

## Environmental Protection Report

# IMPACT ASSESSMENT OF HELSTON SEWAGE TREATMENT WORKS ON WATER QUALITY OF THE RIVER COBER AND LOE POOL

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**NRA**

*National Rivers Authority*

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**IMPACT ASSESSMENT OF HELSTON SEWAGE TREATMENT WORKS ON WATER QUALITY OF THE RIVER COBER AND LOE POOL.**

**SUMMARY.**

The National Rivers Authority South-West (NRA SW) has expressed concern over the contribution of Helston Sewage Treatment Works (STW) to poor water quality in the River Cober and Loe Pool. Therefore, a study of recent water quality data collected at routine monitoring sites was undertaken to determine the extent of impact.

Poor final effluent quality from Helston STW resulted in an increase in BOD and total ammonia concentrations in the River Cober during a rainfall event in October 1989. This caused river water quality standards to be exceeded. However, since 1989 monitored water quality has not exceeded river quality standards.

Non-compliance with river quality standards occurred at Loe Pool outfall during 1989 and 1990 and was attributed to presence of severe algal blooms in Loe Pool. The final effluent from Helston STW could be the principle source of nutrient enrichment to Loe Pool and therefore the principal cause of algal blooms.

It is recommended that the River Cober and the final effluent at Helston STW are monitored during heavy rainfall to determine the current impact of Helston STW on the River Cober under these conditions.

Further investigations will proceed to determine the extent of water quality problems in Loe Pool and the causes and effects of eutrophication. NRA are currently promoting the control of nutrients in the discharge from Helston STW under the requirements of the EC Urban Waste Water Treatment Directive, and have put forward proposals that the waters downstream of Helston STW should be regarded as 'sensitive' for the purposes of the Directive, to the Department of the Environment. As yet the DoE have not confirmed that these proposals have been accepted.

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IMPACT ASSESSMENT OF HELSTON SEWAGE TREATMENT WORKS ON WATER QUALITY OF THE RIVER COBER AND LOE POOL

1. INTRODUCTION

The National Rivers Authority South West (NRA SW) has expressed concern over the contribution of Helston Sewage Treatment Works (STW) to the cause of non-compliance with river quality standards in the River Cober and Loe Pool.

This report sets out to determine the extent of impact. The approach of the study has been to analyse routine water quality data (particularly sanitary determinands) collected during January 1989 to December 1991 from the River Cober and Loe Pool, and from the final effluent at Helston STW.

2. HELSTON SEWAGE TREATMENT WORKS (see Figure 1).

Helston STW treats domestic sewage and trade effluent from the Helston area. Septic tank sludge from council houses at Breage and Godolphin, and sewage sludge from Constantine, St. Keverne and Coverack STW's is brought to Helston STW by tanker. In addition, septic tank sludge is brought to the works from outside the catchment, from Kerrier district.

Helston STW was commissioned in 1930. Since then the population served by the STW has continued to grow and as a consequence the STW has been extended and upgraded in 1959, 1974 and 1985. The current population served by Helston STW is estimated at 8,900 people. However, the projected population served by the STW by the year 2001 is 13,000 people.

Financial provision for improvements to Helston STW is within the current capital expenditure programme of South West Water Services Limited (SWWSL). The first improvement stage was completed in 1988 which consisted of a new inlet works, screens and de-watering equipment. Other minor improvements have also been carried out in 1991 including a general upgrading of maintenance of the works, adjustments to recirculation, a new sludge reception facility, clarifiers on the final humus tank and tighter trade effluent controls.

Further evaluation is ongoing to determine the required work for the second stage of improvement which is due to be completed by October 1993. This is to include an improvement in storm sewage facilities at the treatment works.

The sewage effluent from Helston STW is consented to discharge within the following standards:

<u>Substances</u>	<u>Consents limits</u>
Biochemical Oxygen Demand (BOD)	20 mg/l
Ammonia as N	10 mg/l
Suspended solids (SS)	30 mg/l

Although the final effluent discharges to the River Cober at the same point as the storm sewer overflow, there is provision within the STW to sample the final effluent separately.

The volume of treated sewage discharged under dry weather conditions should not exceed 2821 cubic metres in any period of 24hrs.

Recent problems associated with this works have included:

1. On 20 June 1991, 3000 gallons of untreated sewage were accidentally discharged into the River Cober via surface water drains on the site.
2. The emergency overflow at Helston (Market Street) pumping station has caused water quality problems in the River Cober due to discharges of untreated sewage. However, the overflow has recently been sealed off and the pumps are being uprated.

