# The effect of Guildford STW on the R.Wey

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## 1. Aims and Objectives

Guildford STW discharges to the River Wey Navigation below Stoke Lock. The RQO for the 12km reach between Guildford STW and Woking STW is 1B which was achieved for the July 1991 to June 1992 River Quality assessment. However Guildford STW has failed its consent on a number of occasions mainly as a result of hydraulically overloaded filters with ineffective media.

With this in mind, and the complicated multi-channelled receiving river system, the aims of this study are to :-

(i) Examine in more detail the effects of the STW on the R.Wey;

(ii) Provide information which may be used to reassess the consent limits for the STW.

## 2. Guildford STW

### 2.1 Operations

A plan of Guildford STW is shown in Fig.1 and a process flow diagram is illustrated in Fig.2. The STW comprises a Biological Filtration Plant (BFP) and an Activated Sludge Plant (ASP). The BFP was built in 1960 and receives 40% of the total influent while the ASP, built in 1974, treats the remaining 60%. The 2 plants are served by separate inlets and have separate primary settlement tanks.

The BFP consists of 8 filters discharging to 6 humus tanks. The media is very old and blocked while the filter arms are rotating too quickly resulting in hydraulic overloading of the beds. Hence the final effluent is of poor quality.

The ASP consists of 16 aeration pockets arranged in 4 rows and served by surface aerators (screw-type system). The first pocket in each row is operated on a timer to create an anoxic zone enabling partial denitrification. The ASP discharges to 3 final tanks.

The effluents from the ASP and BFP mix before discharging to the river thereby enabling the higher quality ASP effluent to dilute the poorer quality effluent from the BFP.

Storm sewage is collected in 3 old rectangular tanks serving the BFP and 3 rectangular and 2 circular tanks serving the ASP which overflow to land during heavy storms.

The STW provides treatment for a population of 83,000 which translates to a DWF of 14,940 $m^3/d$ while trade effluent makes up the remaining 4864 $m^3/d$ DWF. The trade effluent from the abattoir and cattle market have a major influence on the STW performance.

FIG.1

# PLAN OF GUILDFORD STW

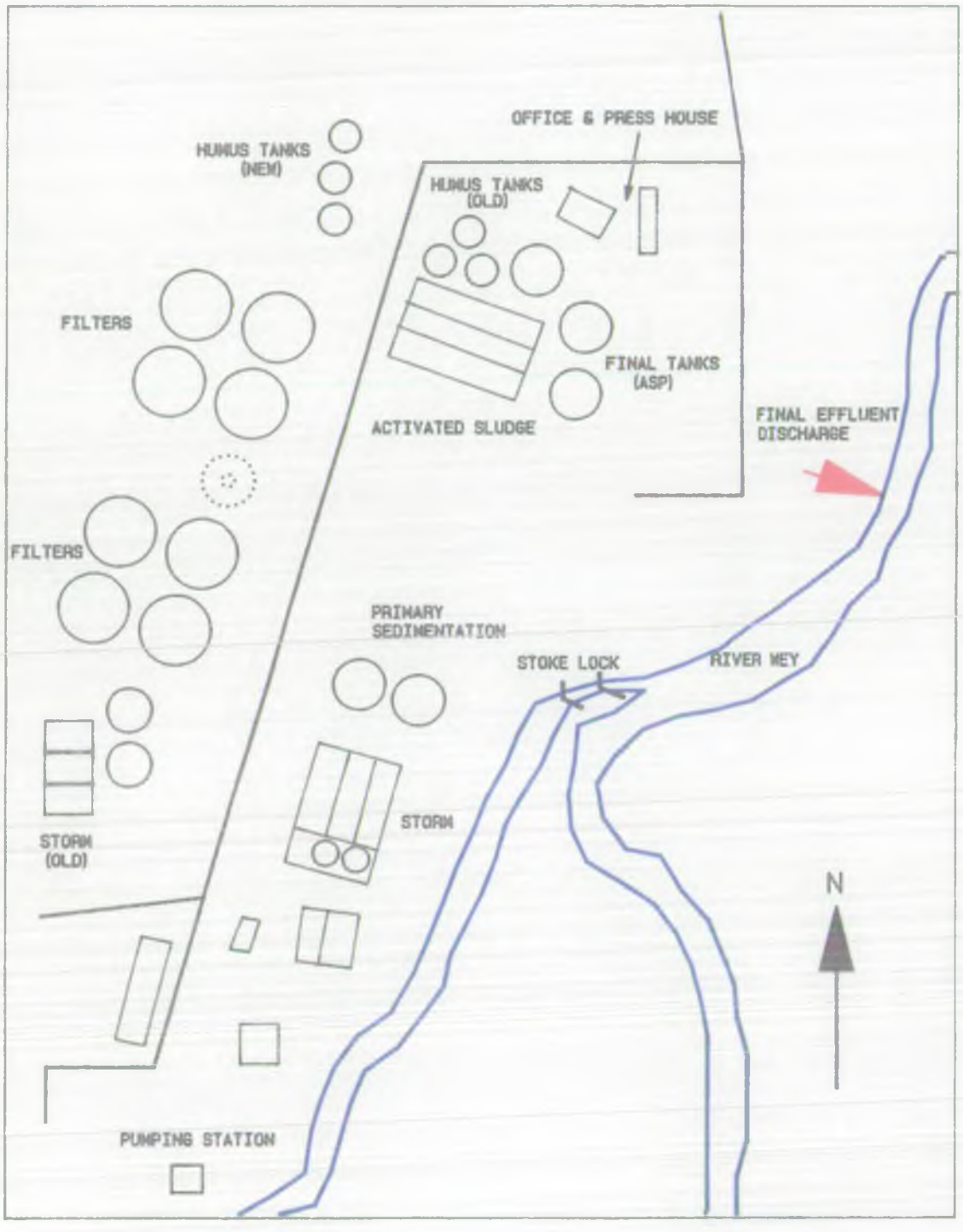
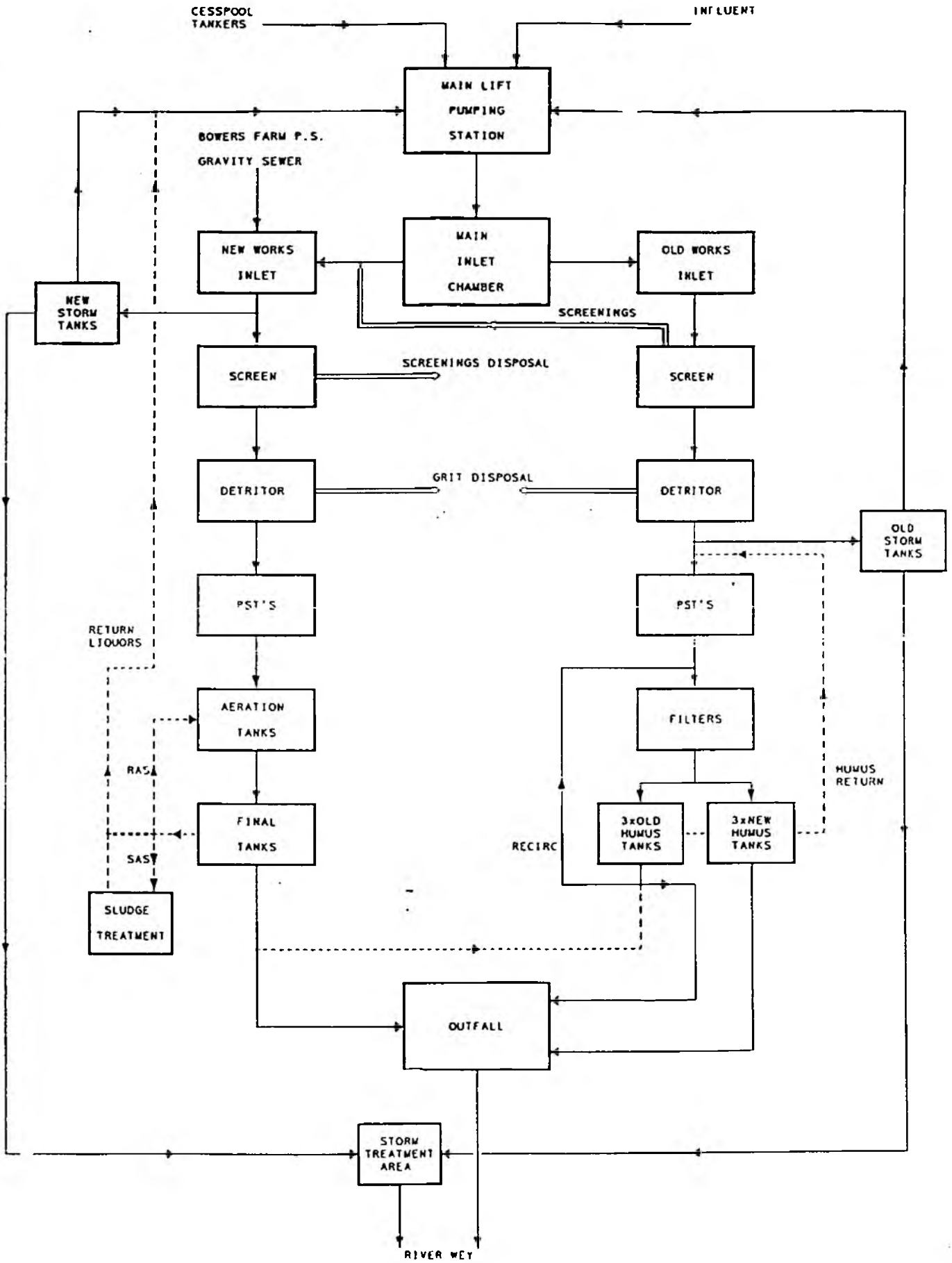


FIG.2

# PROCESS FLOW DIAGRAM : GUILDFORD STW



## 2.2 Consents

There are 2 consents for the STW, one for fully treated effluent and one for storm sewage. These are summarised as follows :-

**Consent 1084** - Fully treated final effluent

| | |
|---|---|
| Suspended Solids at 105°C | 45 mg/l |
| BOD (ATU) 5 days at 20°C | 20 mg/l |
| Ammoniacal Nitrogen | 6 mg/l |
| Maximum discharge of sewage effluent | 67,190 $m^3/d$ |

**Consent 1107** - Storm sewage

No discharge of storm sewage effluent, which has received treatment by storm tanks and over a land area, shall be made until the flow into the STW exceeds 67,190 $m^3/d$

