: Pre-Scheme Water Quality Data - Spring Tide High Water (30-JUL to 01-AUG-88)

Wimpol Site	NRA Site No.	T/M/B	D.O. (mg/l O)	pH	T.O.N. (mg/l N)	NH4 (mg/l N)	Faecal Coliforms (No./100ml)
Z-South	1	T	8.3	8.2	0.005	0.01	0
A-West	3	T	7.9	8.1	0.103	0.018	0
B-West	5	T	7.4	8.1	0.077	0.008	0
C	10	T	8.3	8.1	0.01	0.004	0
D	12	T	7.5	7.7	0.387	0.012	0
E	13	T	7.4	7.5	0.841	0.017	10
F	14	T	9.4	7.7	1.901	0.055	0

Bideford Fine Screen Outfall - Post Scheme Appraisal

Table A.2a: Pre-Scheme Water Quality Data - Neap Tide Low Water (06 to 08-AUG-88)

Wimpol Site	NRA Site No.	T/M/B	D.O. (mg/l O)	pH	T.O.N. (mg/l N)	NH4 (mg/l N)	Faecal Coliforms (No./100ml)
Z-South	1	T	8.9	8.1	0.98	0.1	1000
A-West	3	T	8.8	7.9	0.472	0.021	1000
B-West	5	T	9.6	7.9	1.15	0.036	
C	10	T	7.6	7.9	1.227	0.061	1000
D	12	T	9	7.6	1.438	0.088	
E	13	T	11	8.3	1.687	0.058	
F	14	T	11.7	8.6	1.725	0.029	

Bideford Fine Screen Outfall - Post Scheme Appraisal

Table A.2b: Pre-Scheme Water Quality Data - Neap Tide High Water (06 to 08-AUG-88)

Wimpol Site	NRA Site No.	T/M/B	D.O. (mg/l O)	pH	T.O.N. (mg/l N)	NH4 (mg/l N)	Faecal Coliforms (No./100ml)
Z-South	1	T	8.3	8.1	0.002	0.016	0
A-West	3	T	8.2	8.1	0.003	0.012	5
B-West	5	T	7.6	8.1	0.022	0.002	
C	10	T	7.8	8.1	0.059	0.018	400
D	12	T	7.7	7.6	2.054	0.08	
E	13	T	7.4	7.5	1.61	0.129	
F	14	T	10.8	8.1	1.725	0.025	

Bideford Fine Screen Outfall - Post Scheme Appraisal

Table A.3a: Pre-Scheme Water Quality Data - Spring Tide Low Water (19 to 21-JUL-89)

Wimpol Site	NRA Site No.	T/M/B	D.O. (mg/l O)	pH	T.O.N. (mg/l N)	NH4 (mg/l N)	Faecal Coliforms (No./100ml)
Z-South	1	T	8.8	7.8	0.015	0.015	760
A-West	3	T	10	8.1	0.013	0.015	470
B-West	5	T	9.3	8.1	0.006	0.005	2320
C	10	T	12.5	8.1	0.018	0.027	155
D	12	T	9	8	0.196	0.017	1560
E	13	T	9.9	8	1.373	0.085	1400
F	14	T	9.3	8.4	1.41	0.121	640

Bideford Fine Screen Outfall - Post Scheme Appraisal

Table A.3b: Pre-Scheme Water Quality Data - Spring Tide High Water (19 to 21-JUL-89)

Wimpol Site	NRA Site No.	T/M/B	D.O. (mg/l O)	pH	T.O.N. (mg/l N)	NH4 (mg/l N)	Faecal Coliforms (No./100ml)
Z-South	1	T	7.7	7.9	0.015	0.015	20
A-West	3	T	7.7	7.9	0.009	0.01	130
B-West	5	T	6.9	7.9	0.009	0.02	150
C	10	T	7.1	7.9	0.015	0.033	175
D	12	T	6.2	7.9	0.019	0.028	750
E	13	T	5.3	8.4	0.025	0.052	780
F	14	T	4.5	7.6	0.311	0.18	840

Bideford Fine Screen Outfall - Post Scheme Appraisal

Table A.4a: Pre-Scheme Water Quality Data - Neap Tide Low Water (26 to 28-JUL-89)

Wimpol Site	NRA Site No.	T/M/B	D.O. (mg/l O)	pH	T.O.N. (mg/l N)	NH4 (mg/l N)	Faecal Coliforms (No./100ml)
Z-South	1	T	7.1	7.8	0.025	0.032	650
A-West	3	T	6.8	7.8	0.085	0.16	1300
B-West	5	T	7	7.8	0.071	0.15	
C	10	T	6.7	7.5	0.17	0.39	203
D	12	T	7.4	7.8	0.15	0.14	
E	13	T	7.3	7.9	0.474	0.25	
F	14	T	9.2	8.5	0.672	0.121	

Bideford Fine Screen Outfall - Post Scheme Appraisal

Table A.4b: Pre-Scheme Water Quality Data - Neap Tide High Water (26 to 28-JUL-89)

Wimpol Site	NRA Site No.	T/M/B	D.O. (mg/l O)	pH	T.O.N. (mg/l N)	NH4 (mg/l N)	Faecal Coliforms (No./100ml)
Z-South	1	T	7.4	7.9	0.01	0.059	0
A-West	3	T	7	7.8	0.039	0.02	35
B-West	5	T	6.9	7.8	0.014	0.025	
C	10	T	6.5	7.7	0.023	0.031	15
D	12	T	6.7	7.8	0.033	0.061	
E	13	T	6.4	7.8	0.076	0.139	
F	14	T	6	7.6	0.473	0.21	

APPENDIX B

NRA South West Tidal Waters Investigation Unit Survey Notes

[2]BIDEFORD FINE SCREEN IMPACT SURVEY: NEAPS 7-6-91

The Tidal Waters Investigations Unit has been requested to undertake a water quality survey of the Torridge estuary in the vicinity of Bideford in order to assess the effectiveness of the new fine-screen discharge commissioned towards the end of 1990. The basic requirements may be summarized as follows:

i) Water quality surveys at springs and neaps. The initial survey will take place on the spring tides of 7-6-91.

ii) Water quality samples at HW, mid-ebb, LW and mid-flood for E.coli, Ammonia, TON, and suspended solids (105°C and 500°C).

iii) In situ measurements of temperature, salinity, DO and pH. A hired turbidity meter (Alec PT1) will also be evaluated.

iv) Samples (2 per probe) will be taken on the first and last sampling runs to allow accurate instrument calibration (1 PET and 1 DO bottle).

v) Hourly samples for E.coli will be taken remotely by Epic's at Beam bridge on the Torridge (NGR 4735,2090) and at Rudha bridge on the Yeo (NGR 4390,2250). Each hourly sample will consist of 10 minute sub-samples. Sampling will begin at 18.00 on Thursday 6-6-91.

vi) Current speed measurements will be made in the vicinity of the discharge itself at 1m intervals at LW, mid-flood and HW (Braystoke will be sufficient).

The longitudinal positions of the various sampling sites are detailed on the attached map. The cross-estuary locations are not shown since they will be dependant on bed topography and the position of the main navigation channel. A schematic representation of the proposed sampling schedule for the HW, mid-ebb, LW and mid-flood runs is also attached.

At each location samples will be collected as follows:

Depth < 1.0m - surface only
Depth > 1.0m - surface and near-bed

Probe measurements are also depth dependant and will be taken as follows:

Depth < 0.5m - surface only
Depth 0.5m to 1.0m - surface and near-bed
Depth > 1.0m < 2.0m - surface and 0.5m above bed
Depth > 2.0m - surface, mid-depth and 0.5m above bed

All probe measurements should be taken with the vessel at anchor.

Each sample taken will require three labels to be completed; one for the PET bottle, one for the nutrient bottle and one for the sample registration sheet. The labelling of bottles as samples are taken will save considerable time later and enable the courier to get away on time.

The following is a description of each of the proposed sampling sites, together with information on the required cross-estuary sampling required at each state of the tide:

(1)Appledore: Between shipyard and railway bridge on the east bank.
LW - 1 site (mid-channel)
mid-flood - 1 site (mid-channel)
HW - 1 site (mid-channel)
mid-ebb - 3 sites (mid-channel and close to each bank)

(2)Snuffy/Boathyde: Opposite southern headland of small on west bank.
LW - 1 site
mid-flood - 1 site
HW - 2 sites (channel near west bank and east bank)
mid-ebb - 3 sites (main channel and each bank)

(3)Limers lane: Opposite abrupt squiggle on west bank.
LW - 1 site
mid-flood - 1 site
HW - 1 site
mid-ebb - 3 sites (main channel and each bank)

(4)250m downstream of discharge:
LW - 1 site
mid-flood - 2 sites (main channel and equidistant to west)
HW - 3 sites (main channel and each bank)
mid-ebb - 5 sites (evenly spaced to include main channel)

(5)FSO surface boil: Few meters upstream of storm overflow marker.
All tide - surface sample only and current measurements a 1m depth intervals. No currents at HW.