The NRA has recommended to the Department of the Environment that the River Cober and Loe Pool should be designated under the EC Urban Waste Water Treatment Directive as "sensitive" waters. This will require effluents discharging to these waters to meet the requirements of the Directive and will likely include nutrient control.

### 3. THE RIVER COBER.

NRA SW have continued to use the following use-related Environmental Quality Objectives (EQO) for the River Cober in the vicinity of Helston STW:

- \* Protection of Aesthetic Quality
- \* Protection of Salmonid Fish
- \* Protection of Other Aquatic life/dependant organisms
- \* Protection of Livestock watering
- \* Protection for the Irrigation of crops

The River Cober in this area has also been assigned a River Quality Objective (RQO) of National Water Council (NWC) Class 1B (see Appendix I)

Water quality in the River Cober has not been adequate to achieve the RQO either upstream (Helston Park) or downstream of Helston STW (Below Helston STW) in recent years (see Table 1).

TABLE 1. NWC Classification from 1985 to 1991.

Site	RQO	85	86	87	88	89	90	91
Helston Park	1B	2	3	3	2	3	3	3
Below Helston STW	1B	2	3	3	2	3	3	3

N.B. Annual classification is based on three years data.

A closer examination of the determinands causing non-compliance during the 1991 NWC Classification revealed a difference between the non-compliant determinands for each site (see Table 2). There was non-compliance with BOD and ammonia standards downstream of Helston STW but not upstream.

Non-compliance of suspended solids and copper standards occurred upstream of

Helston STW. The cause of this non-compliance is unknown.

TABLE 2. 1991 NWC Classification by determinand.

Site	RQO	BOD	Total Ammonia	Suspended solids	Copper
Helston Park	1B	-	-	3	2
Below Helston STW	1B	2	3	-	2

Further detailed examination of the routine monitoring data revealed that non-compliant samples were related to heavy rainfall events on 20 October 1989 and 8 November 1989 (see Table 3 and Appendix II).

TABLE 3. Exceedance (\*) of water quality standards 1989 to 1991 in the River Cober.

Date	Helston Park		Below Helston STW			
	Rain D/B (millimetres)	Rain D/O	BOD (mg/l)	Total ammonia (mg/l)	BOD (mg/l)	Total ammonia (mg/l)
20.10.89	14.4	25.9	2.5	0.21	15.6*	3.36*
08.11.89	44.5	5.2	3.8	0.26	3.3	1.80*

D/B = day before D/O = on that day

Helston STW final effluent has exceeded the consented conditions for BOD and total ammonia on 8% of sampled occasions (5 out of 65) between 1989 and 1991 (see Table 4 and Appendix III). High BOD and total ammonia concentrations occurred downstream of Helston STW during rainfall on 20 October 1989 and coincided with exceedance of the final effluent consent conditions at Helston STW. However, there was not a relationship between poor final effluent quality and rainfall on all sampling occasions (see Appendix III).

Table 4. Exceedance (\*) of BOD and total ammonia consent conditions for Helston STW's final effluent 1989-1991.

Date	BOD (mg/l)	Total ammonia (mg/lN)
14.07.89	35.0*	14.60*
20.10.89	50.2*	30.10*
26.02.90	36.0*	7.30
12.07.90	13.0	11.40*
Formal sample		
05.08.91	>100.0*	21.20*

The formal sample data collected on 05.08.91 must be treated with caution because the exact BOD concentration is unknown and is unusually high.

River quality classified using aquatic macroinvertebrates was moderate both upstream and downstream of Helston STW during Spring 1991. There was a noticeable reduction in river quality, according to the macroinvertebrate classification, downstream of the STW in the Summer. However, during Autumn 1991 the situation was reversed and the classification indicated moderate river quality upstream and good river quality downstream (see Table 5).

TABLE 5. River quality classification of macroinvertebrate data using RIVPACS analysis 1991.

Site	Spring	Summer	Autumn
Helston park	B	A	B
Below Helston STW	B	B	A

N.B. see Appendix IV for definition of the RIVPACS analysis.

#### 4. LOE POOL.

Environmental Quality Objectives for Loe Pool are:

- \* Protection of Aesthetic Quality
- \* Protection of Coarse Fish
- \* Protection of Other Aquatic life/dependant organisms
- \* Protection of Livestock watering
- \* Protection for the Irrigation of crops

Loe Pool has been assigned an RQO of NWC Class 1B.

