# NATIONAL RIVERS AUTHORITY THAMES REGION
# BIOLOGY (EAST)
# TEDDINGTON FLOW SURVEY 1989

Survey work undertaken by Biology (East),
Biology (West) and Pollution District 3 staff.

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NRA

THAMES REGION

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## i. SUMMARY.

Due to drought conditions experienced in 1989, water abstraction was increased at sites on the Thames between Windsor and Teddington during July, resulting in a decrease in flows over Teddington Weir, flows remaining at a reduced level until December.

To investigate any effects of the low flows on the river environment, sites above and below the Teddington weir were sampled by NRATR biologists between July and December 1989.

The decrease in flows over the weir was accompanied by an increase in salinity levels at sites in the upper reaches of the Thames estuary.

Changes in the macrobenthic invertebrate community structure were noticed at these sites, with a dramatic fall in BMWP score at the site below Teddington Weir and a steady decrease in scores at the four other estuarine sites. There was no such noticeable effect at sites above the weir. Increases in the occurrence of strictly estuarine organisms, such as Palaemon longirostris, were recorded at the upper estuarine sites, indicating saline encroachment.

The duckweed Lemna spp. proliferated during the low flow period, resulting in the appearance of substantial mats covering the width of the river at various locations along the Thames. This did not occur during the previous major drought year of 1976.

There was no evidence of increases in phytoplankton numbers or benthic diatom cover during the low flow period.

The reduction in flows had no obvious effect on the levels of faecal coliform bacteria in the water. However, these levels were found to be typically very high at most sites, particularly those below Teddington Weir. The maximum recorded level was >150,000 E.coli cells/100 ml at Isleworth, situated below the outfall of Mogden STW.

A continuing survey programme was proposed.

# 1. INTRODUCTION.

## 1.1. The Teddington Flow Proposal.

1.1.1 In June 1986, a public enquiry was held into Thames Water's application to vary its licence (28/39/M/2) to abstract water from the river Thames between Windsor and Teddington, this being referred to as the Teddington Flow Proposal (TFP).

1.1.2 This variation was designed to remove the restriction on abstraction related to the flow of water over Teddington Weir, the minimum flow over the weir was to be reduced to 200 thousand cubic metres per day (tcm/d). It was proposed that greater extraction should be possible during the winter/spring period to allow maintenance of reservoir levels and so prevent excessive drought orders and extraction during summer (TWA 1).

## 1.2. Background to the Teddington Flow Proposal.

**Experience of the 1975/76 drought.**

1.2.1 The Autumn and winter of 1975 were comparatively dry and it was anticipated that unless the spring of 1976 was very wet a difficult water supply situation was likely to be experienced in that year. Extraction from the Thames kept reservoirs full until 31 March, though flows over Teddington Weir fluctuated at or a little above the statutory minimum (773 tcm/d).

1.2.2 The provision in the variation to the abstraction licence permitting the reduction of the residual flow over the weir to below 773 tcm/d could not be invoked until several weeks after the drawdown of the reservoirs had started. The permitted minimum flow (227 tcm/d) was

reached by 14 May. From 1 April to mid October, abstraction was restricted and there was a steady reduction in the reservoir supplies.

1.2.3 It was eventually necessary for Thames Water to obtain a drought order to maintain supplies, further extraction from the river and water being pumped back over Molesey and Teddington weirs permitting the flow over Teddington Weir to be reduced to nil.

1.2.4 It was proposed that if flows had been reduced to 200 tcm/d from 1 April 1976, the reservoirs would still have been full on 14 May. In addition, it was suggested that had earlier access to additional river water been possible, there would have been less need for drastic flow reduction later.

**The Public Enquiry.**

1.2.5 The result of the lessons learned from the water supply problems of 1975/76 was the original abstraction proposal agreed by the Thames Water Planning Committee in March 1981 (TWA 28). This stated that powers should be sought to remove all constraints on abstraction and that consultations should take place with interested parties. Formal procedures were then started in January 1983.

1.2.6 The resulting Thames Water draft variation 2 (TWA 7) included:

- remove the restrictions on abstraction related to the flow of water over Teddington weir: and
- remove the additional restriction on the average daily abstraction rate which applies during the months of May to October inclusive.

1.2.7 The proposed licence variation was advertised in January 1984 and 41 representations were received. As a result of various studies and consultations, Thames Water agreed to modify the original proposal, developing an operating strategy allowing a balance between the security of water supply and the residual flow in the river.

1.2.8 At the public enquiry, Thames Water therefore included a further provision to the effect that "water cannot be abstracted as to cause the flow over Teddington to fall below 200 tcm/d."