(6)250m upstream of discharge:
LW - 1 site
mid-flood - 5 sites (including each bank)
HW - 5 sites (including each bank)
mid-ebb - 3 sites (not banks)

(7)100m upstream of Bideford old bridge:
LW - 1 site (main channel near west bank)
mid-flood - 5 sites (including each bank)
HW - 5 sites (including each bank)
mid-ebb - 3 sites (not banks)

(8)Little America: Opposite stream on west bank, on bend.
LW - 1 site
mid-flood - 3 sites (channel and each bank)
HW - 3 sites (channel and each bank)
mid-ebb - 1 site (channel)

(9)Below Yeo confluence: Opposite 'castle' on west bank.
All tide - 1 site

(10)Addlehole: Opposite large house on east bank.
LW + HW only - 1 site

(11)Upstream of Wear Giffard bridge: Beside road.
LW + HW only - 1 site

ADDITIONAL INFORMATION:

The direction in which the runs should be carried out are as follows:

LW - All boats to work up estuary. Samples collected at Bank end and site 11.

MF - All boats to work down estuary. Samples collected at Little America, Bank End and Appledore.

HW - Boat A to work up estuary, boat C down estuary. Boat B whatever is more convenient. Samples collected at Bank End.

ME - All boats work down estuary.

Transit at Bank Ens will act as the sample store - fridge/coolboxes will be available.

Each boat should carry the following equipment:

- Warden radio
- Coolbox with ice packs
- Sample bottles and crates
- Filtered Ammonia kit (syringes, filters and holders, blank bottles, distilled water)
- Depth sampler with weight at 0.5m
- Plumb line
- Braystoke current meter (suspended mode)) To be used by whichever boat
- Turbidity meter) samples the boil.
- Eagle echosounder and marine band VHF

PROJECTED TIMETABLE:

6-6-91 LATE P.M.: Launch sites to be assessed and Epics set up.
LATER P.M.: Rest of survey team to Bideford with vehicles, equipment and vessels.

7-6-91 07.00: Survey team assemble to prepare and launch vessels.
08.00: LW run to start. Overnight samples to be retrieved from Epics.
09.00: Courier to depart for Exeter with first samples.
10.00: Mid-flood run to start.
11.00: Samples to be collected from Epics.
12.00: Courier departs for Exeter.
13.00: HW run to start.
14.00: Samples to be collected from Epics.
15.00: Courier to depart foe Exeter.
16.00: Mid-ebb run to start.
18.00: General demob. Samples and equipment back to Exeter.

COMMENTS:

Not all of the proposed sampling proved possible due to the restricted movement of vessels at low water. The results given are all that were obtained.

Several major items in the original survey plan were not achieved; notably the remote sampling Epics malfunctioned early during the survey (due to a sediment blockage in the sampling pipe). Thus, no freshwater bacterial inputs were obtained during the survey. Also, no current measurements were made in the vicinity of the outfall diffuser. This was due to insufficient time available.

The final point to note is that because of the above problems and the somewhat irregular nature of the discharge itself, the similar spring tide survey that was planned to occur soon after the above survey was temporarily abandoned. Survey plans were reconsidered - thus the change in the form of the surveys carried out on the spring and neap tides of 14-8-91 and 19-8-91 respectively.

Considerable effort was then focused on establishing the exact nature of the discharge regime. All the information available to date is given in a later section. With a more accurate knowledge of the way in which the discharge was operated, survey planning was made considerably easier.

[3]BIDEFORD FINE SCREEN IMPACT SURVEY: SPRINGS 14-8-91

A spring tide survey of the Torridge Estuary to further examine the impact of the fine screening plant is planned for the 14th August. The survey plan is to place fixed stations approximately 1.5km both upstream and downstream of the fine screen outfall, and to follow a discrete gravity discharge on the ebb tide, a pumped discharge around low water, and a pumped discharge on the flood tide. Freshwater bacterial inputs from the rivers Yeo and Torridge will be determined by remote sampling using the Epic's.

- Epics: Set up to sample every 20 minutes so that each bottle will represent a two hour integrated sample. Such sampling will begin at 21.00 on the 13th and end at 19.00 on 14th. The two sites at which the Epic's will be stationed are; Beam Bridge on the Torridge (NGR 4735,2090) and Rudha Bridge on the Yeo (NGR 4390,2250).

- Fixed Stations: FS1 Alaska; Mid channel approximately 700m downstream of new bridge (by the wreck). FS2 Zodiac; Mid channel approx 500m upstream of old bridge.

  Samples for bacteriology, suspended solids and filtered ammonia will be taken from the surface and 0.5m above estuary bed (if total depth is 2m or greater) every 1.5 hours from 09.30 until 20.00.

  Profiles of temperature, salinity, turbidity, pH and DO should be collected at 1m vertical intervals every 30 minutes from 09.30 to the end of the survey. Current speed should also be recorded at a depth of 1m every 30 minutes. Additional profiling will be carried out as the effluent slug passes.

  Filtered ammonia samples should be cool-boxed (with cool packs) ASAP then transferred to the Transit fridge (at Bank End) by the onshore gopher (HL). Bacteriology samples should be cool-boxed and relayed to the onshore gopher or courier (JP).

  THE ABOVE REGIME MAY BE MODIFIED BY THE CHASE BOAT IN ORDER FOR THE FIXED STATION TO SAMPLE THE SLUG OF EFFLUENT AS IT PASSES.

- Chase Boat: RIB - Personnel AM/CM/CS - to stand by at Bank End; A 0.5m surface drogue and c 10 citrus fruits (grapefruit) will be deployed at the first indication of the effluent discharging. A further drogue will be deployed at the end of the discharge (but no fruit). Once the extent of the plume has been identified and marked in this way a third and fourth drogue, and a different type of citrus fruit (oranges), will be deployed midway between the other two on the west and east edges of the plume, thus marking its lateral extremities. If the lead or mid drogues go aground or become fouled, the fruit should continue to act as a marker.

  Probe measurements of DO, pH, salinity and temperature should be made within the plume where time allows.

  Samples for bacteriology, filtered ammonia and suspended solids should be taken from the centre of the plume, and samples for bacteriology only should be taken from the plume margins where possible. The projected sampling sites are as follows, however these will be subject to change in the field to suite the plume behaviour on the day.

Ebb tide: The discharge boil, 250m downstream of the boil, under the new road bridge, at Fixed Station 1, opposite Appledore shipyard, off Instow beach, Off Skern Point.

Low Water: To be determined on site depending on timing of discharge. The boat will be of limited use on this run so wellies/waders will be the order of the day! Assistance will be required from the onshore gopher.

Flood tide: The discharge boil, 200m downstream of Bideford old bridge, at Fixed Station 2, Little America, just downstream of the Yeo confluence, at Addlehole.

PROJECTED TIMETABLE

06.45	Depart Exeter (Transit + RIB, 180 courier, 184 and a car.
08.00	Arrive Bank End car park, Bideford.
09.00	Collect samples from Epics (HL).
09.15	Boats on station and ready for 09.30 start.
09.30	Start of survey.
10.00	Courier departs for Exeter (JP).
13.00	" " " " (NB)
16.00	" " " " (JP)
20.00	Last samples and profiling.
21.30	Demob and return.

Fixed Station Equipment:

Current meters (Valeport 108 on FS1 & Braystoke on FS2), WTW DO,pH,Sal, Turbidity meter, Depth samplers (large one on FS1). Filtered ammonia kit, filtered ammonia bottles, PET bottles for Bacti (I will get the lab to do SS from the same bottles), crates, cool boxes and packs/ice. Warden Radios, Four HP outboard for FS1.

RIB Equipment: WTW DO,pH,Sal, Depth sampler, Filtered ammonia kit, filtered ammonia bottles, PET bottles for bacti and SS, crates/cool boxes and packs/ice, warden radio, marine VHF.

All instruments are to be pre-calibrated in the survey laboratory.

Gopher Van (184): Cool boxes and packs/ice, warden radio, PET bottles/labels for epic samples.

Transit: Fridge, all 0.5m drogues, crates of fruit, all spare equipment and bottles.

Courier Van: Cool boxes and packs/ice.

SURVEY LOG:

13-8-91 21.00:	Epics in place at Beam bridge (Torridge) and Rudha bridge (Yeo). Each two hour sample to be an integration of 20 minute sub-samples. Sampling tube arranged carefully to avoid blockage.
14-8-91 09.00:	Alaska and Zodiac prepared and launched at Bank End slipway, Bideford. Immediately travelled to fixed station sites.
09.30:	First set of Epic samples retrieved and couriered to Exeter laboratory. N.B. first sample almost 12 hours old by this time. Fixed stations begin sampling/profiling. Weather warm but some cloud.
10.30:	N.B. begins discussions with pump house staff. Chase boat prepared and launched.
12.00:	Chase boat on station over discharge diffuser.
12.05:	Main gravity discharge commences - only two boils visible therefore other three ports of diffuser must be blocked. Some difficulty in determining the leading edge of the plume was encountered. The lead drogue was deployed and grapefruit spread across the leading edge. All drogues were set at 0.5m.
12.20:	Gravity discharge ceases - unusually short. Tail end drogue deployed. Further drogues and oranges deployed mid-way between the lead and tail drogues on each edge of the plume.
12.25:	First plume samples taken 250m downstream of the discharge boil. Grapefruit already travelling faster downstream than drogues (perhaps drogues were being held back by northerly breeze blowing against the tide).
12.45:	Second plume samples taken. Lead drogue and eastern edge drogue both travelled under the eastern span of the new road bridge. Western edge drogue still under the western span of the new bridge. Citrus fruit increasingly difficult to spot.
12.56:	Lead plume drogue passed fixed station 1.
13.01:	Western edge plume drogue passed fixed station 1.
13.20:	Tail plume drogue passed fixed station.
13.25:	Fixed station 1 Alaska samples tail end of plume.
13.40:	Eastern edge plume drogue discovered to be aground upstream of fixed station 1. Upstream, onshore gopher collects

samples from fixed station 2.