Loe Pool is the largest freshwater lagoon in Cornwall covering an area of approximately 50 hectares, with a maximum depth of 6 metres. It was designated as a UK Grade 1 Site of Special Scientific Interest (SSSI) in 1951 due to its value as a habitat not found elsewhere in Cornwall. Loe Pool is also an important regional tourist resource and a recreational facility for the people of Helston.

Water quality has deteriorated at Loe Pool Outfall between 1985 and 1991 (see Table 6). There has been consistent non-compliance of the RQO.

TABLE 6. NWC Classification from 1985 to 1991

Site	RQO	85	86	87	88	89	90	91
Loe Pool Outfall	1B	2	3	3	3	3	4	3

The 1991 NWC Classification revealed non-compliance of pH, temperature, BOD and total and un-ionized ammonia standards (see Table 7 and Appendix V).

TABLE 7. 1991 NWC Classification by determinand.

RQO	pH	Temperature	BOD	Total ammonia	Un-ionized ammonia
1B	3	2	2	2	3

pH exceeded the quality standard 7 times in the last 3 years and all failures have been during July, August and September (see Table 8 and Appendix V). Total ammonia exceeded the quality standard 9 times during the months of August, September, October and November. BOD has exceeded the quality standard 4 times in the last 3 years during the months of July, August and September. See Appendix I for River Quality Standards used in the National Water Council Classification.

There were no failures of river quality standards in the Loe Pool during 1991.

TABLE 8. Exceedance (\*) of water quality standards 1989 to 1991 at Loe Pool outfall.

Date	pH	BOD	Total ammonia
31.07.89	10.6*	6.6*	<0.01
15.08.89	10.5*	2.4	0.02
23.08.89	10.6*	1.5	0.02
30.08.89	10.5*	4.5	0.08
07.09.89	10.4*	4.8*	0.04
13.09.89	9.6*	1.1	0.36
27.09.89	8.4	2.8	0.71*
06.10.89	7.7	4.0	1.20*
11.10.89	7.4	4.2	1.11*
19.10.89	8.7	2.6	0.96*
20.10.89	7.6	4.4	0.97*
24.10.89	7.7	4.7	0.87*
27.10.89	7.0	2.8	0.90*
30.10.89	7.4	2.4	0.90*
08.11.89	7.2	1.3	0.80*
24.08.90	6.5	690.0*	0.24
11.09.90	10.4*	8.4*	<0.01

The data for 24.08.90 must be treated with caution because the BOD concentration was unusually high. It is possible that the sample accidentally contained a high concentration of algae because the sample may have been taken where algae accumulate (for example see Photograph 1).

Dense blooms of blue-green algae frequently occur in Loe Pool consisting mainly of Microcystis aeruginosa (see Photographs 1,2 and 3)

## 5. DISCUSSION.

This study has shown that poor final effluent quality from Helston STW had an impact on water quality in the River Cober during a period of rainfall in



October 1989. The inadequate storm facilities at the treatment works may have contributed to the poor final effluent quality.

Since 1989 monitored water quality of the River Cober has not exceeded river quality standards. This could be the result of improved operation of the STW, or because routine sampling has not co-incident with rainfall greater than 30mm over a two day period (see Appendix II).

Loe Pool is known to suffer from severe blooms of blue-green algae. These are almost certainly the cause of very high pH in the Pool due to photosynthesis. High concentrations of BOD and total ammonia are also likely to be related to the decay of the dense blooms of blue-green algae. Total ammonia concentrations were high in October 1989 at a time when blue-green algae were decaying.

The cause of large blooms of blue-green algae in Loe Pool is likely to be related to high nutrient concentrations in the Pool. The principal source of nutrients could be Helston STW. However, because there are other inputs of nutrients to Loe Pool from the STW at RAF Culdrose, farm drainage and from lake sediments, the cause of eutrophication in Loe Pool can not solely be attributed to Helston STW. In order to be even handed in determining the total contribution of nutrients to Loe Pool further investigation to determine individual accountability must take place.

The implementation of the EC Urban Waste Water Treatment Directive is likely to be the principal factor which will promote nutrient control in the discharge from Helston STW. NRA SW have put forward proposals for the waters downstream of Helston STW to be considered as 'sensitive waters' in terms of this directive. Under the guidelines issued by the DoE, Helston STW has been put forward as a qualifying discharge for nutrient control. However, confirmation has not yet been received from the DoE that proposals have been accepted.

## 6. CONCLUSIONS.

1. Poor final effluent quality from Helston STW has caused an increase in BOD, total ammonia concentrations in the River Cober during a rainfall event. This increase was sufficient to cause exceedance of river quality standards during 1989.
2. Loe Pool suffers from severe blooms of blue-green algae which are thought to be the cause of non-compliance with water quality standards at Loe Pool Outfall.
3. The cause of the major blooms of blue-green algae are the nutrient rich waters in Loe Pool. The relative contributions of nutrients to Loe Pool from Helston STW and other inputs have not yet been determined.