## 3. River Wey, Guildford

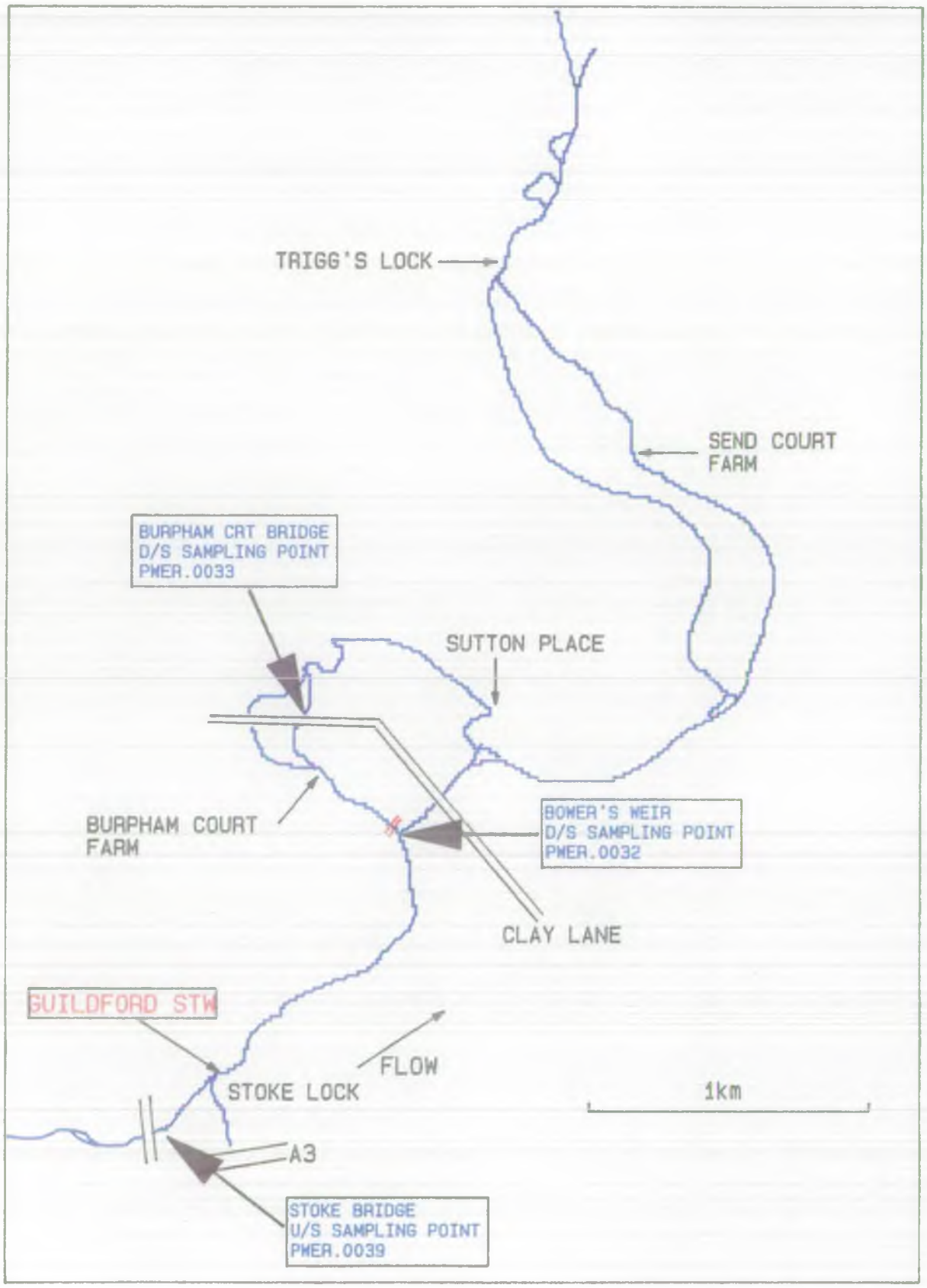
Fig.3 shows the location of the STW and river sampling points on the river in the Guildford area. The STW discharges to the Wey Navigation below Stoke Lock. The channel is characteristically deep, wide and slow moving with branches of natural main river looping off the Navigation sections. The first of these branches occurs at Bower's weir, Jacobswell. Approximately 70% of the water in the Navigation flows over the weir into a short 1km section of comparatively shallow fast-flowing river which rejoins the main channel below Bower's lock. Surplus water not passing through the lock spills over an overfall just above the lock. The river divides again further downstream with a natural channel running almost parallel with the main Navigation for 2km before rejoining below Triggs lock where it then meanders northwards to Send.

## 3.1 River Quality Objectives (RQOs)

The Guildford STW to Woking STW reach, which is approximately 12km in length, has an RQO of 1B. This section rarely fails its RQO for which the reach assessment sampling point is approximately 8km below Guildford STW at Cartbridge, Send. One of the reasons for carrying out this survey was to see if water quality changes significantly in this first 8km section of river given the complicated multi-channelled system. Within the reach there are a number of sampling points which are still used occasionally and for which some historical data are recorded on the Water Archive.

FIG.3

POSITION OF GUILDFORD STW AND RELATED SAMPLING POINTS



### 3.2 Times of Travel

The only data available for this section are as follows:-

| Weybr.flow | Date | Section | Travel time (hours) |
|---|---|---|---|
| 2.750 $m^3$ | 17/10/91 | G'ford STW - Cartbridge | 19.38 |
| 2.660 $m^3$ | 14/10/91 | Cartbridge - Woking STW | 11.20 |

Presently it is not known how the looping sections of natural river channel effect the times of travel and hence effluent transport down the reach.

### 3.3 Hydrometereological Data

The London Weather Centre provided sunshine hrs, rainfall and air temperature for the survey period and these are plotted in Fig.4.

Flow data recorded at Tilford (R.Wey), Shalford (Cranleigh Waters and Tillingbourne) and Weybridge (R.wey) were used to estimate flows at Guildford. Data are shown in Fig.5(a) for September and October 1992, while hourly flow data for 16/09/92 and 17/09/92 are plotted in Fig.5(b). Plans are underway to construct a permanent flow gauging station at Guildford which will be useful for future monitoring and survey work. At present it is still not known how flows are divided between the Navigation and natural river channels which branch off it at various points along the reach.

## 4 Methods

### 4.1 Archive Data

Spot sample data recorded since 1970 for ammoniacal nitrogen (Fig.s 6(a) and 6(b)), BOD (Fig.s 7(a) and 7(b)) and Dissolved Oxygen % (Fig.8) were retrieved from the Water Archive for Guildford STW and river sites above and below the STW in order to examine any changes in STW performance. The sites and corresponding URNs are listed below:-

| | | |
|---|---|---|
| **PWEE.0097N** | Guildford STW final effluent | |
| **PWER.0039-** | Wey at Stoke Bridge, Guildford | (u/s STW) |
| **PWER.0032-** | Wey at Bower's weir, Burpham | (d/s STW) |
| **PWER.0033-** | Wey at Burpham Court Bridge | ( " " ) |
| **PWER.0034-** | Wey at Cartbridge, Send | ( " " ) |

FIG.4

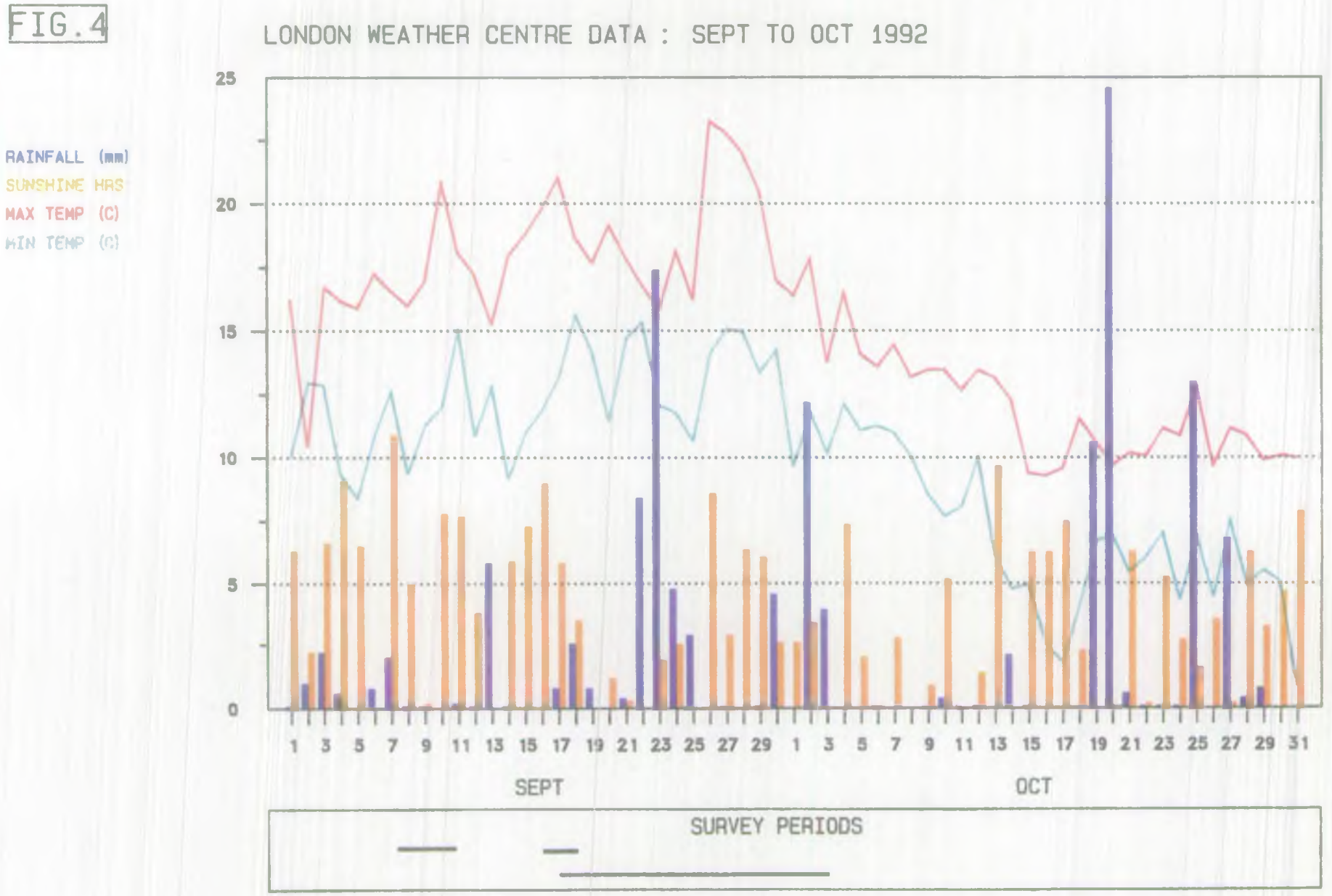

LONDON WEATHER CENTRE DATA : SEPT TO OCT 1992
RAINFALL (mm)
SUNSHINE HRS
MAX TEMP (C)
MIN TEMP (C)
25
20
15
10
5
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31
SEPT
OCT
SURVEY PERIODS

FIG.5(a)