13.45: Citrus fruit no longer visible - apparently disappeared.

13.50: Plume samples taken just behind lead drogue off Appledore shipyard.

14.00: All samples collected so far by fixed station 1 and chase boat were transported to eastern bank and handed to courier for transport to the laboratory.

14.05: Lead drogue lost - final ebb tide samples taken close to the western edge plume drogue off Appledore slipway, although all remaining drogues were following the main navigation channel due to a lack of water.

14.10: Comprehensive search for lead drogue made - tide off Skern point very strong. Finally discovered lead drogue aground on sand bar just upstream of Instow beach.

14.30: Ebb run finished - a visual search for the citrus fruit released on the ebb was made from the shore. Chase boat beached at Appledore. Oranges were identified on the same sand bar as the lead drogue. Due to the lack of water the low water plume track was abandoned - the mudflats were too difficult to move about on. The rest of the samples collected on the ebb tide were couriered to Exeter.

18.00: Flood tide just beginning at Appledore - chase boat travelled up estuary slowly with rising water level-frequent groundings.

18.10: A further search for the lost citrus fruit revealed the presence of a single grapefruit at the base of the sea wall at Instow. No others were located.

19.00: Start of flood run - boil sample taken (this discharge was one of the regular small pumped discharges that occurred every 20 minutes). Flooding tide very strong indeed, thus no time for edge samples. Only a few oranges deployed as a plume marker due to the excessive current speed.

19.15: Second plume samples taken 100 m downstream of Bideford old bridge. Chase boat grounded trying to obtain eastern edge samples - great difficulty experienced in breaking free.

19.20: Fixed station 2 took next plume samples as oranges passed. Vessel was dragging anchor and moved approximately 100m upstream while samples were being obtained.

19.30: Final flood tide samples obtained at the Little America bend. Current speed very high - difficulty experienced in holding station. Several grapefruit, presumably from the previous ebb tide release, were observed passing upstream at high velocity. There was no way the plume could be followed further due to the high current speeds and narrow channel.

20.00: Demobilization and vessel recovery at Bank End slipway, Bideford. All samples refrigerated and couriered to Exeter by the survey team.

FURTHER COMMENTS:

The freshwater input sampling by the pre-programmed Epics appeared to work well. However, many of the overnight samples were considerably 'older' than six hours by the time they were delivered to the laboratory. The results given may thus be somewhat of an underestimate.

The fixed station data collection went smoothly, but the chase boat experienced several problems - the main one of which was a lack of time to complete all the planned sampling/measurements. No direct water quality measurements were made within the effluent plume as a result. Also, the citrus fruit proved to be less useful as a means of plume tracking than had been anticipated. A considerable difference was noted between the behaviour of the 0.5m drogues and the fruit - the fruit moving more quickly.

Also, as we were to discover later, the main gravity discharge of the tank sewer that we tracked turned out to be only a fraction of the volume of similar discharges on days leading up to our survey. The reason for this discrepancy remains unclear, especially as the influx of sewage to the system appeared from the pump house records to be very similar to preceding days.

The planned low water plume track proved to be impossible to carry out due to the total lack of water and the unstable nature of the mud/sand flats. The discovery of much of the citrus fruit, lost early on the ebb tide run, on the exposed sand bar close to Instow beach suggested that at least some of the plume had become trapped by the bed topography in the area close to Instow on the eastern edge of the estuary. This in turn suggests that certain ebb tide discharges may impact directly on Instow beach which is EC designated.

Our suspicion that only two diffuser ports were operational (out of the possible five) was confirmed at low water - the rest had been covered by sediment. Presumably this means that the desired initial dilution of effluent is not being achieved.

The onset of the flood tide was sudden. Any discharge that occurs during this period of the tidal cycle will undoubtedly be pushed far up-estuary. The plume we attempted to track travelled at least 2km upstream within 25 minutes of being discharged. Although the mixing of any effluent released on the flood tide will be greatly enhanced by the numerous supports of Bideford's old bridge, the increasingly restricted volume of water further up estuary is likely to lead to concentrated 'slugs' of effluent impacting on areas far upstream of Bideford itself.

The ineffectiveness of the use of only citrus fruits and drogues in tracking the effluent plume during the spring tide survey led to a change in plans for the following neap tide survey. Fluorescein would also be employed in this case.

The data collected during the spring tide survey follows this description, and is preceded by a diagram of all the various sampling sites and some indication of the progress of the two discharges tracked. The paper records of the various sewer levels, obtained from the pump house, covering the period of the above survey are enclosed at the front of the folder. The actual regime of the discharge is described in the last section.

[4]BIDEFORD FINE SCREEN IMPACT SURVEY: NEAPS 19-8-91.

A neap tide survey of the Torridge estuary is planned for the 19th August. The aims of the field work will be similar to the previous survey of 14th August, except on this occasion we are only interested in a single large gravity discharge of the main tank sewer on a neap tide ebb. The discharge will be tracked in a similar way to our previous effort, but with the additional use of fluorescein.

Only one fixed station will be used - at the site approximately 700m downstream of the new road bridge. The chase boat (RIB) will operate as before but carry dye, three 0.5m drogues and the remaining citrus fruit.

EQUIPMENT:

Fixed Station: Alaska, Ammonia and bacti bottles, filtration kit, depth sampler, Valeport 108 current meter and associated ropes and weights. Temperature, salinity, pH, DO and turbidity probes and top boxes. Warden radio.

Chase boat: RIB, bottles as above and filtration kit, probes as above, fluorescing (approximately 4 x 1 litre containers), 3 x 0.5m drogues and the remaining citrus fruit from the survey of 14-8-91.

SAMPLING PROGRAMME:

Fixed Station: Begin sampling and profiling approximately one hour before expected discharge (15.50) = 14.50 start. Profile every 30 minutes at 1m vertical intervals from near bed to near surface. Current speed and direction should be recorded at a depth of 1m every 30 minutes. Water samples for bacteriology, suspended solids and Ammonia should be taken at the two depths of 0.5m below surface and 0.5m above bed, but only at hourly intervals. Additional profiling and sampling should be carried out as the effluent plume passes.

Chase boat: As on the previous survey (14-8-91) surface samples for bacteriology, suspended solids and Ammonia should be taken in the centre of plume at the following provisional sites; discharge boil, 250m downstream of the boil, under the new road bridge, at the Fixed station, off Appledore shipyard, off Instow beach and off Skern point. Also, channel edge samples should be collected where time allows. Such samples will be for bacteriology and suspended solids only.

Shore person: To leave Exeter approximately 1.5 hours in advance of the rest of the survey team and travel to Bideford fine screen pumping station to ascertain the exact situation and a record of the various sewer levels. Also to collect a bacteriology sample from both the rivers Yeo and Torridge at Rudha and Beam bridges respectively. These samples should be repeated at approximately 14.30. Later in the day assistance will also be required in vehicle and trailer movements ashore.

All samples taken afloat should be coolboxed with ice immediately. The entire sampling run will be returned to the laboratory in Exeter by the survey team itself - thus no need for couriers.

It is anticipated that both vessels will be prepared and launched at the Bank End slipway in Bideford. Vessel recovery will be achieved at Appledore slipway due to the likely lack of water later in the day.

Estimated departure time from Exeter is 11.00 on 19-8-91. The single plume track we will be attempting should begin just before 16.00.

SURVEY LOG:

19-8-91	09.30:	Shore person departs Exeter.
	10.45:	Bacteriological samples obtained from the rivers Torridge and Yeo at Beam and Rudha bridges respectively.
	11.00:	Shore person ascertains from pump house staff that system appears to be functioning correctly. Confirms this with survey team in Exeter.
	11.20:	Rest of survey team leave Exeter with vessels and equipment.
	13.00:	Survey teams arrive Bideford Bank End and begin vessel mobilization. Weather very hot, sky cloudless.
	14.20:	Fixed station vessel Alaska launched and travels to site. Second set of bacteriological samples obtained from rivers Torridge and Yeo.
	15.00:	Fixed station sampling/profiling commences. Some boil visible from the discharge point - this confirmed as not being the major gravity discharge. Chase boat made ready and launched - a brief engine problem was solved afloat. Shore person continued liaison with pump house staff.
	15.30:	Main gravity discharge commenced without prior warning- about 20 minutes earlier than originally anticipated. Chase boat sampling begins immediately. Probing of surface water also completed.
	15.35:	Approximately 0.5 l of fluorescein was injected across the front edge of the plume, the front2 edge of which was now highly visible. 0.5m drogues were deployed at the front edge of the plume and at either lateral extreme. Fixed station and chase boat DO readings both exceptionally high. Probes checked frequently. High readings most likely associated with large phytoplankton biomass - large amounts of filamentous strands visible in the water column.
	15.50:	Second plume samples and water quality measurements taken 250m downstream of discharge boil. Tail plume drogue deployed over outfall. Dye already spread across half the estuary width.
	16.10:	Next set of plume samples and measurements taken off Limers lane, approximately 100m downstream of new road bridge. Dye patch split by main bridge support. Most concentrated patch appeared to pool against west bank just downstream of the new bridge.
	16.15:	Dye patch becoming less visible - a further 0.5 l of fluorescein injected to reinforce patch.