7. RECOMMENDATIONS.

1. The River Cober and final effluent at Helston STW must be monitored during heavy rainfall to determine whether Helston STW continues to have an impact on water quality since 1989.

Action - Pollution Officer West.

2. More definitive studies must be carried out to determine the relative contributions of nutrients to Loe Pool from Helston STW and other inputs.

Action - Freshwater Officer.

3. The cause of poor water quality upstream of Helston STW should be investigated.

Action - Freshwater Officer.

PHOTOGRAPH 1



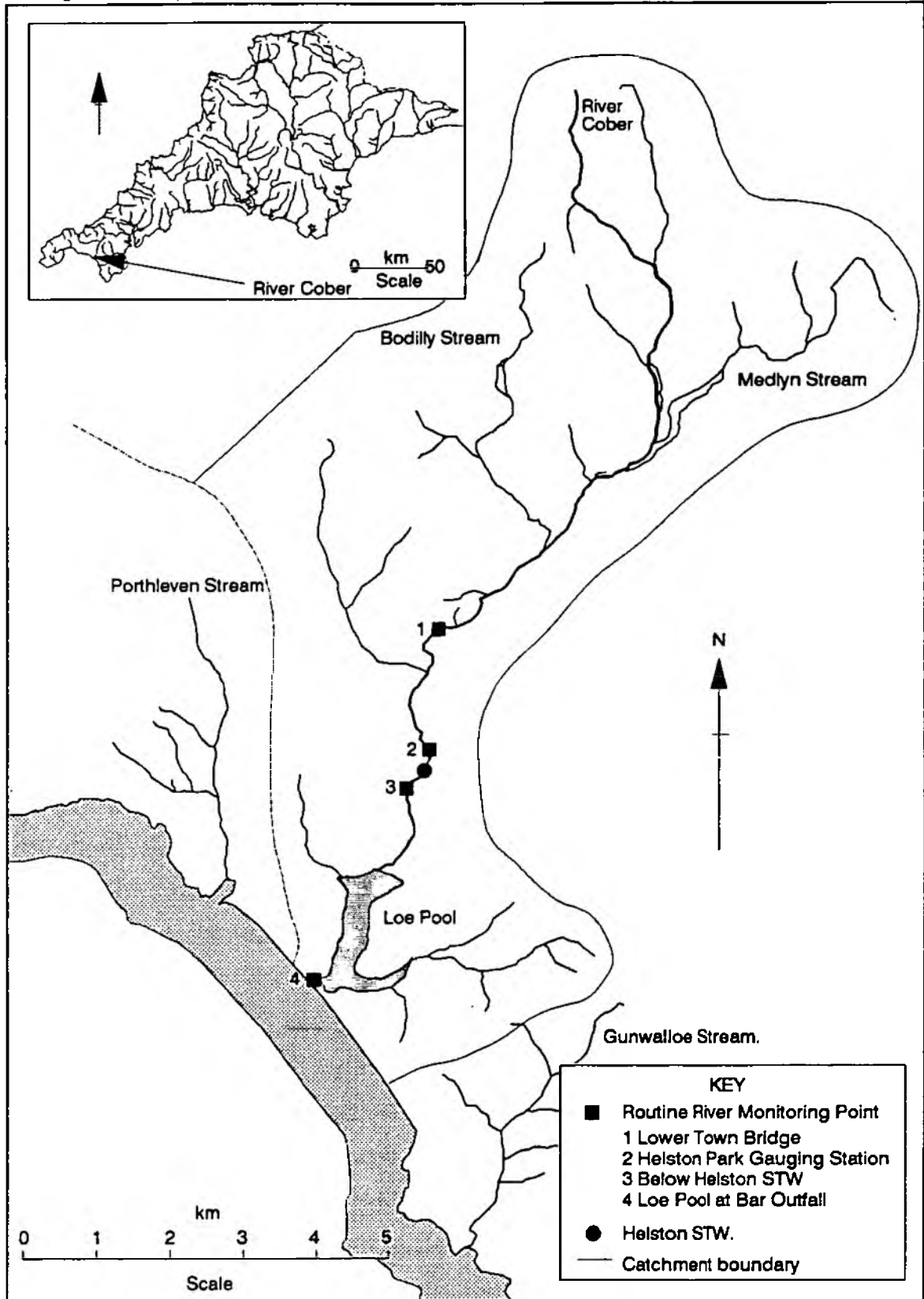
PHOTOGRAPH 2





PHOTOGRAPH 3

Figure 1. Map of the River Cober and Loe Pool Catchment showing Helston STW.