1.3. The predicted effects of the Teddington Flow Proposals.

1.3.1 The predicted effects of the new flow regime on the physical, chemical and biological components of the river environment were outlined in several Thames Water documents (TWA 1, TWA 32, TWA 33, TWA 40, TWA 75). The more important conclusions relating to this report were as follows:

**Water Quality.**

1.3.2 The TFP would have no significant detrimental effect on the river water quality between Windsor and Teddington.

1.3.3 Lower flows into the estuary would result in only small changes in the dissolved oxygen (DO) levels of the tideway. Storm discharges between Chiswick and Woolwich cause a significant deterioration in DO which would be more pronounced at low flows. In order to alleviate such problems, Thames Water proposed to use the mobile oxygen injection unit (the "Thames Bubbler") to offset any DO reduction due to storm sewage.

1.3.4 Variations in freshwater flows have a significant effect on the salinity levels in the estuary between Teddington and London Bridge. It was concluded that during drought years such as 1976, the TFP would reduce the extent of saline encroachment, but that this incursion would be slightly increased during non-drought years.

**Water Levels.**

1.3.5 Changes in river depth would be small when put in perspective with the tidal movements in the estuary. It was considered that Mogden sewage treatment works (STW) effluent is important in maintaining the water level below Richmond at low tide during a drought.

**Biology.**

1.3.6 Lower flows may cause diatoms to settle out of the water column and so increase the risk of blue green algal blooms (e.g. Microcystis). Levels of resulting minimum DO, however, would not be reduced to values that could stress the biota.

1.3.7 Floating plants, such as Lemna and Azolla, should be dispersed, even at low flows, possibly only being a nuisance in still backwaters.

1.3.8 Invertebrate macrobenthic community structure could be changed in areas of silt deposition. There would be little variation in biomass and no significant consequences for higher predators.

1.3.9 The invertebrate community between Molesey and Teddington should not be affected.

1.3.10 Slightly increased saline intrusion in non-drought summers would have only local effects with no significant changes in biomass. The TFP will prevent the major effects which would otherwise occur during droughts.

1.3.11 Species at the Syon Park site of special scientific interest (SSSI) should not be affected by flooding with slightly brackish water.

1.3.12 Repetition of the 1976 weather conditions after implementation of the TFP would not produce salinities great enough to jeopardise successful hatching of roach and dace.

## 1.4. The Reasons for the Teddington Flow Survey, 1989.

1.4.1 The document TWA 1 states "If the TFP is approved...Thames Water will be able to give better management to the river. The flow over Teddington weir will not often be reduced to 200 tcm/d. When this does occur, the river will be closely monitored and controlled."

1.4.2 The winter of 1988 and summer/autumn of 1989 saw conditions of very low rainfall, so increased abstraction under the TFP was deemed necessary, resulting in the reduction in flows over Teddington weir. Under the terms of the TFP the river environment was monitored by Thames Water Authority biologists (now Thames Region National Rivers Authority), the survey commencing in July 1989.

## 2. METHOD.

### 2.1. Sites.

2.1.1 Sample sites were selected to cover the 50.7 km of the river Thames between Egham and Battersea, the area most likely to be affected by increased water extraction between Datchet and Hampton (TWA 1). Ease of access and suitability of substrate were also major factors in site selection, particularly below Teddington Weir.

2.1.2 Five sites were selected to cover the tidal region between Teddington and Battersea: d/s Teddington Weir, Isleworth, Kew, Hammersmith Bridge and Cadogan Pier (Fig. 1). Table 1 and Appendix 1 contain details of site positions. The full suite of samples was taken at each site.

2.1.3 Above the weir, sites were selected to correspond with previous benthos sites or those used to monitor the bacterial levels at abstraction sites. This gave a total of eight sites: Egham, Littleton, Chertsey, Walton, Hampton Court, Raven's Ait, Kingston and u/s Teddington weir (Fig. 2). Littleton and Raven's Ait were benthos only, while Egham, Chertsey, Hampton Court and Kingston were phytoplankton/coliform bacteria only. Table 1 contains details of sample allocation and site position.

### 2.2. Sampling methods and analysis.

2.2.1 The components of the river environment most likely to be affected by changes in river flow were monitored during the Teddington Flow Survey. These were as follows:

**Macrobenthos community structure** (all sites).

2.2.2 Samples of the macrobenthos were obtained using the kick sample method as outlined by the Freshwater Biological Association (FBA). This

entailed a three minute kick of the substrate into a standard FBA net of mesh 900 µm, dimensions 230 x 255 mm and bag depth of 275 mm. This was supplemented by a one minute search of other habitats, e.g. under large boulders. Upstream of the weir, a sweep of any vegetation present was included in the three minute kick.

2.2.3 Above the weir, samples were sorted on site. Samples from estuarine sites were transferred to plastic buckets and sorted in the laboratory.

2.2.4 For each site, the macrofauna were sorted, removed and identified to family level in order to allocate a score; calculated using the system devised for the Department of Environment by the Biological Monitoring Working Party (BMWP) (BMWP, 1980). Each designated taxon is attributed a score relating to its apparent tolerance to pollution influences (Appendix 2), the scores being summed to give a value for each site.