16.25: Front edge of dye patch passes fixed station 1. Plume samples taken. Western bank drogue grounded approximately 200m upstream of the fixed station. Eastern bank drogue in very shallow water and approaching debris on mudflats. The eastern edge drogue was thus recovered by the chase boat.

16.55: Plume samples taken off Appledore shipyard. Dye still visible. Lead and tail drogues still afloat - moving down main navigation channel.

17.25: Dye approaching bend in navigation channel off Appledore slipway. A further 0.5 l of fluorescine injected. Dye travelling slightly ahead of lead drogue. Dye now directly following the track of the main navigation channel.

17.30: Plume samples taken off Appledore slipway. No water quality measurements made. Chase boat then travelled upstream to recover western edge drogue, grounded earlier upstream. Plume then observed from land at Appledore.

18.00: Further fluorescein injected into plume off Instow beach.

18.10: Plume samples taken midway along Instow beach. No water quality measurements made due to the danger of grounding at the edge of the channel. Dye already mixing quickly as the confluence with the Taw approached.

18.30: Dye patch lost - only drogues to follow. Further dye injected (approximately 10ml) mid-channel at the Taw-Torridge confluence. Within 15 minutes it had been fully mixed and was no longer visible.

19.00: Final plume samples and measurements made off the end of Instow beach, near the lead drogue. It is likely that the plume was fully mixed by this stage. Final fixed station samples taken.

19.05: Both remaining drogues recovered by chase boat. Arrangements made with shore personnel to recover vessels at Appledore slipway due to a lack of water at Bank end.

19.30: Vessels recovered at Appledore, all samples transferred from coolboxes to transit fridge. General demobilization and return to Exeter.

FURTHER COMMENTS:

The use of dye and drogues proved a far more effective method of accurately tracking the effluent plume than the citrus fruit used previously (14-8-91).

Once again the fixed station data collection went smoothly. The chase boat also managed to collect more information on this occasion due mainly to the presence of extra personnel on board.

Despite the fact that the main gravity discharge we intended to track occurred earlier than expected, the discharge itself lasted approximately 40 minutes and was consequently much closer to the magnitude we were expecting. Examination of the pump house records will confirm the volume of the discharge.

The only unusual aspect of any of the data collected appears to be the exceptionally high DO readings. Both vessels recorded equally high values thus instrument malfunction seems very unlikely. Frequent recalibrations were also carried out. More likely is the fact that the meteorological and nutrient conditions (the weather was extremely warm) had resulted in a short term phytoplankton bloom. Certainly large amounts of filamentous material were visible in the water column throughout the day.

As on the previous survey (14-8-91), only two surface boils were visible over the discharge, thus it is likely that three of the five diffuser ports remained blocked by sediment (although this could not be confirmed by a visual inspection at low water).

As before, all the various data collected during the above survey is enclosed in this section. A map of all the actual sampling sites is also enclosed, together with some indication of the progress of the dye and drogues. The relevant paper records obtained from the pump house are, as before, enclosed at the front of this folder.

[5]DISCHARGE REGIME AND PUMP HOUSE RECORDS:

We have managed to obtain only those records relevant to our Spring tide survey of 14-8-91 and our Neap tide survey of 19-8-91. The paper records obtained from the pump house (attached inside the cover of the project file) represent three things:

i) The main tank sewer level - highlighted in green
ii) The influx of sewage to the system - highlighted in blue
iii) The storm sump level - not highlighted

As far as we have been able to ascertain, the levels shown on the records are not correctly calibrated as yet. As a result of this, the volumes of the various discharges shown on the records have been derived only from the known capacities of the various pumps and information obtained during conversations with the system operators. The effluent itself is screened through a 1.5mm mesh.

The actual regime of the discharge is summarized by the attached pie diagram. According to this regime, the main tank sewer gravity discharge is supposed to commence at HW+2 in order to catch the strongest period of ebbing tide. However, the timing of this discharge did not appear to be fully under control at the time of our fieldwork.

The major controlling device for the timing of the system with respect to the tide is a 'lunar clock'. This has apparently been programmed in advance with predicted tidal times for the next five years. Such times were derived for SWWSL by an independent consultant using Admiralty predictions for Avonmouth and a 'correction factor'. The reliability of the system, and the predictions on which it is based, is unknown. At the time of our fieldwork we remained unconvinced that the system was operating precisely to specification, and sources have it that the main tank discharge often occurs sooner after HW than HW+2.

Further information relating to the discharge contained in this section is as follows:

i) Notes on the operating regime
ii) Extracts from the pumping station operating manual
iii) Diagram of the main tank sewer
iv) A copy of the DoE consent for the Bideford Fine Screen discharge

Much of the background and the history relating to the Bideford fine screening plant is contained in the document supplied with this project folder: 'Torridge District Council Inquiry into an appeal by South West Water Authority regarding the proposed fine screening plant at Bideford, and into an application by the Authority for consent to discharge fine screened sewage to the Torridge estuary at Bideford'. 1985.

APPENDIX C

Bideford Fine Screen Outfall Post-scheme Appraisal Data

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Bideford Fine Screen Outfall Post-scheme Appraisal Data

Bideford Fine Screen Outfall - Post Scheme Appraisal

Table C.1a: Discharged Effluent Plume Neep Tide Survey (07-JUN-91) - Low Water Sampling

Site No.	Time (BST)	Total Depth (m)	T/M/B	Temp (deg.C)	Sal. (ppt)	DO (% sat.)	pH	Feecal Coliforms (No./100ml)	S.Solids 105C (mg/l)	S.Solids 500C (mg/l)	Total Organics (mg/l)	TON (mg/l N)	NH4 (mg/l N)	Cloud Cover (OCT)
4	8.50	0.5	T	14.5	19.6	94	8.07	800	32	25	7	0.87	0.152	8/8
5	9.20	1.8	T	14.6	18.8	94	8.08	310	12	10	2	1.14	0.136	8/8
			B	14.6	18.9	95	8.08							
8	9.45	0.5	T	15.0	17.2	95	8.01	510	15	10	5	1.05	0.137	7/8
8	8.30	>1	T	14.5	12.9	88	8.02					1.22	0.129	
			B	14.5	13.0	87	8.02							
9	8.45	0.5	T	14.7	11.6	88	8.01	1800	25	18	7	0.47	0.144	
			B	14.7	12.8	88	8.01							
10	9.05	0.5	T	14.7	12.0	87	7.98	1700	41	27	14	0.59	0.14	
11	8.06	0.9	T	14.5	9.4	84		2900	14	12	2	1.07	0.127	
	8.14		B	14.5	9.4	85								
12	9.21	0.5	T	14.9	7.2	87		1300	15	<1	15	1.18	0.121	
13	9.45	0.4	T	14.9	0.6	90		480	38	20	18	1.51	0.082	

Bideford Fine Screen Outfall - Post Scheme Appraisal

Table C.1b: Discharged Effluent Plume Neap Tide Survey (07-JUN-91) - Mid Flood Sampling