ESTIMATED AVERAGE DAILY FLOW - R.WEY, GUILDFORD
SEPTEMBER - OCTOBER 1992

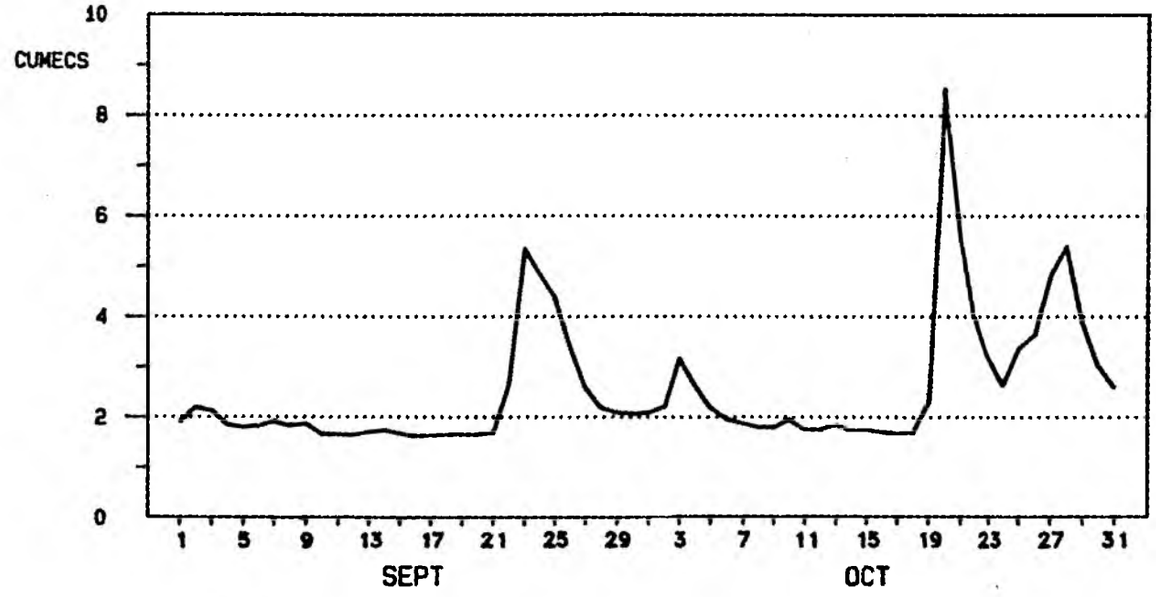



FIG.5(b)

ESTIMATED FLOW (15 MIN AVE.S) - R.WEY, GUILDFORD
16/09/92 TO 17/09/92

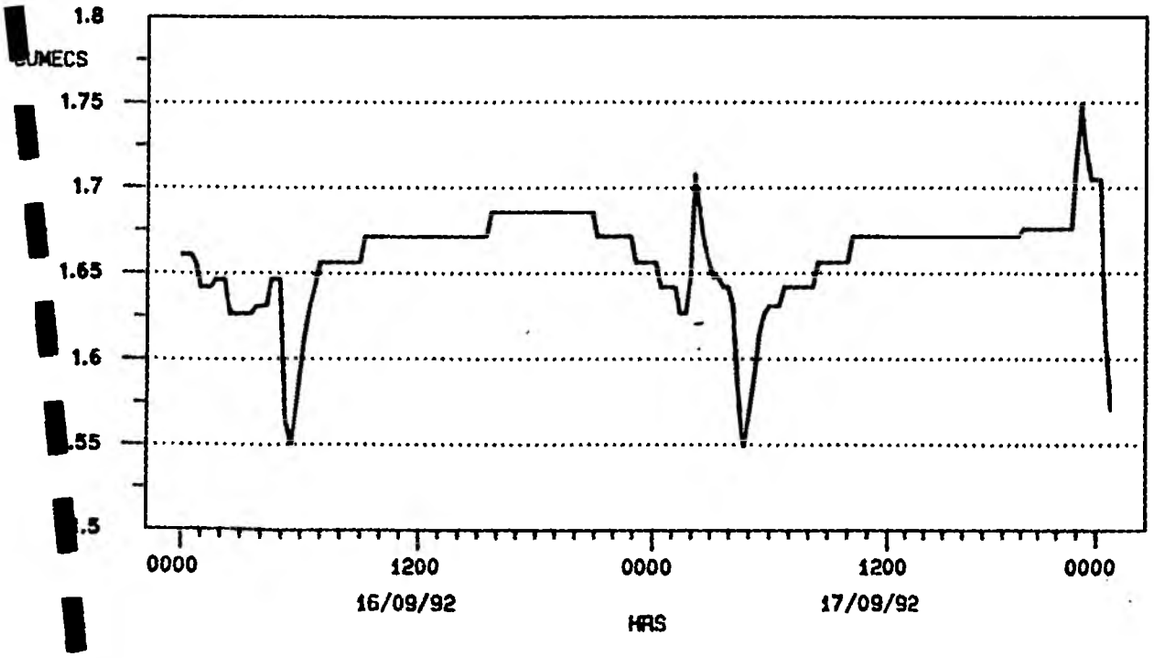
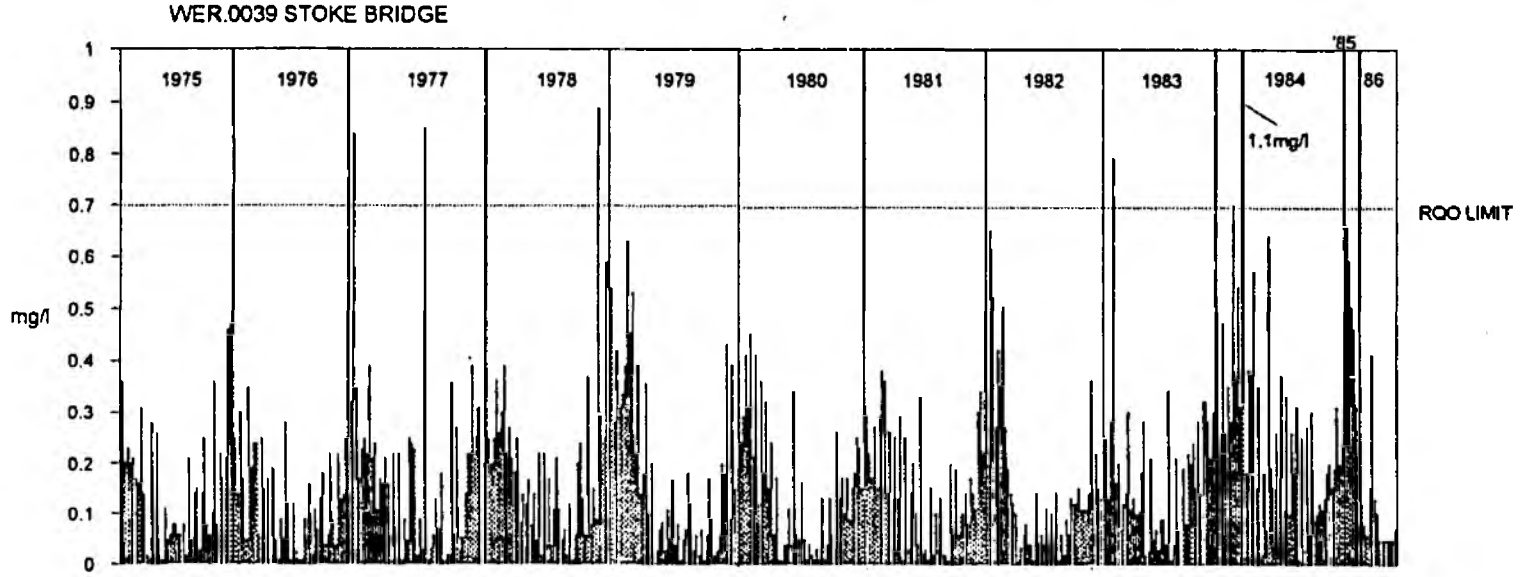