## APPENDIX I

### NWC CLASSIFICATION SYSTEM

#### CRITERIA USED BY NATIONAL RIVERS AUTHORITY - SOUTH WEST REGION FOR NON-METALLIC DETERMINANDS

River Class	Quality Criteria
1A	Dissolved oxygen % saturation greater than 80%. BOD (ATU) not greater than 3 mg/l O. Total ammonia not greater than 0.31 mg/l N. Non-ionised ammonia not greater than 0.021 mg/l N. Temperature not greater than 21.5 C. pH greater than 5.0 and less than 9.0. Suspended solids not greater than 25 mg/l.
1B	Dissolved oxygen % saturation greater than 60%. BOD (ATU) not greater than 5 mg/l O. Total ammonia not greater than 0.70 mg/l N. Non-ionised ammonia not greater than 0.021 mg/l N. Temperature not greater than 21.5 C. pH greater than 5.0 and less than 9.0. Suspended solids not greater than 25 mg/l.
2	Dissolved oxygen % saturation greater than 40%. BOD (ATU) not greater than 9 mg/l O. Total ammonia not greater than 1.56 mg/l N. Non-ionised ammonia not greater than 0.021 mg/l N. Temperature not greater than 28 C. pH greater than 5.0 and less than 9.0. Suspended solids not greater than 25 mg/l.
3	Dissolved oxygen % saturation greater than 10%. BOD (ATU) not greater than 17 mg/l O.
4	Dissolved oxygen % saturation greater than 10%. BOD (ATU) not greater than 17 mg/l O.

#### STATISTICS USED BY NATIONAL RIVERS AUTHORITY - SOUTH WEST REGION

Determinand	Statistic
Dissolved oxygen	5 percentile
BOD (ATU)	95 percentile
Total ammonia	95 percentile
Non-ionised ammonia	95 percentile
Temperature	95 percentile
pH	5 percentile
Suspended solids	95 percentile
	arithmetic mean