Site No.	Time (BST)	Total Depth (m)	T/M/B	Temp (deg.C)	Sal. (ppt)	DO (% sat.)	pH	Faecal Coliforms (No./100ml)	S.Solids 105C (mg/l)	S.Solids 500C (mg/l)	Total Organics (mg/l)	TON (mg/l N)	NH4 (mg/l N)	Cloud Cover (OCT)
4	11.50	3.5	T	14.3	2.8	102	8.18	140	11	6	5	0.08	0.048	8/8
			M	13.0	33.4	102	8.18							
			B	13.0	34.4	102	8.18							
5	11.36	4.5	T	13.7	31.0	103	8.14	730	58	48	10	0.17	0.058	8/8
			M	13.6	31.7	97	8.15							
			B	13.6	31.7	97	8.15							
7	11.16	3.5	T	14.3	2.8	102	8.17	220	83	68	15	0.40	0.092	8/8
			M	14.3	28.0	100	8.16							
			B	14.3	28.0	100	8.17							
9	11.20	2.0	T	14.3	26.9	96	8.18	1900	33	25	8	0.51	0.119	8/8
			M	14.3	26.9	97	8.18							
			B	14.3	26.8	97	8.18							
9a	11.35	0.3	T	14.4	27.7	95	8.18	1300	41	27	14	0.44	0.11	8/8
9b	11.25	2.5	T	14.2	27.8	97	8.18	41000	29	16	13	0.40	0.125	8/8
			M	14.2	28.4	95	8.18							
			B	14.2	28.3	96	8.18							
9c	11.15	2.5	T	14.5	24.9	99	8.17	250	31	20	11	0.63	0.111	8/8
			M	14.5	25.7	99	8.17							
			B	14.5	25.5	99	8.17							
9d	11.05	0.3	T	14.8	22.6	98	8.17	390	49	28	21	0.83	0.11	7/8
			B	14.7	22.7	97	8.17							
10	11.45	5.5	T	14.4	27.0	98	8.18	860	26	13	13	0.50	0.108	8/8
			M	14.3	27.5	96	8.18							
			B	14.3	27.4	95	8.17							
10a	12.10	2.5	T	14.2	28.2	94	8.16	1000	27	8	19	0.47	0.112	8/8
			M	14.2	28.5	94	8.18							
			B	14.2	28.4	94	8.16							
10b	12.02	5.0	T	14.3	28.2	96	8.18	1100	19	3	16	0.41	0.128	8/8
			M	14.1	28.8	94	8.18							
			B	14.2	28.6	92	8.17							
10c	11.56	2.5	T	14.4	27.7	99	8.18	500	42	19	23	0.48	0.115	8/8
			M	14.3	27.6	98	8.18							
			B	14.3	27.6	98	8.18							
10d	11.50	0.6	T	14.6	25.5	97	8.18	280	46	20	26	0.62	0.109	8/8
			B	14.5	26.1	97	8.18							
11	11.50	>3.0	T	15.1	21.5	98		3300	41	20	21	0.69	0.15	8/8
			M	15.0	21.8	101								
			B	15.0	22.2	104		3500	27	17	20	0.62	0.139	
11a	12.09	2.4	T	14.9	23.8	97		4200	33	11	22	0.71	0.133	8/8
			M	14.8	24.5	97								
			B	14.8	24.8	99		3100	33	18	15	0.65	0.127	
11d	11.57	>3.0	T	14.9	22.8	99		2600	36	17	19	0.58	0.116	
			M	14.8	23.8	101								
			B	14.8	23.8	104		1600	36	18	18	0.68	0.136	
12	11.20	2.0	T	15.4	14.4	95		3100	50	32	18	1.14	0.134	
			B	15.3	15.6	100		21000	40	30	10	0.96	0.136	

Table C.1c: Discharged Effluent Plume Neap Tide Survey (07-JUN-91) - High Water Sampling

Site No.	Time (BST)	Total Depth (m)	T/M/B	Temp (deg.C)	Sal. (ppt)	DO (% sat.)	pH	Faecal Coliforms (No./100ml)	S.Solids 105C (mg/l)	S.Solids 500C (mg/l)	Total Organics (mg/l)	TON (mg/l N)	NH4 (mg/l N)	Cloud Cover (OCT)
4	13.10	5.5	T	13.1	33.8	102	8.22	10	38	29	9	0.07	0.021	7/8
			M	13.0	33.9	101	8.28							
			B	12.9	34.2	103	8.23							
5	13.30	5.0	T	13.5	33.0	102	8.02	10	8	4	4	0.12	0.038	
			M	13.0	33.4	97	8.02							
			B	13.0	33.6	102	8.21							
5c	13.20	4.0	T	13.3	33.2	101	8.02	10	4	2	2	0.10	0.028	6/8
			M	13.0	33.4	95	8.02							
			B	13.0	33.6	103	8.21							
6	13.45	3.0	T	13.7	32.1	99	8.18	10	15	13	2	0.17	0.052	6/8
			M	13.7	32.1	97	8.18							
			B	13.5	32.3	100	8.18							
7	14.10	5.0	T	14.0	31.3	97	8.17	110	29	25	4	0.18	0.068	6/8
			M	13.9	31.4	96	8.17							
			B	13.7	31.7	98	8.17							
7a	14.20		T	14.9	30.5	97	8.13	130	20	17	3	0.23	0.087	8/8
7d	14.00		T	14.2	31.1	97	8.17	90	46	39	7	0.19	0.067	
8	14.30		T					300000	26	13	13	0.28	0.879	
9	13.10	4.5	T	14.0	30.5	97	8.19	290	20	19	1	0.23	0.076	3/8
			M	13.8	30.8	97	8.19				0			
			B	13.8	30.8	97	8.19	800	5	1	4	0.25	0.098	
9a	13.00	3.3	T	14.2	29.9	98	8.19	3200	26	21	5	0.28	0.103	4/8
			M	14.0	30.1	98	8.19				0			
			B	14.1	30.1	98	8.18				0			
9b	13.05	3.5	T	14.0	30.2	98	8.19	220	17	15	2	0.28	0.089	3/8
			M	14.0	30.4	97	8.19				0			
			B	13.9	30.5	97	8.19				0			
9c	13.22	0.5	T	14.5	29.9	96	8.18	310	16	13	3	0.42	0.116	
9d	13.38	0.3	T	15.8	29.2	92	8.12	210	50	45	5	0.36	0.181	
10	14.00	5.5	T	14.4	29.3	98	8.19	520	22	12	10	0.38	0.112	4/8
			M	14.1	29.6	95	8.19				0			
			B	14.0	29.8	95	8.19	2200	27	24	3	0.32	0.098	
10a	14.13	3.0	T	14.4	29.2	100	8.19	2000	21	14	7	0.36	0.104	4/8
			M	14.3	29.3	100	8.19				0			
			B	14.1	29.8	96	8.19				0			
10b	14.09	5.5	T	14.5	29.4	100	8.19	1700	14	13	1	0.43	0.134	
			M	14.3	29.3	100	8.19				0			
			B	14.1	29.8	96	8.19				0			
10c	13.54	5.0	T	14.2	29.3	97	8.19	720	13	9	4	0.37	0.109	4/8
			M	14.1	29.6	95	8.19				0			
			B	14.1	29.7	96	8.19				0			
10d	13.48	5.5	T	14.4	29.2	99	8.19		22	21	1	0.33	0.093	
			M	14.1	29.6	95	8.19				0			
			B	14.0	29.7	96	8.18	470			0			3/8
11	14.41	4.5	T	15.5	21.7	104	8.19	790	18	12	6	0.69	0.144	5/8
			M	14.7	26.1	101	8.19				0			
	14.46		B	14.3	27.9	95	8.17	1200	16	16	0	0.50	0.12	
11a	14.35	0.3	T	15.6	22.3	102	8.18	630	14	14	0	0.66	0.146	5/8
11c	14.40	3.4	T	15.7	22.1	104	8.09	1100	9	9	0	0.81	0.117	
			M	14.7	26.8	103	8.09				0			
			B	14.5	27.8	100	8.07	1300	9	9	0			
12	14.24	3.8	T	15.8	19.9	103	8.04	1600	20	12	8	0.66	0.119	
			M	14.8	25.4	97	8.02				0			
			B	14.8	25.3	100	8.01	2200			0			
13	14.00	4.2	T	16.0	10.3	90	7.91	1900	17	13	4	1.26	0.128	
			M	14.8	25.4	97	8.02				0			
			B	15.4	17.3	99	7.95	3800	32	21	11	1.05	0.133	
14	13.38	0.8	T	15.6	0.0	112	8.29	240	7	1	6	1.91	<0.010	
			B	15.6	0.0	114	8.32				0			

Table C.1d: Discharged Effluent Plume Neap Tide Survey (07-JUN-91) - Mid Ebb Sampling