**FIG.6(a)** AMMONIACAL NITROGEN



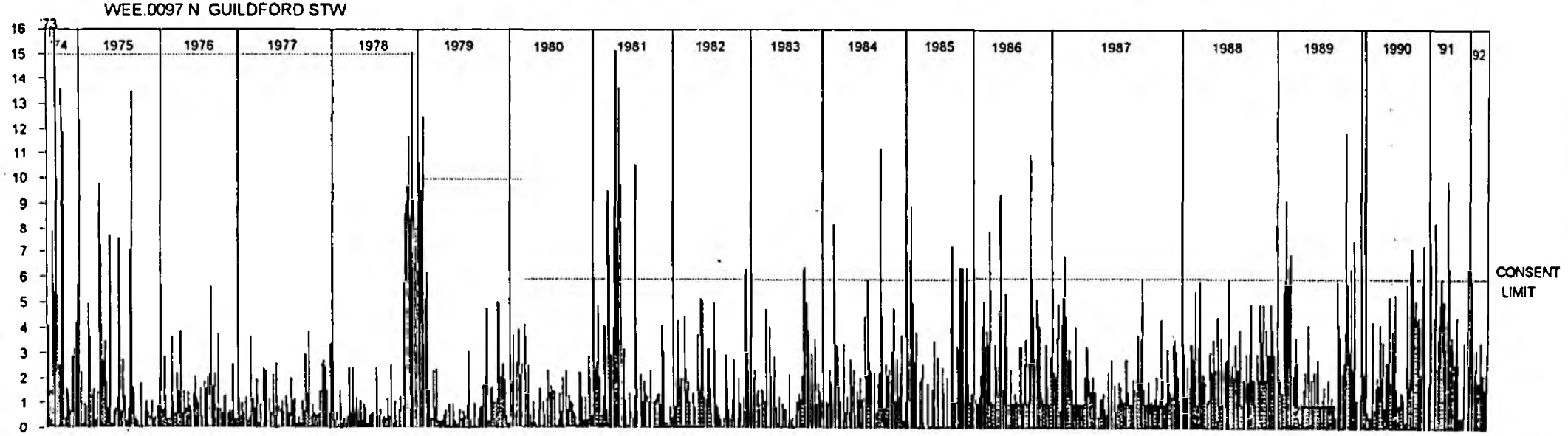



FIG.6(b) AMMONIACAL NITROGEN

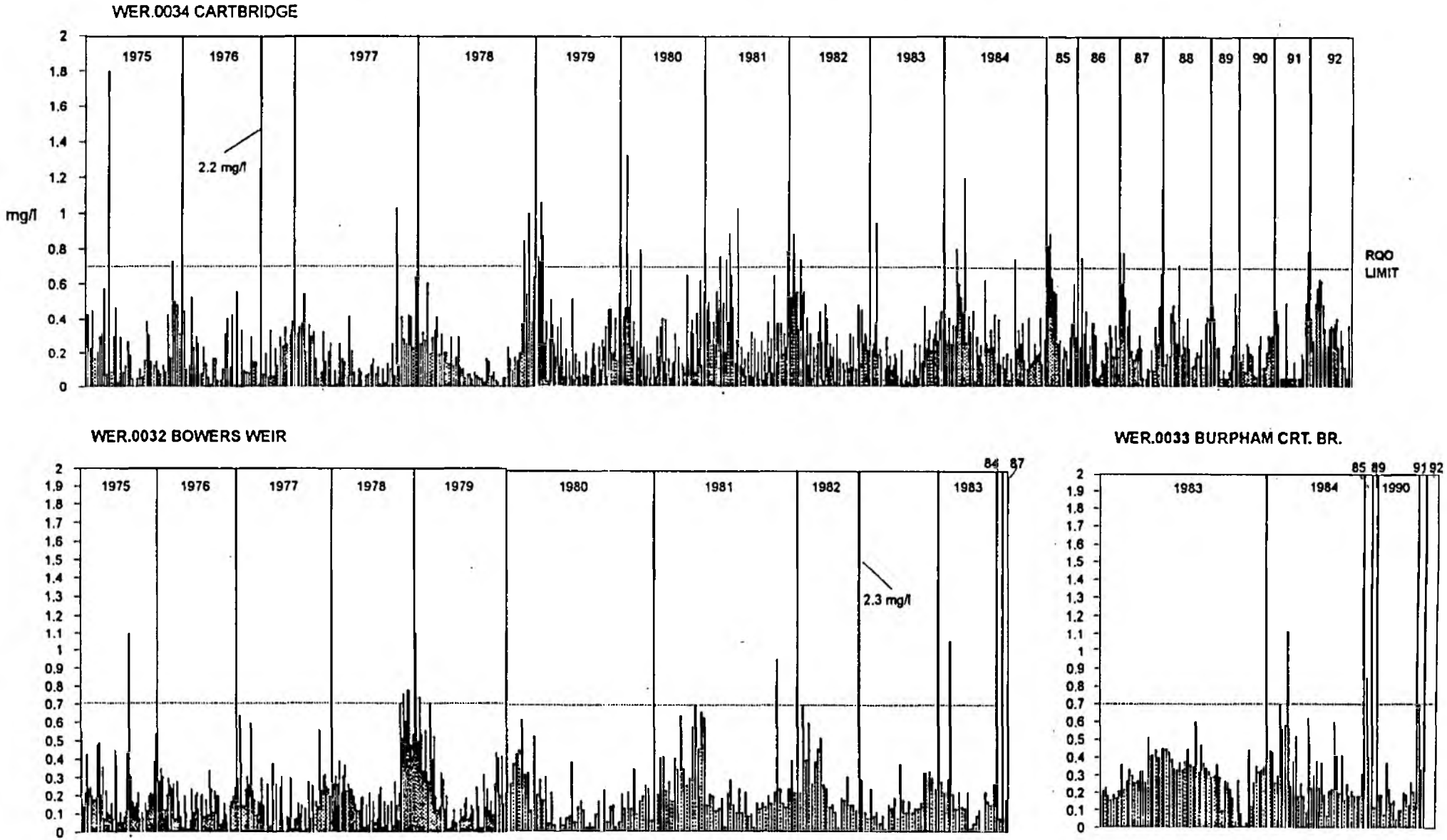


FIG.7(a) BOD

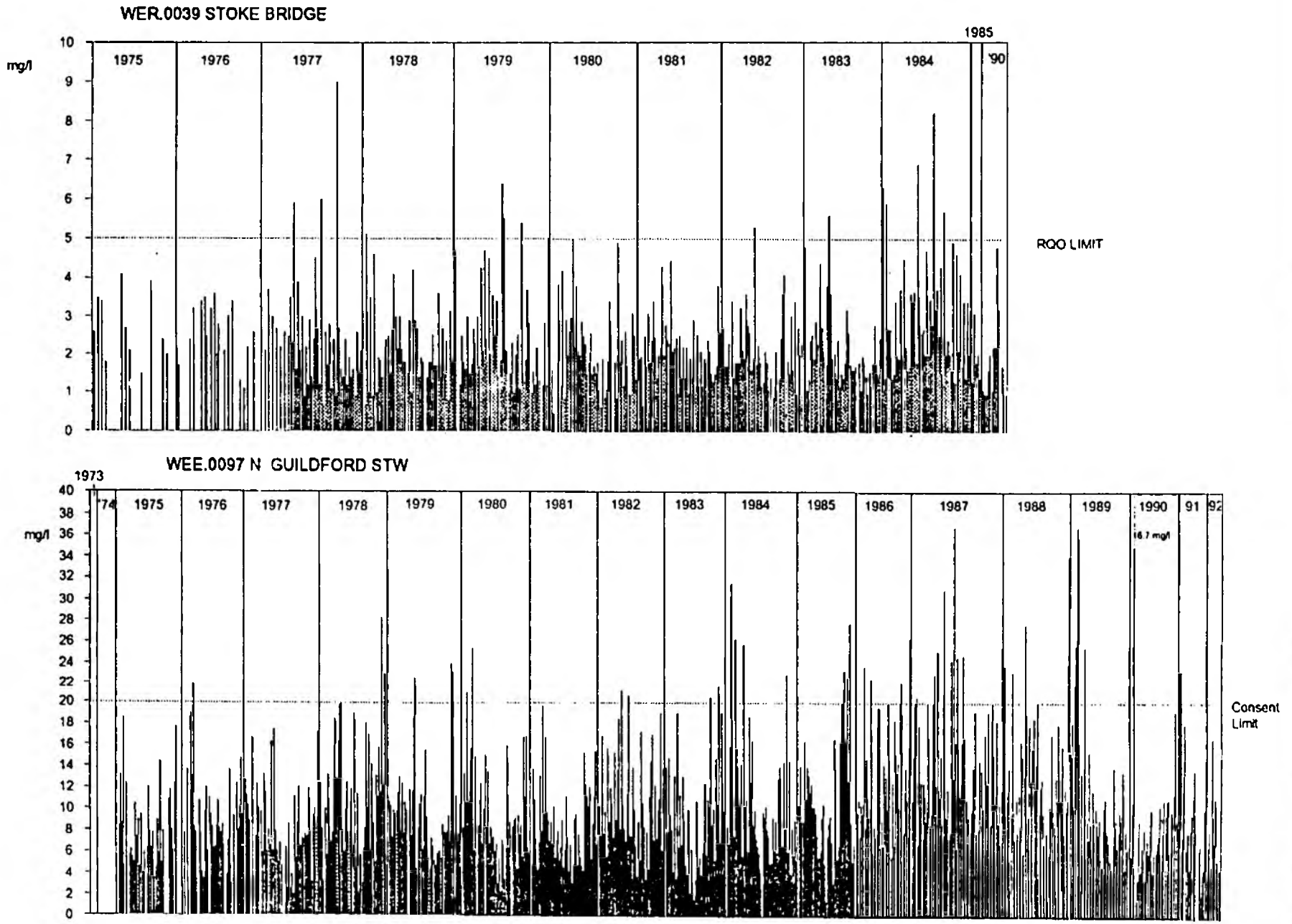
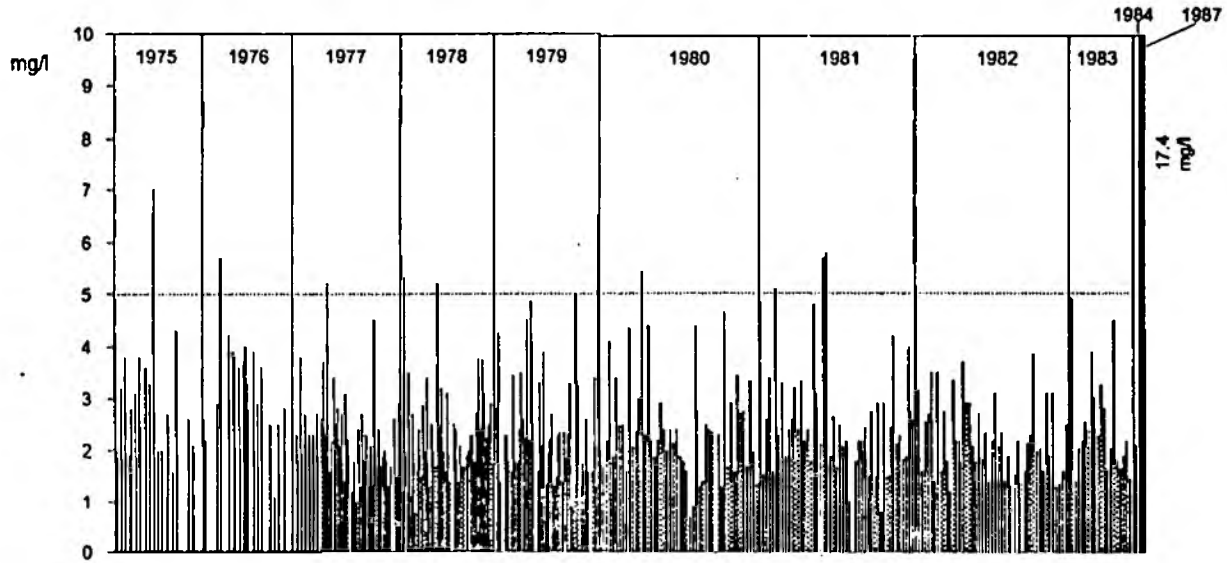
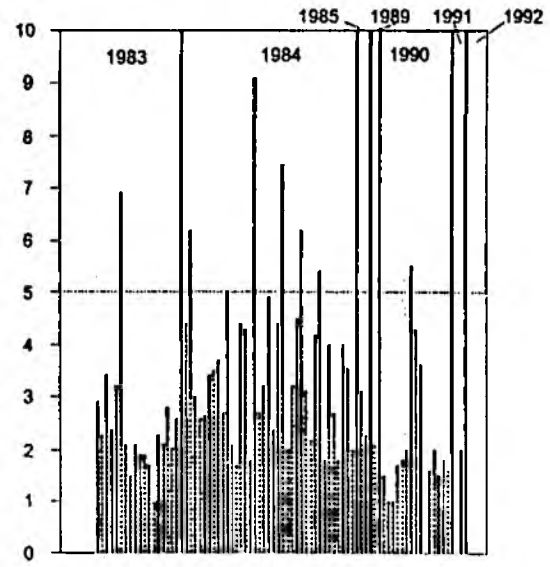

WER.0039 STOKE BRIDGE
mg/l
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
'90
ROO LIMIT
WEE.0097 N GUILDFORD STW
1973
'74
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
91
92
16.7 mg/l
Consent Limit

**FIG.7(b)** BOD

WER.0032 BOWERS WEIR




WER.0033 BURPHAM CRT. BR.