**APPENDIX II**

**Routine water quality in the River Cober upstream and downstream of Helston STW during 1989 to 1991.**

Date	Rain D/B	Rain D/O	Helston Park Gauging Station.						Below Helston STW.					
			pH	BOD	S.Solids	Tot. NH3	PO4	NO3	pH	BOD	S.Solids	Tot. NH3	PO4	NO3
03/02/89	0.0	0.0	-	-	-	-	-	-	6.0	3.1	11	0.21	1.06	7.7
21/04/89	0.0	0.0	-	-	-	-	-	-	6.9	3.1	8	0.37	0.78	6.7
31/07/89	0.6	2.5	-	-	-	-	-	-	7.0	3.5	27	0.28	1.88	9.4
29/09/89	0.0	0.0	7.1	1.3	53	0.07	0.03	3.7	7.1	2.7	32	0.31	0.46	6.0
06/10/89	0.0	0.1	7.2	1.9	20	0.06	0.03	3.8	7.1	2.5	39	0.22	0.96	5.9
08/10/89	3.0	1.7	7.1	0.6	19	0.05	0.02	3.6	7.0	0.6	24	0.05	0.01	3.7
20/10/89	14.4	25.9	7.5	2.5	396	0.21	0.12	3.3	7.2	15.6	36	3.36	2.14	3.9
30/10/89	26.7	12.4	7.0	2.0	68	0.11	0.36	4.0	7.1	2.3	20	0.17	0.36	4.0
08/11/89	44.5	5.2	6.6	3.8	204	0.26	0.15	2.7	7.0	3.3	95	1.80	0.23	2.6
08/12/89	0.5	0.0	6.9	1.3	15	0.05	0.02	5.1	6.9	1.5	19	0.16	0.02	5.1
24/01/90	0.0	0.0	7.2	1.7	8	0.19	0.03	5.0	7.1	1.9	11	0.19	0.04	4.9
26/02/90	7.4	16.4	-	-	-	-	-	-	7.0	2	7	0.13	0.05	7.4
21/03/90	0.7	3.2	6.9	1.1	5	0.06	5.90	0.0	6.9	1.3	6	0.09	0.14	6.6
26/04/90	0.0	2.7	6.9	0.8	3	0.12	0.06	5.2	6.9	1.4	3	0.20	0.85	7.8
18/05/90	0.0	0.3	7.3	3.2	14	0.13	0.02	4.9	7.2	3.3	7	0.11	0.01	5.4
28/06/90	0.6	0.0	6.7	1.6	7	0.11	0.03	4.9	6.7	2.4	5	0.12	0.03	4.9
23/07/90	0.0	0.0	6.9	2.4	3	0.12	0.03	4.1	7.0	2.6	6	0.13	0.04	4.2
24/08/90	0.0	0.0	6.8	1.9	2	0.12	0.06	4.9	6.6	3.4	4	0.33	2.79	10.6
11/09/90	0.0	0.0	6.9	1.6	0	0.14	0.06	4.3	6.9	2.7	4	0.20	2.17	8.4
05/10/90	0.0	0.0	7.4	2.5	6	0.10	0.04	4.3	6.9	3.1	3	0.34	1.79	17.1
01/11/90	2.7	7.6	6.9	3.6	22	0.13	0.05	3.8	6.9	3.4	22	0.14	0.06	3.9
19/11/90	0.0	0.9	6.9	2.2	14	0.09	0.04	4.7	6.9	3.8	7	0.42	0.54	5.6
25/01/91	0.0	0.0	6.8	1.6	10	0.04	0.01	6.0	6.8	1.6	9	0.07	0.11	6.3
27/02/91	1.4	1.5	6.8	0.8	14	0.08	0.02	6.4	6.9	0.5	1	0.08	0.02	6.5
01/03/91	0.0	0.0	6.9	2.0	6	0.04	0.01	6.0	6.9	1.6	8	0.03	0.01	6.1
02/04/91	9.0	8.3	6.8	1.6	14	0.13	0.03	5.5	6.8	1.6	12	0.14	0.22	5.9
09/05/91	0.0	0.0	7.1	0.5	3	0.04	0.02	5.4	6.9	1.3	9	0.40	0.75	8.6
10/07/91	0.5	0.0	6.9	2.6	6	0.08	0.03	4.4	6.9	1.8	45	0.09	0.04	4.4
05/08/91	3.7	14.1	7.1	1.2	5	0.12	0.03	4.9	7.1	1.4	4	0.12	0.04	4.9
06/09/91	0.0	0.0	7.1	1.2	2	0.05	0.03	4.6	6.9	2.4	6	0.18	0.98	6.7
30/10/91	18.4	7.5	7.2	<1.0	24	0.07	0.03	3.7	7.1	2	11	0.10	0.17	4.2
25/11/91	1.0	0.2	7.5	1.0	9	0.04	0.01	5.5	7.3	1.3	7	0.08	0.19	6.0
06/12/91	0.0	0.0	7.5	<1.0	8	0.04	0.03	5.6	7.5	1.3	7	0.12	0.28	6.4

Rainfall in mm, D/B = rainfall before collection of routine sample, D/O = rainfall on same day of routine sample collection.

Concentrations in mg/l.

- Data not available.



### APPENDIX III

Routine effluent quality from Helston STW during the period  
1989 to 1991.

Date	Rain D/B	Rain D/O	pH	BOD	S.Solids	Tot. NH3
20/01/89	0.0	11.2	6.1	11.0	30	1.10
27/01/89	0.0	5.0	6.7	10.0	24	1.90
03/02/89	0.0	0.0	6.6	12.0	25	1.30
17/02/89	16.1	20.6	6.0	17.0	35	2.60
31/03/89	0.0	0.0	6.5	11.0	20	0.70
21/04/89	0.0	0.0	6.8	16.0	43	3.90
28/04/89	0.9	9.2	6.8	17.0	24	5.70
12/05/89	1.5	0.0	6.3	16.0	29	2.90
26/05/89	0.0	0.0	6.4	6.4	23	0.90
02/06/89	0.1	4.8	6.6	14.0	16	2.40
23/06/89	0.0	0.0	6.4	11.0	20	1.00
30/06/89	0.0	0.0	6.6	16.0	49	2.90
06/07/89	2.6	2.5	6.4	12.0	28	2.50
07/07/89	2.5	0.0	6.5	9.0	17	1.00
14/07/89	0.0	0.0	6.8	35.0	32	14.60
21/07/89	0.0	0.0	6.4	6.2	20	1.40
28/07/89	0.0	0.0	6.6	9.7	27	0.90
31/07/89	0.6	2.5	6.6	15.0	18	1.50
20/10/89	14.4	25.9	7.0	50.2	48	31.01
05/01/90	2.8	0.7	6.8	6.3	31	1.10
02/02/90	13.3	24.2	6.8	6.5	19	0.50
26/02/90	7.4	16.4	7.3	36.0	35	7.30
15/03/90	0.0	0.0	7.0	13.7	22	1.70
21/03/90	0.7	3.2	6.8	4.4	26	1.40
20/04/90	5.9	1.0	6.4	11.0	30	1.00
26/04/90	0.0	2.7	6.3	7.4	25	1.00
12/07/90	0.0	0.0	6.6	13.0	22	11.40
16/08/90	3.8	8.0	6.2	12.0	15	1.60
25/01/91	0.0	0.0	6.3	13.0	19.0	0.80
27/02/91	1.4	1.5	6.8	12.0	28.0	1.04
02/04/91	9.0	8.3	6.6	14.0	35.0	0.90
09/05/91	0.0	0.0	6.3	11.0	38.0	3.00
01/07/91	2.4	1.2	6.2	15.0	15	0.70
11/07/91	5.9	3.0	5.9	5.6	18	0.70
03/09/91	0.0	0.0	6.5	7.0	21	3.10
23/09/91	3.0	1.7	6.6	10.0	20	2.40
15/10/91	2.8	3.8	6.3	11.0	14	0.80