Site No.	Time (BST)	Total Depth (m)	T/M/B	Temp (deg.C)	Sal. (ppt)	DO (% sat.)	pH	Faecal Coliforms (No./100ml)	S.Solids 105C (mg/l)	S.Solids 500C (mg/l)	Total Organics (mg/l)	TON (mg/l N)	NH4 (mg/l N)	Cloud Cover (OCT)
4	16.50	2.0	T	14.6	30.2	104	8.18	1100	21	16	5	0.26	0.096	7/8
			M	14.3	31.0	101	8.18				0			
			B	13.9	31.8	102	8.20				0			
4a	16.40		T	14.7	31.2	100	8.20	690	22	14	8	0.19	0.074	
4d	17.00		T	14.9	30.9	100	8.19	1800	75	62	13	0.20	0.09	
5	16.20	3.5	T	14.5	30.1	102	8.18	700	37	26	11	0.27	0.085	6/8
			M	14.6	30.3	102	8.18				0			
			B	14.3	30.4	100	8.18				0			
5a	16.20		T	14.5	30.4	101	8.02	1700	44	35	9	0.24	0.098	8/8
5d	16.30		T	15.0	30.8	98	8.17	370	61	55	6	0.21	0.082	
6	16.00	2.0	T	14.6	29.4	102	8.02	2400	26	22	4	0.30	0.168	8/8
			M	14.5	29.7	102	8.02				0			
			B	14.3	30.3	99	8.02				0			
6a	16.10		T	14.2	29.8	97	8.02	150	39	34	5	0.27	0.094	
6d	15.50		T	14.2	29.6	100	8.02	290	65	56	9	0.39	0.082	
7	16.04	1.5	T	14.7	27.8	102	8.20	700	3	<1	<3	0.47	0.109	8/8
			M	14.5	28.8	100	8.20				0			
			B	14.4	29.0	101	8.20				0			
7a	15.51	1.5	T	16.3	29.7	100	8.18	620	12	10	2	0.30	0.094	8/8
			M	16.7	29.8	98	8.18				0			
			B	16.9	29.9	98	8.18				0			
7b	16.00	2.0	T	14.4	29.1	101	8.20	1100	32	26	6	0.37	0.108	8/8
			M	14.3	29.3	100	8.19				0			
			B	14.2	29.8	100	8.19				0			
7c	16.09	3.3	T	14.9	26.9	104	8.21	5100	18	14	4	0.38	0.143	
			M	14.7	29.0	100	8.19				0			
			B	14.6	29.2	100	8.19	3400	26	18	8	0.49	0.118	
7d	16.20	0.8	T	15.2	26.2	104	8.22	610	37	13	24	0.35	0.105	
			B	15.2	26.4	102	8.22				0			
8	16.30	1.5	T	15.3	23.0	107	8.23	620	47	31	16	0.77	0.119	
			M	15.0	26.3	102	8.21				0			
			B	14.7	27.6	100	8.19				0			
9	16.05	2.9	T	15.4	24.7	105	8.07	110	32	15	17	0.63	0.098	
			M	14.9	27.7	104	8.06				0			
			B	14.8	28.3	104	8.06	1500	31	19	12	0.50	0.103	
9b	16.10	3.0	T	15.5	23.4	105	8.08	860	32	15	17	0.72	0.1	
			M	15.0	26.7	104	8.06				0			
			B	14.7	28.0	104	8.06				0			
9c	15.51	3.5	T	15.4	26.8	102	8.05	760	21	7	14	0.49	0.1	
			M	15.4	28.6	101	8.05				0			
			B	15.5	28.9	101	8.05				0			
10	16.20	4.5	T	15.8	19.2	105	8.07	1000	15	3	12	0.72	0.112	
			M	15.1	24.8	104	8.06				0			
			B	14.9	26.1	101	7.87	900	18	5	13	0.61	0.101	
10b	16.35	2.5	T	15.6	19.3	105	8.06	1100	37	13	24	1.03	0.093	
			M	15.2	22.9	103	8.06				0			
			B	14.9	25.4	103	8.05				0			
10c	16.30	1.8	T	15.8	19.5	105	8.07	900	17	4	13	0.74	0.113	
			B	15.6	22.1	107	7.79				0			
11	16.45	2.5	T	16.2	12.4	98	8.03	1800	28	9	19	1.20	0.116	
			M	15.8	15.7	101	8.02				0			
			B	15.4	21.0	103	8.13	2900	21	5	16	0.97	0.109	
12	17.00	1.0	T	10.4	6.7	102	8.00	1100	22	4	18	1.23	0.072	
			M	16.3	7.8	102	7.98				0			
			B	15.4	18.0	95	7.98				0			

Bideford Fine Screen Outfall - Post Scheme Appraisal

Table C.2a: Discharged Effluent Plume Spring Tide Survey (14-AUG-91)
Mid Flood Sampling

Site Number	Time (BST)	Faecal Coliforms (counts/100ml)			NH4 (mg/l N)	SS(105C) (mg/l)
		West channel	Mid channel	East channel	Mid channel	Mid channel
8	19:01		97000		0.375	296
10	19:13		19000	1300	0.142	76
11	19:30		3900		0.163	48

Bideford Fine Screen Outfall - Post Scheme Appraisal

Table C.2b: Discharged Effluent Plume Spring Tide Survey (14-AUG-91)
Mid Ebb Sampling

Site Number	Time (BST)	Faecal Coliforms (counts/100ml)			NH4 (mg/l N)	SS(105C) (mg/l)
		West channel	Mid channel	East channel	Mid channel	Mid channel
3	14:06		500		0.0406	
4	13:51		900		0.0627	
5	13:26	400	4500	300	0.0561	
6	12:44	2100	9000	140	0.123	
7	12:22	700	68000	140	0.23	

Bideford Fine Screen Outfall - Post Scheme appraisal

Table C.3: Discharged Effluent Plume Neap Tide Survey (19-AUG-91)
Mid Ebb Sampling

Site Number	Time (BST)	Depth (m)	Temp. (deg. C)	Salinity (ppt)	D.O. (%sat)	pH	Faecal Coliforms (counts/100ml)			NH4 (mg/l)	SS(105C) (mg/l)
	Mid channel	Mid channel	Mid channel	Mid channel	Mid channel	Mid channel	West channel	Mid channel	East channel	Mid channel	Mid channel
1	19:00	0.5	18.8	31.9	135	8.42	890	280	100	0.041	
	18:58	2.5	18.7	32.5	132	8.38					
2	18:11	0.5					750	410	120	0.0398	72
3	17:28	0.5					1900	1400	1100	0.0441	155
4	17:00	0.5	18.4	31.5	136	8.4	7600	3500	490	0.0584	92
	16:54	2.5	18	32.8	123	8.31					
5	16:32	0.2	18.8	28.9	157	8.54	19000	56000	650	0.326	103
		1	18.7	29.5	152	8.52					
		2	18.9	30.6	136	8.43					
	16:28	2.8	18.2	32.1	121	8.34		6000		0.0879	157
6	16:10	0.5	18.8	29.1	162	8.5	20000	39000	640	0.155	111
	16:08	3	18.2	31.5	140	8.38					
7	15:51	0.5	19	27.4	169	8.58	330	340000	350	0.944	75
	15:50	2	18.3	29.5	163	8.53					
8	15:33	0.5	18.3	26.7	167	8.53		800000		2.16	127
	15:32	3	18	30.2	150	8.48					

Table C.4: Spring Tide Fixed Station Profiling Date - Site 5 (14-AUG-91)

Time (BST)	Tidal State	Depth (m)	Temp. (deg.C)	Salinity (ppt)	D.O. (%sat)	pH	Turbidity (ppm)	Curr. Spd. (m/s)	Curr. Dirn. (deg.)	SS(105C) (mg/l)	E.coli (No./100ml)	NH4 (mg/l)
9:35	HW	0.2	17.1	35.1	92	8.14	5			2.4	140	0.0141
		1	17.1	35.1	92	8.14	4.3	0.02	61			
		2	17.1	35.1	92	8.14	4.4					
		3	17.1	35.1	92	8.15	3					
		4	17.1	35.2	92	8.16	3.6					
		5	17.1	35.2	86	8.15	2.9					
		6	17.1	35.2	91	8.15	3					
9:42		7.3	17.1	35.2	88	8.15	3			5.4	130	0.0131
10:00	HW+0.5	0.2	17.2	35	95	8.13	5.2					
		1	17.1	35.3	96	8.16	3.6	0.22	40			
		2	17.1	35.3	97	8.16	3.6					
		3	17.1	35.2	97	8.15	3.8					
		4	17.1	35.3	99	8.16	3.4					
		5	17.1	35.3	98	8.16	3					
		6	17.1	35.3	96	8.16	3					
10:06		7	17.1	35.3	94	8.16	4					
10:30	HW+1.0	0.2	17.6	35	98	8.13	5					
		1	17.2	35.2	98	8.14	4.5	0.47	46			
		2	17.2	35.2	98	8.14	4.2					
		3	17.1	35.3	98	8.14	4					
		4	17.1	35.3	99	8.15	3.5					
		5	17.1	35.3	99	8.16	3.3					
10:37		6.5	17.2	35.3	98	8.16	4					
11:00	HW+1.5	0.2	17.2	35.1	97	8.14	5.7			11	160	0.0195
		1	17.3	35.1	99	8.12	5.5	0.45	47			
		2	17.2	35.1	99	8.13	5.5					
		3	17.3	35.1	98	8.16	6					
		4	17.2	35.1	98	8.16	5.8					
		5	17.2	35.1	98	8.14	6					
11:05		6	17.2	35.1	97	8.16	6.3			3.4	250	0.0207
11:30	HW+2.0	0.2	17.2	35.1	97	8.13	4					
		1	17.2	35.2	97	8.13	5.2	0.57	42			
		2	17.2	35.1	98	8.14	5					
		3	17.2	35.1	98	8.15	4.8					
		4	17.2	35.1	98	8.15	5					
11:36		5	17.2	35.1	99	8.16	7					
12:00	HW+2.5	0.2	17.4	34.9	99	8.13	7					
		1	17.4	35	97	8.13	7	0.61	41			
		2	17.3	35	97	8.14	7.5					
		3	17.3	35.1	97	8.13	8.5					
12:04		4.5	17.3	35	86	8.12	9.5					
12:30	HW+3.0	0.2	17.4	34.7	97	8.11	9			6.4	440	0.0305
		1	17.4	34.8	96	8.12	9.5	0.65	43			
		2	17.4	34.8	96	8.12	10					
		3	17.4	34.8	97	8.12	11.6					
12:34		4	17.4	34.9	97	8.13	13			15	530	0.0272
12:57	HW+3.5	0.2	17.6	34.1	95	8.08	11			10	160	0.0481
		1	17.6	34.2	95	8.09	14	0.75	44			
		2	17.6	34	95	8.1	14					
13:30		3	17.6	34.1	95	8.09	18			11	170	0.0418