WER.0034 CARTBRIDGE

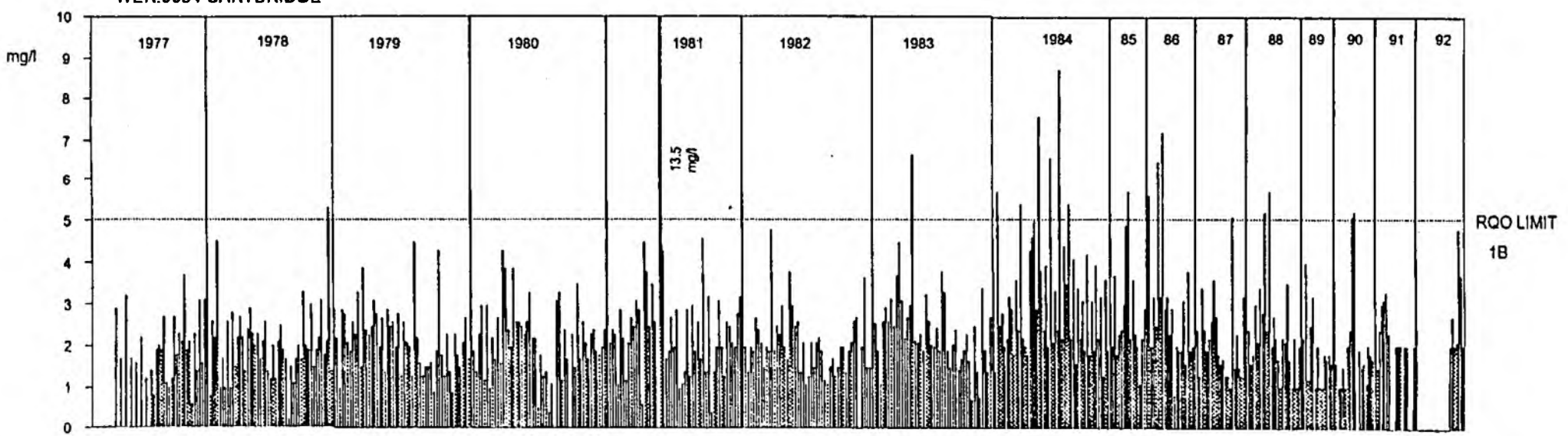
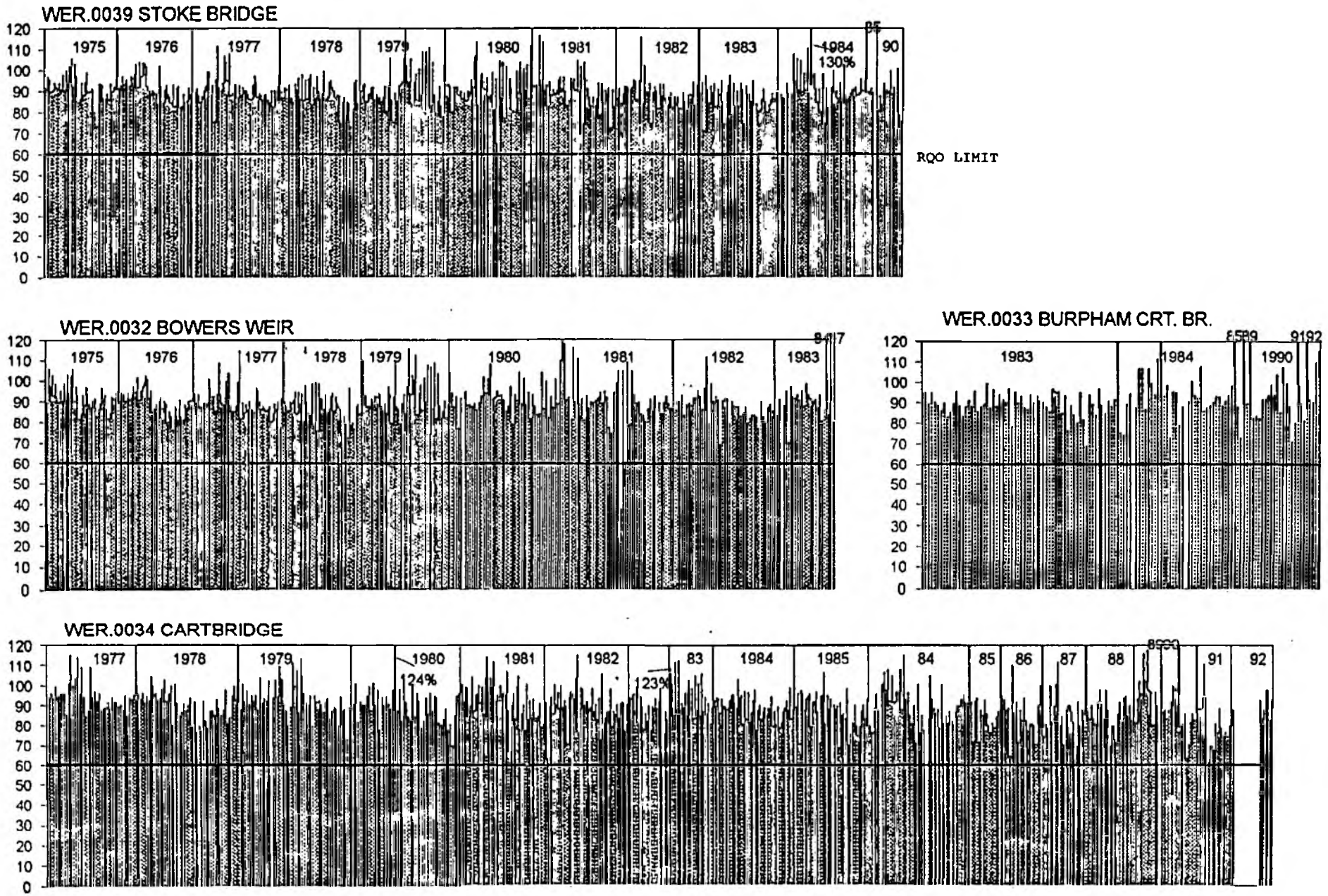


**FIG.8** DISSOLVED OXYGEN %



## 4.2 **Surveys : Water quality monitoring**

4 surveys were carried out along the reach in order to determine the effect of the STW effluent on the receiving river:

(i) 07/09/92 to 08/09/92 **Burpham Court & Triggs lock :** 24hr autosamplers were installed at the above sites on the river below the STW. Burpham Court is on the natural channel which branches off the main Navigation at Bowers weir. The autosampler at Triggs lock was installed on the river below the point of convergence with the natural channel, 6.5km below the STW. Samples were taken every hour for a period of 24 hrs and then analysed for ammoniacal nitrogen using a **Palintest photometer 5000.**

(ii) 09/09/92 to 10/09/92 **Sutton Place & Send Court Fm :** 24hr autosamplers were installed on the natural river channel at Sutton Place and Send, both downstream of the STW. Samples were taken hourly for 24 hrs and analysed using a **Palintest photometer 5000.**

(iii) 16/09/92 to 17/09/92 **Stoke lock to Bower's lock :** A 24 hour boat survey was carried out on the 2 km stretch of the Wey Navigation between the 2 locks. Samples were taken at Stoke lock (immediately upstream of Guildford STW), 400m d/s STW, 800m d/s STW, Bower's weir and at Bower's lock. Each sampling run took approximately 40 mins. and the time, temperature and dissolved oxygen % were recorded at each site. In addition to these a 1 litre sample was collected for later analysis.

A 24hr autosampler collected hourly effluent samples from the STW final effluent chamber. TWU provided inlet flow data for calculating loads.

A 24hr autosampler and recording DO% meter were installed at Burpham Court on the natural river channel below Bower's weir to see if the weir improved the water quality.

Samples were analysed for ammoniacal nitrogen using a **Palintest photometer 5000** and **Grant multimeter.** Every other sample was sent to the lab for further analysis enabling the other results to be cross-checked.

(iv) 17/09/92 to 07/10/92 **Sutton Place & Send Court Fm :** **pHOX 100 DPM** meters fitted with data loggers were installed on the natural river channels at the above sites to record DO%, temp, AmmN, pH & turbidity.

## 5 Results

### 5.1 Archive data

Fig.6(a) and 6(b) show ammoniacal nitrogen (AmmN) in river and STW spot samples taken from the mid 1970's. River samples show the usual seasonal pattern with concentrations increasing in winter. No easily identifiable trend exists with river concentrations over time although a slight increase may be seen in the STW effluent in recent years probably as a result of increasing catchment pressure and the declining performance of the filters. This is supported by the archive BOD data in Fig.7(a) and 7(b). DO% for river samples (Fig.8) show levels to be well above the 60% level required for RQO 1B classification although very little data has been collected for the 1990's.

### 5.2 Surveys

(i) 07/09/92 to 08/09/92 **Burpham Court & Triggs Lock** : River flow was less than 2 cumecs and there was very little rain either during or immediately prior to the survey. Results are displayed on Fig.9 which includes a map showing the positions of the autosamplers. AmmN, measured using a **Palintest photometer 5000**, revealed concentrations of less than 0.2 mg/l with almost no AmmN at Triggs Lock approximately 6km below the STW but levels between 0.02 and 0.16 mg/l on the main river channel at Burpham Court Farm approximately 2km below the STW. The results for Burpham Crt Fm appear to show a diel pattern with AmmN rising between 1700 and 2200 hrs although the very low concentrations are subject to analytical error. A malfunction with the autosampler prevented the collection of a full 24 hours samples, but nevertheless results appear to indicate that the STW has some influence of the quality of the water in the natural channel at Burpham Crt.

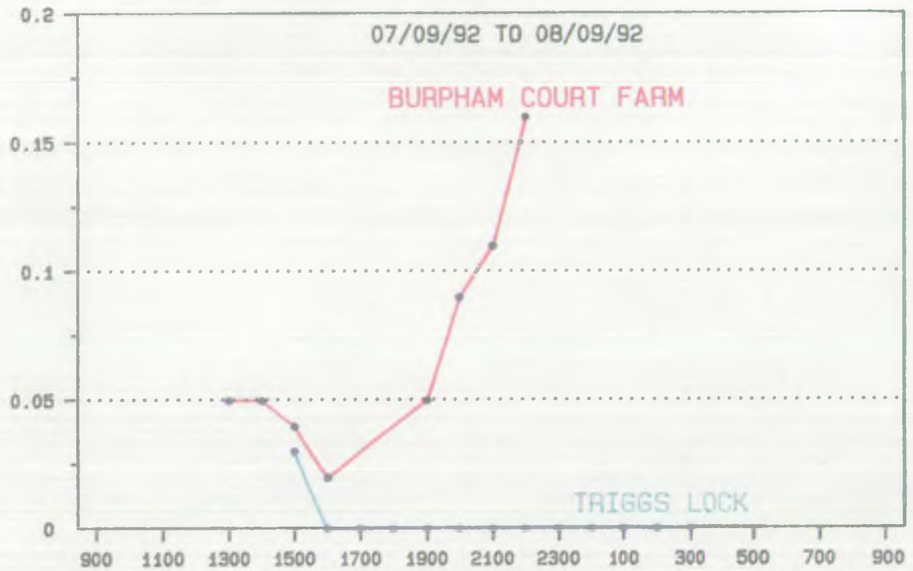
(ii) 09/09/92 to 10/09/92 **Sutton Place & Send Crt Fm:** This survey closely followed that above and results are also shown on Fig.9. AmmN was detected at both sites albeit at low concentrations. Sutton Place had a maximum concentration of 0.22mg/l recorded at 1600 hrs while the maximum at Send Crt Fm, further downstream, was 0.18mg/l. Both sites indicated a diel fluctuation with a difference of 2 hours between their peak times. Results for Sutton Place appear to indicate a second major peak concentration occurring after 0300 hrs.