Rainfall in mm, D/B = rainfall before collection of routine sample

D/O = rainfall on same day of routine sample collection.

Concentrations in mg/l.

- Data not available.

**APPENDIX III (continued)**

**Formal sample quality of effluent from Helston STW during the period 1989 to 1991.**

Date	Rain D/B	Rain D/O	pH	BOD	S.Solids	Tot. NH3
28/06/90	0.6	0.0	6.6	18.3	22	5.90
12/07/90	0.0	0.0	6.3	11.0	35	0.70
28/08/90	0.0	3.4	6.1	11.1	22	1.74
18/09/90	0.0	4.7	6.0	10.8	22	1.90
11/10/90	0.8	0.0	6.2	12.4	23	1.50
29/10/90	7.7	10.6	6.7	12.5	21	0.80
30/10/90	10.6	5.0	6.5	8.6	17	0.63
05/11/90	0.0	0.0	6.7	11.0	17	1.59
08/01/91	5.8	13.6	6.8	13.6	26	1.40
28/01/91	0.5	0.0	6.7	13.0	16	1.10
07/02/91	0.3	2.0	6.6	13.1	21	2.10
27/02/91	1.4	1.5	6.9	12.5	26	0.90
06/03/91	0.6	4.1	6.6	10.5	28	0.90
20/03/91	8.2	1.7	6.7	9.0	13	0.50
02/04/91	9.0	0.3	6.7	15.6	37	0.80
29/04/91	6.1	11.9	6.4	13.0	25	1.00
09/05/91	0.0	0.0	6.3	13.0	30	2.80
10/06/91	0.5	0.0	6.2	13.8	12	0.70
20/06/91	6.6	2.3	6.5	9.9	21	2.70
10/07/91	0.0	5.9	6.4	9.9	12	0.60
05/08/91	2.7	14.1	6.7	>100	601	21.20
28/08/91	0.0	0.0	6.7	13.4	16	2.60
03/09/91	0.0	0.0	6.7	14.4	15	3.30
23/09/91	3.0	1.7	6.5	10.2	16	2.60
15/10/91	2.8	3.8	6.4	10.3	12	0.90
29/10/91	1.1	18.4	6.5	10.0	21	0.86
22/11/91	0.0	0.0	6.8	11.0	29	1.10
06/12/91	0.0	0.0	6.8	13.0	16	1.80

Rainfall in mm, D/B = rainfall before collection of routine sample

D/O = rainfall on same day of routine sample collection.

Concentrations in mg/l.

#### APPENDIX IV RIVPACS ANALYSIS

Using each seasons data the Biological Monitoring Working Party (BMWP) system is used to calculate a BMWP score, an average score per taxon (ASPT) and a number of scoring families for both observed and predicted data. Environmental quality indices (EQI) are calculated by dividing observed biotic scores by RIVPACS predicted biotic scores. The site is classified by using the following EQI ranges:

Biological classification defined by EQI ranges for three seasons combined data.

Biological class	Description	EQI ASPT range	EQI Number of families range	EQI BMWP score
A	Good	=>0.89	=>0.79	=>0.75
B	Moderate	0.77-0.88	0.58-0.78	0.50-0.74
C	Poor	0.66-0.76	0.37-0.57	0.25-0.49
D	Very poor	=<0.65	=<0.36	=<0.24

The overall NRA Biological Classification for a site is derived from one of two measures: if the class based on EQI ASPT is lowest, that is taken to be the NRA Biological class of the site; if the class based on EQI ASPT is not the lowest, the mode of the three classes is the NRA Biological Class of the site.