Table C.4 (continued): Spring Tide Fixed Station Profiling Data - Site 5 (14-AUG-91)

Time (BST)	Tidal State	Depth (m)	Temp. (deg.C)	Salinity (ppt)	D.O. (%sat)	pH	Turbidity (ppm)	Curr. Spd. (m/s)	Curr. Dirn. (deg.)	SS(105C) (mg/l)	E.coli (No./100ml)	NH4 (mg/l)
13:30	HW+4.0	0.2	17.9	32.8	91	8.06	25					
		1	17.9	33.2	91	8.06	22	0.87	44			
		2	17.9	33.1	91	8.07	33					
13:33		2.5	17.9	33	91	8.06	24					
14:00	HW+4.5	0.2	18.1	30	90	8.03	30			22	5100	0.0866
		1	18.1	31.2	89	8.04	30	0.92	43			
14:02		2	18.1	31.3	90	8.05	50			22	3400	0.0878
14:30	HW+5.0	0.2	18.4	28	89	8.02	30					
		1	18.4	28	88	8.02	57	0.85	40			
14:32		1.5	18.4	28.1	88	8.02	50					
15:00	HW+5.5	0.2	18.7	25.8	88	8.01	44					
		1	18.7	25.8	87	8.02	35	0.69	38			
15:02		1.5	18.7	26.1	88	8.02	55					
15:30	HW+6.0	0.2	19	24.1	89	8	40			38	2100	0.134
15:31		1	19	24.3	87	8.02	35	0.49	38			
16:00	HW-6.0	0.2	19.1	23.2	88	8	30.2					
16:01		1	19.1	23.2	86	8.01	35	0.44	38			
16:30	HW-5.5	0.2	19.2	21.9	88	8.01	30					
16:31		0.8	19.2	21.9	87	8.02	29	0.4	38			
17:00	HW-5.0	0.2	19.3	21.3	88	8.03	30			30	900	0.145
17:01		0.8	19.3	21.3	88	8.01	25	0.33	39			
17:30	HW-4.5	0.2	19.4	20.7	91	8.04	23					
17:31		0.5	19.3	20.7	90	8.05	23	0.3	40			
18:00	HW-4.0	0.2	19.5	20.4	87	8.01	12					
18:01		0.5	19.5	20.5	87	8.01	20.2	0.03	48			
18:30	HW-3.5	0.2	19.5	27	107	8.12	60			32	2200	0.0831
		1	19	30.2	112	8.16	90	1.11	233			
18:32		1.5	19	29.6	112	8.16	70					

Table C.5: Spring Tide Fixed Station Profiling Data - Site 11(approx.) (14-AUG-91)

Time (BST)	Tidal State	Depth (m)	Temp. (deg. C)	Salinity (ppt)	D.O. (%sat.)	pH	Turbidity (ppm)	Curr. Spd. (m/s)	Curr. Dirn.	SS(105C) (mg/l)	E.coli (No./100ml)	NH4 (mg/l)
9:33	HW	0.2	17.1	33.7	78	8.11	8.5				2100	0.0383
		1	17.1	34.1	80	8.14	9.5	0.06	ebb			
		2	17.1	34.3	83	8.14	9					
		3	17.1	34.3	82	8.14	10.5					
		4	17.1	34.3	82	8.14	11					
		5	17	34.3	75	8.14	11.5					
9:40		6	17	34.3	71	8.14	9.5				600	0.0408
10:00	HW+0.5	0.2	17.3	33.5	84	8.11	7.4					
		1	17	34.1	85	8.13	9	0.28	ebb			
		2	17	34.2	84	8.13	8.8					
		3	17	34.3	82	8.14	8.7					
		4	17.1	34.4	84	8.14	8.8					
		5	17.1	34.4	82	8.14	9.2					
10:05		6	17	34.4	82	8.14	8.2					
10:30	HW+1.0	0.2	17.1	33.9	85	8.12	10.7					
		1	17.1	33.9	84	8.12	14.9	0.65	ebb			
		2	17.1	33.9	84	8.12	15.5					
		3	17.1	34	83	8.12	15					
		4	17.1	34	84	8.12	17.8					
		5	17.1	34	83	8.12	16.8					
10:35		5.5	17.1	34	82	8.12	17.9					
11:00	HW+1.5	0.2	17.2	33.1	82	8.09	10.6				170	0.0481
		1	17.2	33.1	81	8.09	12.8	0.53	ebb			
		2	17.3	33.1	80	8.1	13.6					
		3	17.2	33.4	81	8.1	13.8					
		4	17.2	33.4	80	8.1	14.8					
11:05		5	17.1	33.5	78	8.1	17					
11:30	HW+2.0	0.2	17.4	32.5	80	8.05	52					
		1	17.2	32.6	80	8.08	19					
		2	17.2	32.7	80	8.08	18					
		3	17.2	32.9	79	8.07	20					
11:35		4	17.2	32.9	76	8.04	35					
12:00	HW+2.5	0.2	17.7	30.7	78	8.04	15.7					
		1	17.6	31	78	8.05	17.5	0.71	ebb			
		2	17.6	31.6	77	8.05	23.3					
		3	17.5	31.7	77	8.05	24.2					
12:04		3.5	17.5	31.7	77	8.05	26					
12:30	HW+3.0	0.2	18.1	27.4	77	8.02	18.3			10	400	0.111
		1	17.7	28.5	76	8.03	22.3	0.71	ebb			
		2	17.6	29.4	76	8.03	26.1					
12:34		3	17.5	29.8	75	8.04	33.3			36	2800	0.115
13:00	HW+3.5	0.2	18.1	25.4	74	7.99	25	0.72	ebb			
		1	17.9	26.3	73	8	27.7					
		2	17.8	27.1	72	8	32					
13:03		2.5	17.8	27.2	72	8	50					
13:30	HW+4.0	0.2	17.9	23.3	71	7.96	30.8					
		1	18	23.8	69	7.97	41	0.65	ebb			
13:32		2	17.9	23.9	69	7.97	49					

Table C.5 (continued): Spring Tide Fixed Station Profiling Data - Site 11(approx.) (14-AUG-91)

Time (BST)	Tidal State	Depth (m)	Temp. (deg. C)	Salinity (ppt)	D.O. (%sat.)	pH	Turbidity (ppm)	Curr. Spd. (m/s)	Curr. Dirn.	SS(105C) (mg/l)	E.coli (No./100ml)	NH4 (mg/l)
14:00	HW+4.5	0.2	18.1	20.7	69	7.95	41			50	3700	0.143
		1	18.1	33.2	71	7.96	51.5	0.55	ebb			
14:01		1.5	18.1	21.5	70	7.98	60					
14:30	HW+5.0	0.2	18.3	19.7	69	7.94	51					
14:31		1	18.3	19.8	69	7.93	69	0.37	ebb			
15:00	HW+5.5	0.2	18.6	18.5	71	7.95	41.3					
15:01		1	18.7	18.5	71	7.98	56.4	0.23	ebb			
15:30	HW+6.0	0.2	19	17.7	74	8	40.1					
15:31		1	18.8	17.7	72	7.98	48.1	0.16	ebb	20	2300	0.153
16:00	HW-6.0	0.2	19.3	17.3	76	8	32.8					
16:01		0.5	19.2	17.4	75	8	35.3	0.13	ebb			
16:30	HW-5.5	0.2	19.3	17	78	8	25.2					
16:31		0.5	19.4	17.1	78	8.01	29.9	0.13	ebb			
17:00	HW-5.0	0.2	19.3	16.6	789	8.02	27.8	0.17	ebb	24	3300	0.166
17:30	HW-4.5	0.2	19.4	16.2	78	8.03	24.5	0	slack			
18:00	HW-3.5	0.2	19.7	16	80	7.65	31.2	0.046	flood			
18:30	HW-3.0	0.2	19.6	15.7	78	7.99	22.1	0	flood	20	2500	0.181
19:00	HW-2.5	0.2	19.5	16	88	8.07	70					
19:01		1	19.7	15.8	85	8.06	109	0.55	flood			
19:23	HW-2.0	0.2	19.2	26	94	8.09	74			58	3400	0.107
		1	19.2	27	93	8.08	90	1.28	flood			
		2	19.2	27	93	8.09	130					
19:33		3	19.2	23.7	95	7.89	150			64	3900	0.121

Table C.6: Neap Tide Fixed Station Profiling Data - Site 5 (19-AUG-91)