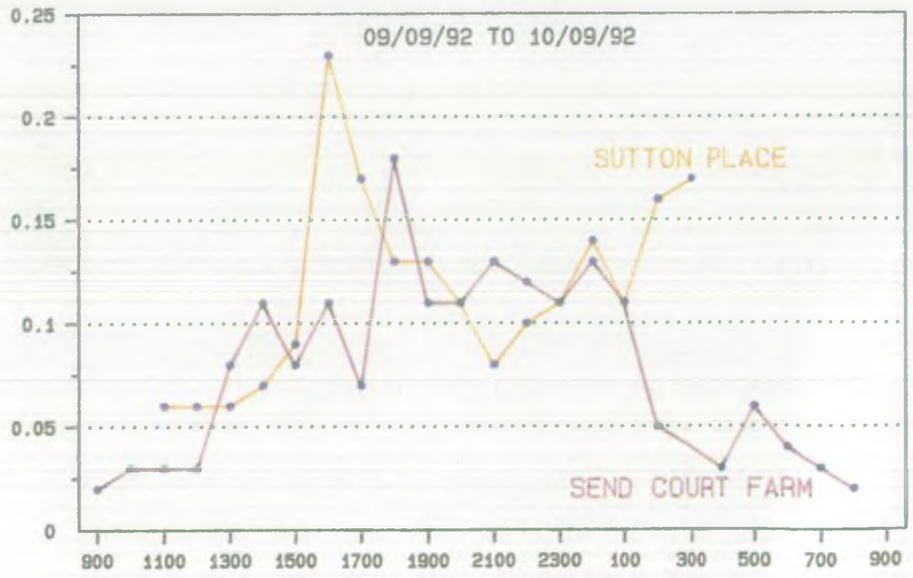
(iii) 16/09/92 to 17/09/92 **Stoke Lock to Bower's Lock:** Flows remained low for this survey with weather conditions similar to those above. The lab. analysed results for the STW samples showed peak AmmN concentrations occurring at 2200 hrs and 0800 hrs and coincided with inlet flows to the STW. **Palintest** results confirm this pattern in Fig.10. The peak AmmN load from the STW occurred at the same times with

FIG.9

# 24 hr AUTOSAMPLER SURVEY : R.WEY D/S GUILDFORD STW

AMMONIACAL NITROGEN mg/l
(measured by PALINTEST PHOTOMETER)



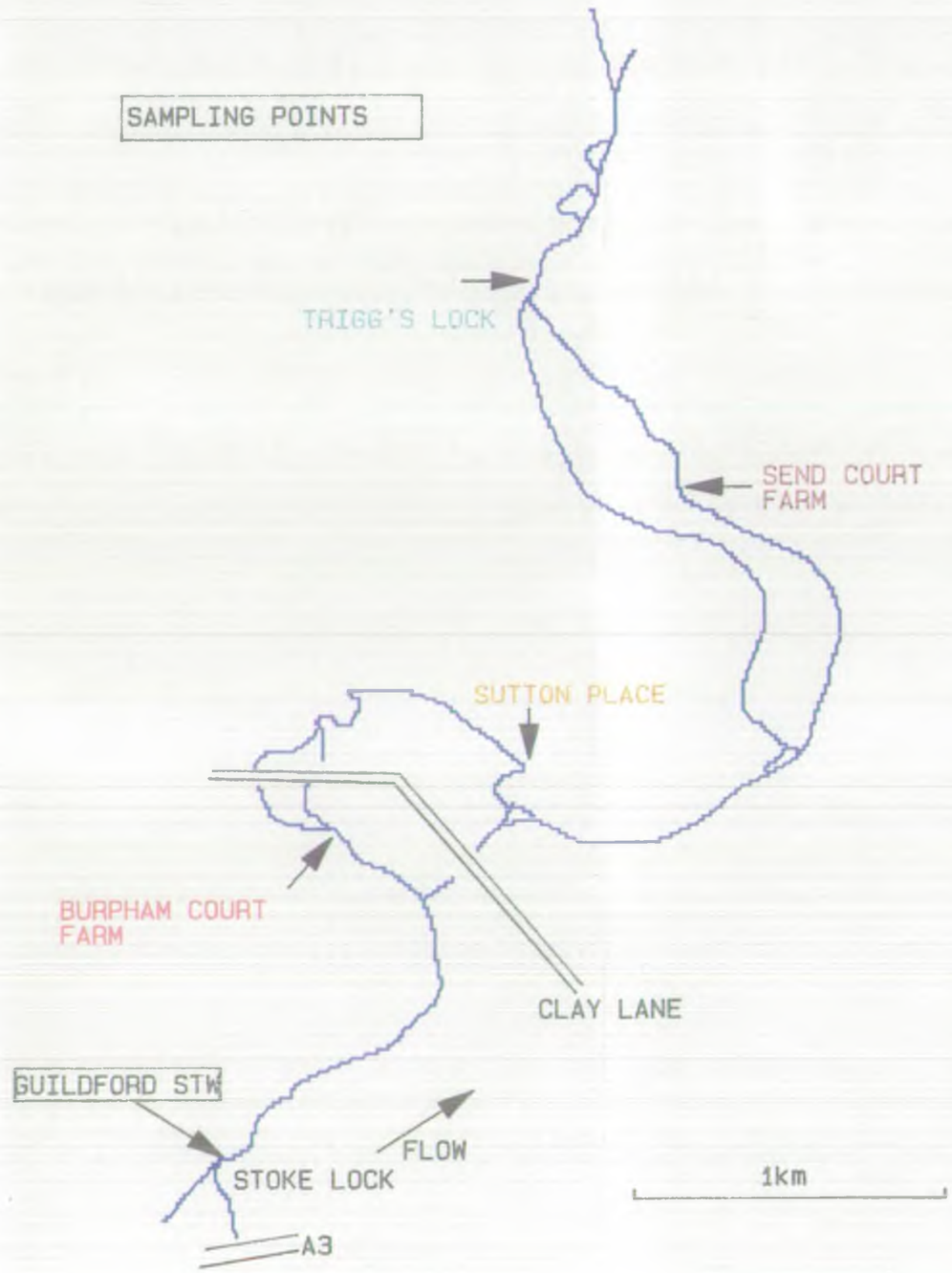
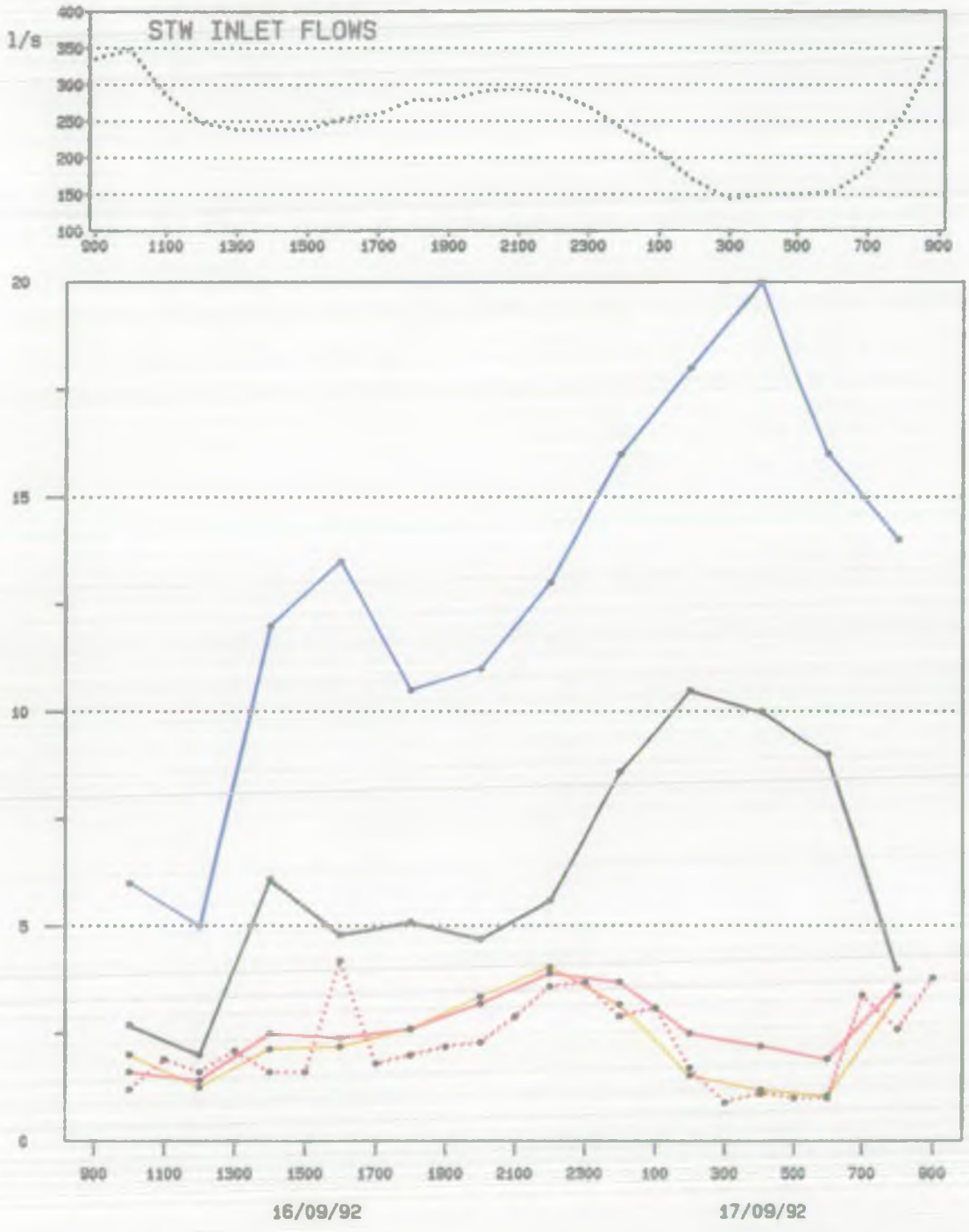



FIG.10

# GUILDFORD STW 24hr AUTOSAMPLER SURVEY



the highest values of approximately 3.5 kg/hr. Suspended Solids and BOD in the effluent both peaked at times of low flow through the STW suggesting that their influence on the river quality would be minimal in terms of the total effluent load discharged. All 3 parameters remained within their consent limits.