# APPENDIX V

## Routine water quality in the Loe Pool at Bar Outfall.

Date	Rain D/B	Rain D/O	DO %	pH	BOD	S.Solids	Tot. NH3	PO4	NO3
03/02/89	0.0	0.0	91	6.1	2.8	2	0.10	0.22	6.0
21/04/89	0.0	0.0	100	6.9	2.4	4.8	0.09	0.16	5.5
31/07/89	0.6	2.5	-	10.6	6.6	17	<0.01	0.26	0.8
15/08/89	8.9	0.4	-	10.5	2.4	10	0.02	-	0.6
23/08/89	0.0	0.0	-	10.6	1.5	8.4	0.02	-	0.4
30/08/89	0.0	3.7	-	10.5	4.5	6.4	0.08	-	0.3
07/09/89	0.0	0.0	-	10.4	4.8	34.4	0.04	-	0.4
13/09/89	11.2	2.8	-	9.6	1.1	4	0.36	-	0.6
27/09/89	0.0	0.0	-	8.4	2.8	4.8	0.71	-	0.9
29/09/89	0.0	0.0	74	8.5	3.6	15	0.70	0.50	0.7
06/10/89	0.0	0.1	80	7.7	4.0	4.8	1.20	0.45	0.9
11/10/89	0.2	1.8	-	7.4	4.2	5.2	1.11	-	0.9
19/10/89	0.0	14.4	-	8.7	2.6	4	0.96	-	0.9
20/10/89	14.4	25.9	84	7.6	4.4	6	0.97	0.27	0.9
24/10/89	0.0	0.0	-	7.7	4.7	3.2	0.87	-	1.1
27/10/89	6.9	8.6	81	7	2.8	2.4	0.90	0.24	1.4
30/10/89	26.7	12.4	82	7.4	2.4	2.6	0.90	0.26	1.3
08/11/89	44.5	5.2	85	7.2	1.3	4.4	0.80	0.25	1.6
08/12/89	0.5	0.0	84	6.9	2.0	4.8	0.11	0.25	4.7
24/01/90	0.0	0.0	90	7	2.4	15.2	0.23	0.11	5.0
22/02/90	0.0	0.0	93	7.2	1.8	12	0.09	0.07	6.9
21/03/90	0.7	3.2	103	7.6	2.4	4.8	0.02	0.08	5.8
26/04/90	0.0	2.7	102	7.4	1.8	3.2	0.04	0.20	4.9
18/05/90	0.0	0.3	94	8	3.7	6.4	0.05	0.15	4.4
28/06/90	0.6	0.0	88	6.7	3.2	6.8	0.15	0.03	4.9
23/07/90	0.0	0.0	90	9.2	2.1	4	0.05	0.28	2.0
24/08/90	0.0	0.0	58	6.5	690.0	527	0.24	0.13	<0.1
11/09/90	0.0	0.0	157	10.4	8.4	25.2	<0.01	0.39	0.0
05/10/90	0.0	0.0	72	7.8	2.3	3.6	0.67	0.54	0.6
01/11/90	2.7	7.6	82	7.1	2.0	4.0	0.51	0.33	1.2
19/11/90	0.0	0.9	90	7.5	1.5	1.6	0.30	0.28	1.8
25/01/91	0.0	0.0	84	7	1.4	4.4	0.10	0.08	6.5
27/02/91	1.4	1.5	91	7.1	1.1	4	0.11	0.09	6.2
01/03/91	0.0	0.0	93	7	1.8	2	0.08	0.10	6.0
02/04/91	9.0	8.3	97	7.1	1.1	1.6	0.04	0.08	6.5
09/05/91	0.0	0.0	107	7.6	0.9	1.2	0.02	0.15	5.3
10/07/91	0.5	0.0	97	7.5	1.8	4.4	0.09	0.20	3.2
05/08/91	3.7	14.1	102	7.4	1.6	2.4	0.09	0.17	3.0
06/09/91	0.0	0.0	94	7.9	3.4	12.8	<0.01	0.12	2.4
30/10/91	18.4	7.5	94	7.6	3.0	3	<0.02	0.16	2.5
25/11/91	1.0	0.2	90	7.6	1.7	3.8	0.11	0.15	4.2
06/12/91	0.0	0.0	92	7.5	1.0	3.7	0.17	0.17	4.9

Rainfall in mm, D/B = rainfall before collection of routine sample, D/O = rainfall on same day of routine sample collection. Concentrations in mg/l.

- Data not available.