Time (BST)	Tidal State	Depth (m)	Temp. (deg. C)	Salinity (ppt)	D.O. %sat.)	pH	Turbidity (ppm)	Curr. Spd (m/s)	Curr. Dirn. (deg.)	SS(105C (mg/l)	E.coli (No./100ml	NH4 (mg/l)
15.00	HW + 1.0	0.2	18.4	32.2	116	8.30	3.4			68	10	0.0410
		1.0	18.3	32.2	116	8.30	3.7	0.12	35			
		2.0	17.8	33.0	108	8.24	1.8					
15.04		3.5	17.8	33.0	108	8.24	2.4			37	60	0.0412
15.30	HW + 1.5	0.2	18.4	31.8	123	8.85	2.9					
		1.0	18.4	31.8	123	8.34	3.7	0.25	31			
		2.0	17.9	32.9	109	8.26	2.0					
15.34		3.0	17.9	33.1	107	8.24	1.8					
16.00	HW + 2.0	0.2	18.7	30.7	141	8.43	3.5					
		1.0	18.6	31.1	136	8.41	4.5	0.31	40			
		2.0	18.5	31.4	133	8.39	4.6					
16.04		2.8	17.9	32.5	112	8.30	3.0					
16.28	HW + 2.5	0.2	18.8	28.9	157	8.54	5.7			103	56000	0.3260
		1.0	18.7	29.5	152	8.52	6.4	0.38	40			
		2.0	18.9	30.6	136	8.43	5.2					
16.32		2.8	18.2	32.1	121	8.34	4.4			157	6000	0.0879
17.00	HW + 3.0	0.2	18.6	27.0	174	8.63	6.2			51	5400	0.0774
		1.0	18.7	27.8	167	8.58	7.4	0.33	42			
17.03		2.5	18.6	29.9	143	8.49	7.5			89	14000	0.1020
17.30	HW + 3.5	0.2	18.6	26.1	182	8.66	6.8					
		1.0	18.7	26.2	180	8.64	7.5	0.41	36			
17.32		2.0	18.6	27.4	174	8.62	7.5					
18.00	HW + 4.0	0.2	18.6	25.8	179	8.67	9.0					
		1.0	18.6	26.1	174	8.66	8.0	0.27	46			
18.02		2.0	18.7	26.3	174	8.66	8.5					
18.30	HW + 4.5	0.2	18.7	25.8	178	8.69	13.0					
		1.0	18.7	26.1	177	8.68	15.5	0.18	46			
18.32		1.5	18.9	26.3	175	8.69	15.5					
19.00	HW + 5.0	0.2	18.8	22.2	177	8.70	14.0			79	5000	0.0342
19.01		1.0	18.8	22.8	170	8.70	16.8	0.22	38			

Table C.7: Freshwater Faecal Coliform Data for the Rivers Torridge and Yeo (13/14-AUG-91)

Date	Time Period (BST)	Faecal Coliforms (No./100ml)	
		River Torridge (Beam Bridge)	River Yeo (Rhudha Bridge)
13-Oct-91	21:00 - 23:00	1900	1400
13/14-Oct-91	23:00 - 01:00	3000	1600
14-Oct-91	01:00 - 03:00	4000	3000
14-Oct-91	03:00 - 05:00	4300	2100
14-Oct-91	05:00 - 07:00	4400	1700
14-Oct-91	07:00 - 09:00	1900	3200
14-Oct-91	09:00 - 11:00	1000	1700
14-Oct-91	11:00 - 13:00	1300	4100
14-Oct-91	13:00 - 15:00	700	3200
14-Oct-91	15:00 - 17:00	1300	2400
14-Oct-91	17:00 - 19:00	1600	4100
14-Oct-91	19:00 - 21:00		2400

APPENDIX D

Historic Water Quality Data

APPENDIX D

Historic Water Quality Data

Table D.1a: Summary of Available Dissolved Ammonia Data (ug/l) 1982-1991

Site No.	NAME	N.G.R.	1982 (SWW) Mean	1982 (SWW) Maximum	1982 (SWW) Date	1984 (SWW) Mean	1984 (SWW) Maximum	1984 (SWW) Date	1985 (SWW) Mean	1985 (SWW) Maximum	1985 (SWW) Date	1987 -89 (WIMPOL) Mean	1987 -89 (WIMPOL) Maximum	1987 -89 (WIMPOL) Date	1991 NRA (Neaps) Mean	1991 NRA (Neaps) Maximum	1991 NRA (Neaps) Date
A	Instow	470 305	190 (2)	280	10-6-82												
3	Appledore	466 306	175 (2)	280	10-6-82	9 (47)	63	26-9-84				53			79 (4)	152	7-6-91
5	Boathyde	462 288										68			79 (4)	136	7-6-91
6	Snuffy/Cleve	556 640	295 (2)	330	1-7-82	12 (49)	70	26-9-84							119 (3)	168	7-6-91
7	New Bridge	457 278													90 (4)	109	7-6-91
8	Surface Boil	457 276													376 (3)	879	7-6-91
9	East the Water	458 273	690 (2)	1150	1-7-82	18 (48)	59	26-9-84							109 (4)	144	7-6-91
B	Bridgeland St	455 267	390 (2)	530	1-7-82												
10	Bideford Bridge	456 264	180	220	10-6-82							95			118 (4)	140	7-6-91
11	Little America	454 252				15 (48)	59	26-9-84	116 (25)	240	11-6-85				134 (4)	150	7-6-91
12	Pillmouth	462 247										115			112 (4)	136	7-6-91
13	Addlehole	472 239										102			105 (3)	128	7-6-91
14	Weare Gifford	465 227							65 (25)	100	11-6-85	89			<10 (1)	<10	7-6-91
C	Beam	474 209	63 (3)	70	2-8-82	67 (48)	358	26-9-84	59 (25)	80	11-6-85						

Table D.1b: Summary of Available Total Coliform Data (Counts/100ml) 1982-1991

Site No.	Site Name	N.G.R.	1982 (SWW)			1984 (SWW)			1985 (SWW)			1987- -89 (WIMPOL)			1991 NRA (Neaps)		
			Mean	Maximum	Date	Mean	Maximum	Date	Mean	Maximum	Date	Mean	Maximum	Date	Mean	Maximum	Date
A	Instow	470 305	18700 (5)	67448	2-6-82												
3	Appledore	466 306	8418 (8)	44000	1-7-82	5866 (51)	77000	26-9-84				4000	12800				
5	Boathyde	462 288										4000	12500				
6	Snuffy/Cleve	556 640	556640 (8)	3660000	19-5-82	33138 (51)	230000	26-9-84									
7	New Bridge	457 278															
8	Surface Boil	457 276															
9	East the Water	458 273	9220564 (8)	73000000	1-7-82	19028 (50)	135000	22-8-84									
B	Bridgeland St	455 267	378386 (8)	167000	1-7-82												
10	Bideford Bridge	456 264	8638 (8)	40000	1-7-82							4800	19000				
11	Little America	454 252				32540 (51)	210000	22-8-84	19064 (25)	100000	11-6-85						
12	Pillmouth	462 247										6200	12000				
13	Addlehole	472 239										3500	7000				
14	Weare Gifford	465 227							7464 (25)	32000	11-6-85	6400	11500				
C	Beam	474 209	7054 (11)	40000	2-8-82	39422 (48)	246000	26-9-84	7558 (25)	37000	11-6-85						

Table D.1c: Summary of Available Faecal Coliform Data (Counts/100ml) 1982-1991

Site No.	NAME	N.G.R.	1982 (SWW)			1984 (SWW)			1985 (SWW)			1987 -89 (WIMPOL)			1991 NRA (Neaps)		
			Mean	Maximum	Date	Mean	Maximum	Date	Mean	Maximum	Date	Mean	Maximum	Date	Mean	Maximum	Date
A	Instow	470 305	31308 (11)	128000	2-7-82												
3	Appledore	466 306	1904 (8)	6500	1-7-82	2252 (52)	24700	26-9-84				600	5100		513 (4)	1100	7-6-91
5	Boathyde	462 288										1200	3750		438 (4)	730	7-6-91
6	Snuffy/Cleve	556 640	23487 (8)	162000	1-7-82	13863 (50)	136000	15-8-84							974 (3)	2400	7-6-91
7	New Bridge	457 278							605 (8)	1400	15-4-85				343 (3)	700	7-6-91
8	Surface Boil	457 276													2E+06 *(2)	3000000	7-6-91
9	East the Water	458 273	278050 (8)	1850000	1-7-82	7293 (51)	75000	22-8-84							1025 (4)	1900	7-6-91
B	Bridgeland St	455 267	152080 (8)	830000													
10	Bideford Bridge	456 264	2337 (8)	7500	1-7-82							500	1850		1020 (3)	1700	7-6-91
11	Little America	454 252				10450	90000	5-9-84	6120 (25)	19300	11-6-85				2198 (4)	2900	7-6-91
12	Pillmouth	462 247										1000	2500		1775 (4)	3100	7-6-91
13	Addlehole	472 239										900	1850		1190 (2)	1900	7-6-91
14	Weare Gifford	465 227							1413 (25)	4400	11-6-85	650	2200		240 (1)	240	7-6-91
C	Beam	474 209	1353 (11)	2120	10-6-82	15693	75000	22-8-84	953 (25)	4300	11-6-85						

Bideford Fine Screen Outfall-Post Scheme Appraisal

Table D.2: Instow Beach Mean Microbilogical Bathing Water Quality (NRA)

Year	Mean Total Coliforms (No./100ml) (n=20)	Mean Faecal Coliforms (No./100ml) (n=20)
1988	7670	2564
1989	1529	656
1990	2326	1311
1991	3534	1002