Fig.11 shows the AmmN and DO% for the river survey sites. Fewer river samples were collected during the survey period due to equipment failure although the general pattern of AmmN concentrations recorded in the river began to follow that of the STW with maximum levels around 0.3mg/l. As the AmmN concentrations in the river rose, the DO% fell. The latter is more a result of photosynthetic activity rather than the effect of the STW effluent. The autosampler at Burpham Crt Fm yielded a full set of results and showed peaks of AmmN at 1500 and 0500 hrs. The latter peak was possibly the result of the AmmN plug travelling downstream from the STW giving an approximate travel time of 7 hours.

In order to get some idea of the full diel pattern in the river below the STW the theoretical AmmN concentration was calculated from the effluent AmmN loads and river flows:-

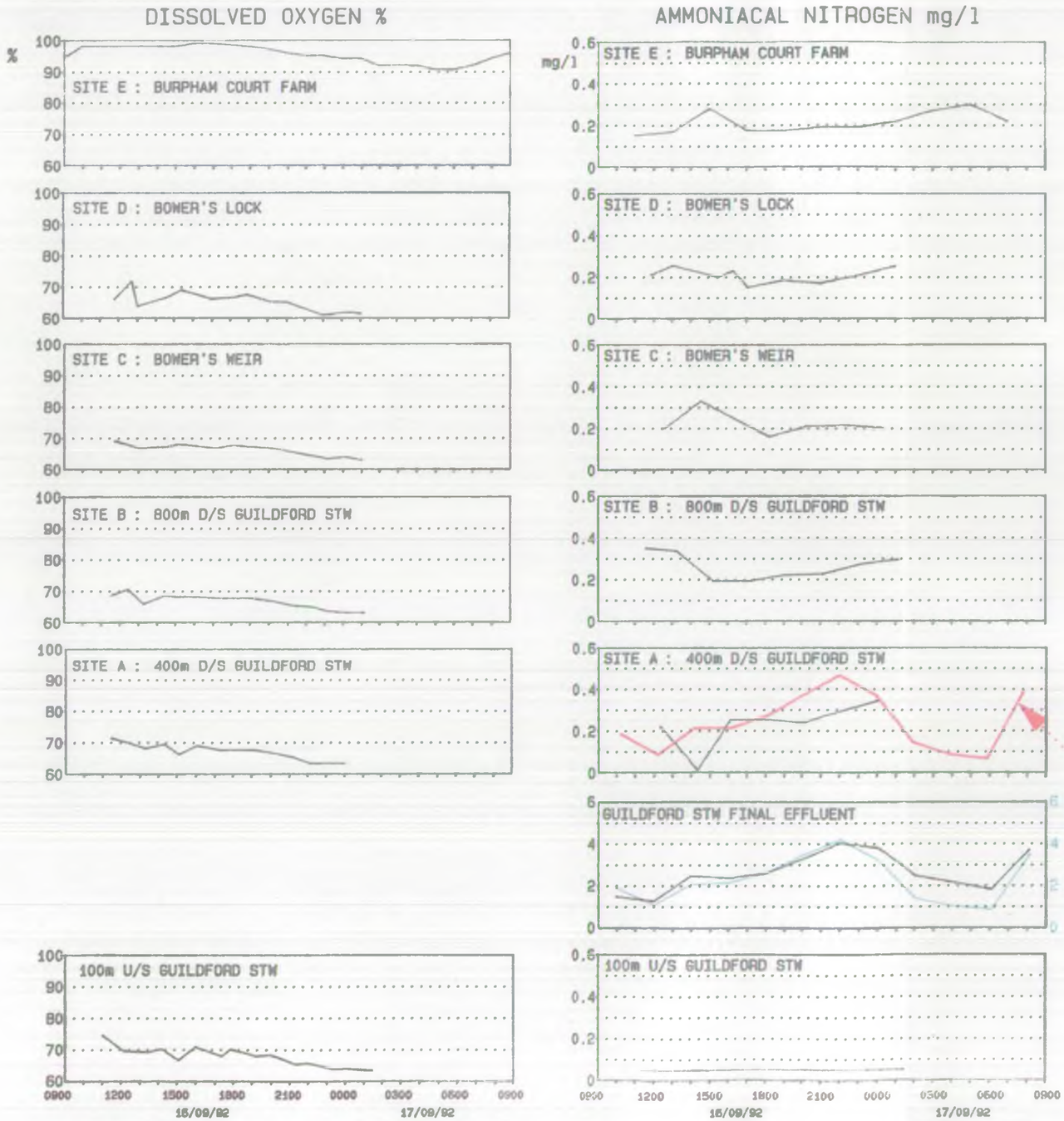
Theor.conc. = AmmN effluent load / (river+STW flow)

The results, plotted in red in Fig.11, follow quite closely the concentrations in the river below the STW and show that river AmmN levels were approaching their peaks at the point of abandoning the survey.

AmmN results determined by **Palintest** and recorded on the **Grant** multimeter are plotted in Appendix 1 for comparative purposes. The **Grant** readings bear little resemblance to results from the lab and **Palintest** and indicate the accuracy problems of using ion selective meters in the field where concentrations are low.(Since this survey the **Grant** ammonium probe has been changed).

DO% is also plotted for the survey sites in Fig.11 and show an expected diel pattern with a peak in the afternoon and a decline throughout the night. The only full set of data, recorded at Burpham Court Farm below the weir, indicate a trough at about 0600 hrs. This site also demonstrates the oxygenating effect of the weir with levels approximately 30% higher than the other sites. Comparison of u/s STW and d/s STW sites show that the effluent has very little effect on the DO% of the river.

FIG.11

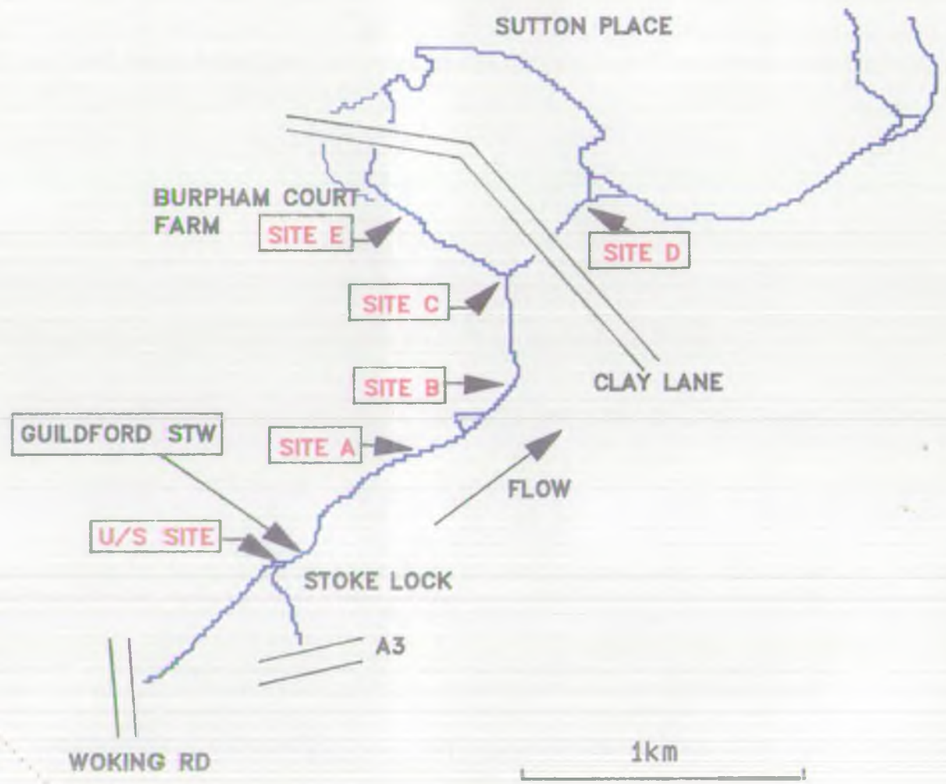






GUILDFORD STW & RIVER WEY SURVEY
16/09/92 TO 17/09/92

SAMPLING POINTS




THEORETICAL CONCENTRATION OF AMM.N IN RIVER BELOW STW DISCHARGE CALCULATED FROM STW EFFLUENT LOADS AND FLOWS IN RIVER

(iv) 17/09/92 to 07/09/92 **Sutton Place & Send Court Fm : pHOX 100 DPM** failed to record any data at Sutton Place but provided results for DO%, temperature, conductivity and pH for the Send Court Farm site. The data are plotted in Fig.12 and demonstrate the effect climate has on the water quality with large diel variations in DO% during dry, sunny periods and water temperatures which closely matched air temperatures. The data are unable to provide much information about the effect of the STW, particularly as AmmN was not recorded.

## 6. Discussion

The surveys show that although Guildford STW produces an effluent with AmmN of less than 5mg/l it still has a detectable effect on the R.Wey. The effect is very slight with concentrations of less than 0.4 mg/l in the river.

The survey of the 16/9 to 17/9 carried out on the river between Stoke Lock and Bower's Lock revealed concentrations of AmmN very close to the theoretical values calculated from effluent loads and river flows. It is this section of the river which is most effected by the STW effluent. Water flowing over Bower's Weir is well aerated adding approximately 30% DO at the time of the survey. This is very significant as it is estimated that approximately 70% of the flow follows this route. The aeration did not appear to effect the AmmN concentrations in the river below the weir and may have been because of the low water temperature reducing the rate of nitrification.

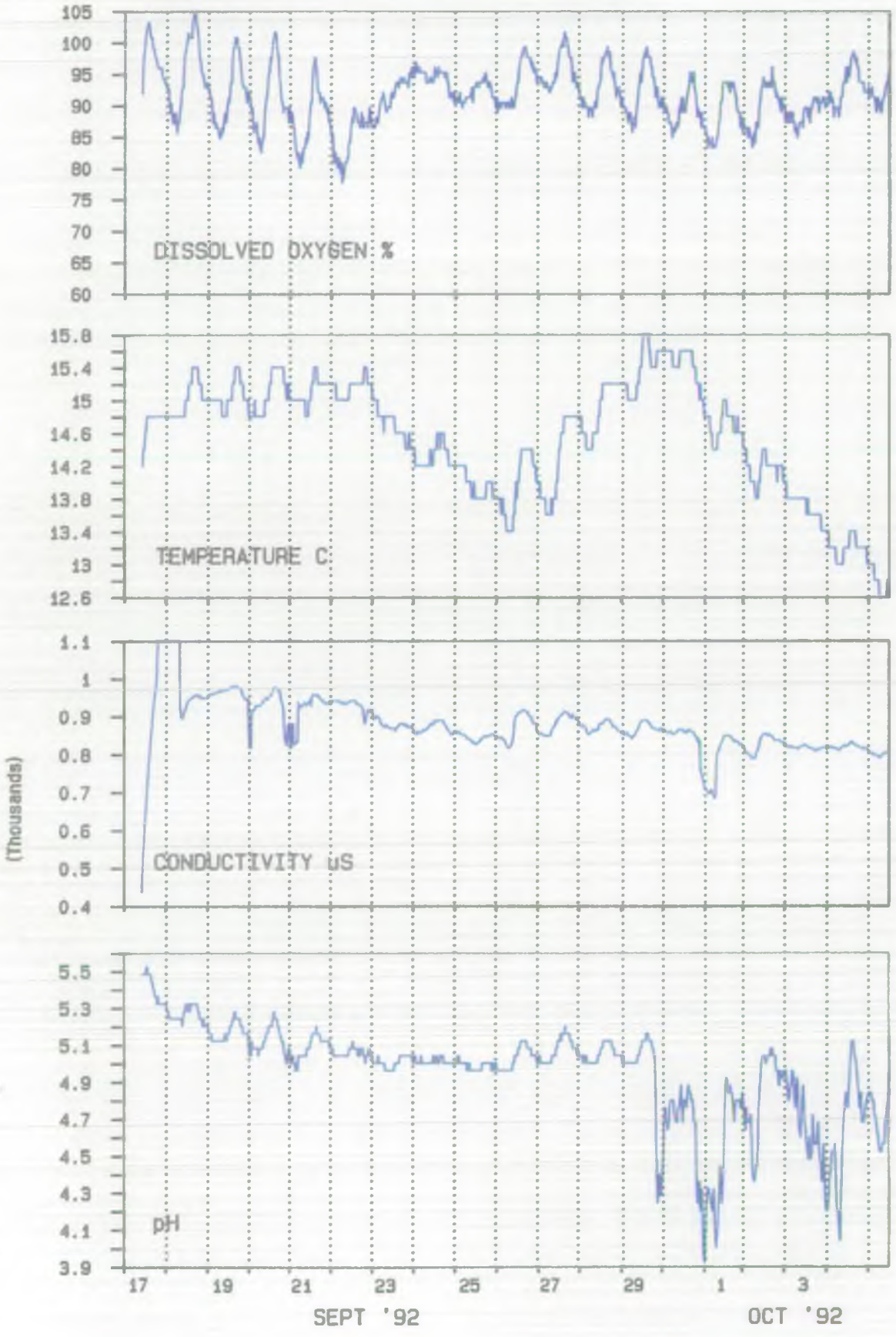
The data indicate a time of travel (TOT) of approximately 7 hours between Stoke Lock and Bower's Weir. Unfortunately existing TOT and flow data is not detailed enough to confirm this.

AmmN is detectable at least as far downstream as Send Court Farm although the recorded concentrations at this point are less than 0.2 mg/l (using **Palintest**) and therefore subject to a proportionally greater analytical error. However, even at these low levels, a pattern does seem to emerge with diel fluctuations in the river.

As far as RQOs are concerned the river meets the quality for classification as a 1B watercourse with respect to DO% (limit 60%) and AmmN (limit 0.7mg/l). Problems may arise in the future with the imposition of the new Statutory Water Quality Objectives (SWQOs) as the DOE consultation paper proposes 90%ile and 10%ile limits for a B watercourse (equivalent to 1B in the RQO classification) of 0.6 mg/l AmmN and 70% DO. The Wey Navigation stretches of the river immediately below the STW would fail to meet the DO% standard while those sections of natural channel are sufficiently aerated by the weirs. This situation may be exacerbated during hot weather with the production of algal blooms.

FIG. 12

R.WEY SEND COURT FARM
pHOX 100 DPM METER : SURVEY RESULTS



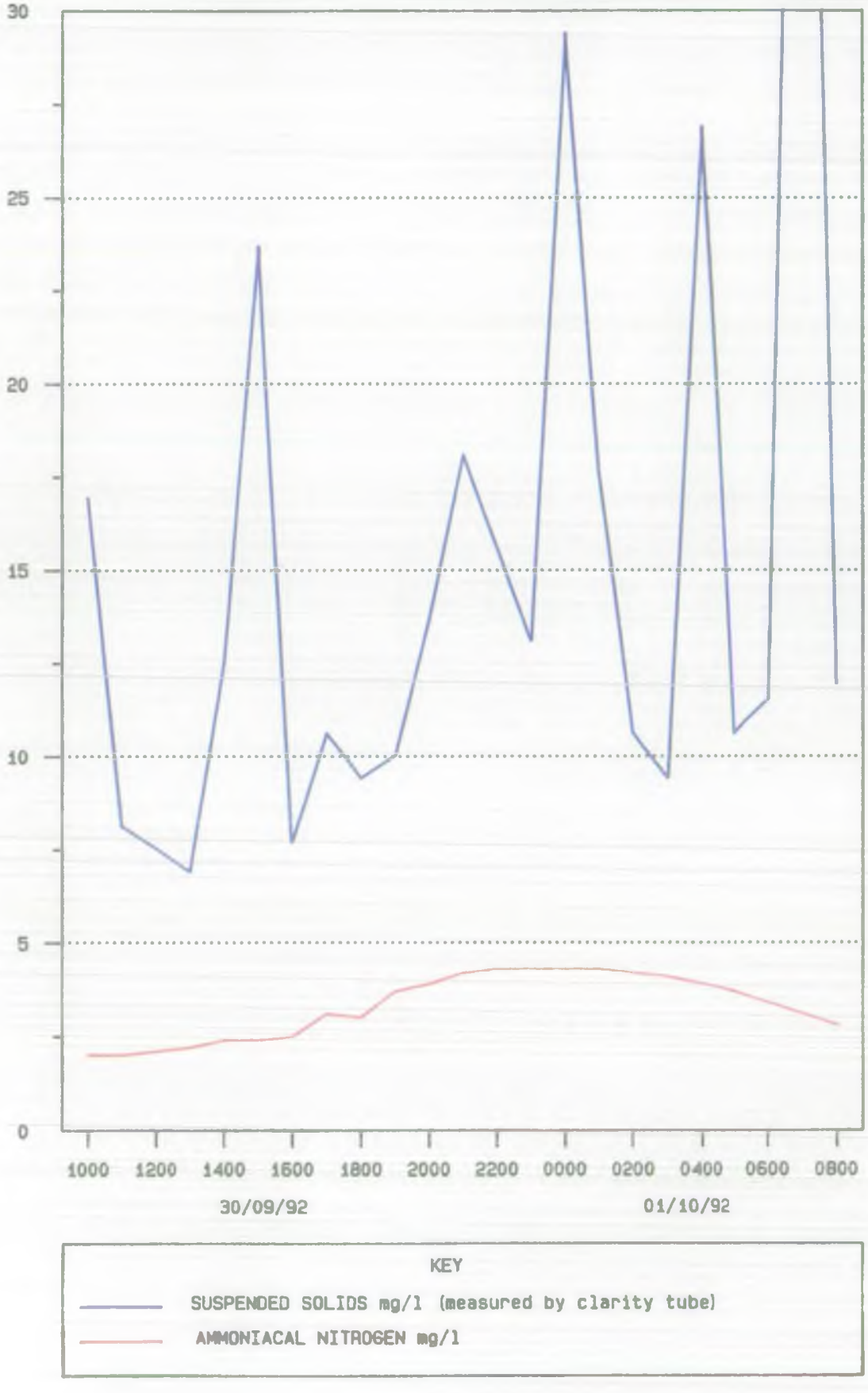
The STW effluent quality data does reveal a slightly unusual diel pattern for AmmN with peak concentrations occurring at the same time as peak inlet flows. One would normally expect an initial drop in AmmN concentration in the final effluent with well treated water produced during the low flow period being pushed out of the STW as the relatively rapid hydraulic increase in flow takes effect. This is shown by the data for suspended solids and BOD which reach maximum concentrations a few hours after peak inlet flows. The implications of this coinciding pattern of AmmN and flows is that the actual AmmN load discharged to the river is higher than would 'normally' be expected. As yet no explanation has been forwarded for this pattern although it has been suggested that the 'juggling' of flows within the STW between the overloaded filters and AS plant may be responsible.

TWU have provided data from a 24hr survey of the STW effluent carried out between 30/09/92 and 01/09/92. The data are plotted in Fig.13 and show a similar pattern for AmmN with a peak occurring between 2300 hrs and 0000 hrs. The pattern exhibited by suspended solids is less discernable although the greatest concentrations appear to occur either side of the AmmN peak. The methods used to measure AmmN and suspended solids were **CHEMetrics** test kit and **Clarity Tube** respectively, and can therefore not be directly compared with NRA survey data. The latter method is based on the ability to see a cross marked on the base of a graduated glass tube as increasing amounts of effluent are added. This method is therefore particularly prone to error as very small particles in the effluent, although impairing vision, may not yield particularly high suspended solids in terms of mg/l.

Spot samples taken at the STW over the last 2 years have revealed AmmN consent failures of just over 5% and do indicate a problem with the STW which is most likely to have resulted from poor quality effluent being produced by the BFP rather than the ASP. The poor quality of the BFP effluent has in recent months been temporarily controlled by carefully re-routing flows within the STW to ensure adequate dilution by the ASP effluent. It is however recognised that there is a problem with the biological filters and work is required at the STW.

FIG.13

GUILDFORD STW 24HR AUTOSAMPLER SURVEY
(THAMES WATER UTILITIES DATA)



## 7. Summary

The biological filters at Guildford STW are overloaded and producing a poor quality of effluent.

This effluent is diluted by the good quality effluent produced by the activated sludge plant and produced a final effluent which remained within its consent limits for the duration of this survey.

Spot samples taken over the last few years have shown the STW is approaching the point of failing the 95%ile limit for AmmN which indicates the need for repairs/upgrading of the STW to meet increasing catchment pressure.

All survey results however indicate that the effluent is having a minimal effect on the R.Wey Navigation section into which it discharges. The approximate dilution of river water to effluent was 6:1 at the time of the survey.

The section most effected by the effluent was from the outfall just below Stoke Lock to Bower's weir. Approximately 70% of the flow went over the weir and into the shallow fast flowing natural channel with DO% increasing by 30%. The AmmN concentrations remained almost unchanged and may have been due to the low water temperature effecting the rate of nitrification.

Further downstream at Send Court Farm and Triggs Lock levels of AmmN were still detectable but very low. The overfall at the head of this second section of natural channel is also likely to have improved the DO% and overall quality of the river.

Further work which may prove useful for the future includes :-

(a) Determining the flow splits where the river bifurcates to form separate Navigation and natural channels.
(b) Determining the TOTs down the different channels.
(c) Carrying out further 24 hr sampling programs at the STW to gain a better understanding of the diel pattern of the effluent quality.