2.2.5 In addition, the Average Score Per Taxon (ASPT) was calculated thus:

$$ASPT = \frac{BMWP}{n}$$

n = number of scoring families.

This value has been used as a supplement to BMWP, indicating whether there is a specific removal of the more sensitive high-scoring taxa.

2.2.6 For sites below the weir, presence of non-scoring taxa was also recorded to allow for the influx of primarily estuarine invertebrates, thus indicating any saline encroachment.

**Phytoplankton Community** (all sites).

2.2.7 Water samples for phytoplankton community analysis were obtained using a 200 ml glass water bottle and returned to the laboratory.

2.2.8 A 10 ml water sub-sample was centrifuged for 20 minutes and the concentrate examined under a microscope to identify the algal cells

present. For sites above the weir, diatoms and flagellates were identified to genus. Estuarine sites were classified into pennate diatoms, centric diatoms and flagellates. All other groups were classified to genus.

**Coliform Bacteria Levels** (all sites).

2.2.9 Water samples for coliform counts were obtained as for phytoplankton.

2.2.10 Presumptive bacterial counts for both total coliforms and Escherichia coli were obtained using the standard membrane filtration technique with incubation using sodium lauryl sulphate broth as a growth medium (HMSO, 1982).

**Macrophytes** (all sites).

2.2.11 Observations of the proliferation of aquatic macrophytes, particularly the floating species of Lemna and Azolla, were made at each visit. Any covering of these plants was recorded.

**Benthic Algae** (estuarine sites only).

2.2.12 Complaints arose during 1976 from the appearance of "brown slime" - the spread of primarily benthic diatoms on the foreshore areas of the upper estuary. As a result, any increase in benthic algal cover at the five sites downstream of Teddington was recorded.

**Temperature** (estuarine sites only).

2.2.13 On-site temperature of river water was recorded at estuarine sites using a mercury thermometer.

**Salinity** (estuarine sites only).

2.2.14 Salinity values for sites downstream of Teddington Weir were obtained from weekly boat run data by TWA/NRATR staff, the data being converted to mid-tide level in order to allow temporal and spatial comparison.

2.2.15 Comparative data from 1976 were also obtained.

## 2.3. Timing of Samples.

2.3.1 Sampling commenced during the first week of July 1989 (week 27) when the need for additional abstraction became apparent. Sampling frequency varied above and below the weir.

2.3.2 At the estuarine sites, all parameters were sampled once per week at low tide until 5th October (week 40), whereupon monthly samples were deemed sufficient. Above the weir, bacteriological samples were taken weekly, benthic samples fortnightly until 21/8/90 (week 34), then monthly and phytoplankton samples on eight dates spread between July and October.

2.3.3 Table 2 details the main parameters sampled at each visit.

## 3. RESULTS AND DISCUSSION.

### 3.1. Physico-chemical parameters.

3.1.1 It is valuable to describe first the variations in the river's physical and chemical environment over the sample period, particularly for the sites below the weir which would be most severely affected by a reduction in the flow regime. This will allow any changes witnessed in the phytoplanktonic, macrobenthic or macrophytic communities to be put into context.

**Gauged flow over Teddington Weir.**

3.1.2 The further extraction of water from points between Datchet and Hampton commenced during week 29 (to a target flow of 600 tcm/d) and increased during week 32 (reducing the target flow to 300 tcm/d). Extraction remained at this level until week 47, when the target flow returned to 600 tcm/d.

3.1.3 The flow of water over the weir is constantly rec
daily flows. Fig. 3 illustrates the mean weekly flows (in tcm/d) for the sample period 1989, together with equivalent values for the last major drought year of 1976. For further comparison, average monthly flow values for a 10 year period are included. Appendix 3 contains full details of the maximum, minimum and mean flows.

3.1.4 Both 1989 and 1976 were well below the average for summer flows, but the flow regimes for the two years differed. 1976 saw very low flows from an early stage, culminating in practically zero flow for four weeks (weeks 36-39). However, by week 40, the rain had returned and flows increased dramatically from the point. 1989 in comparison saw flows maintained at a level above that of 1976, largely due to the implementation of the TFP. However, rain did not return until week 49-50, when flows dramatically increased.

3.1.5 The two flow regimes could therefore be described as follows:

1976 - Acute. Drastically low flows recovering by October.

1989 - Chronic. Relatively low flows extending to December.

Salinity.

3.1.6 The different flow regimes produced equivalent effects in the salinity profile of the upper estuary. Fig. 4 illustrates the variations in salinity over the 1989 sample period for six points below the weir; a dramatic increase in salinity levels for most sites, with noticeable increases even for Kew and Richmond. It has to be stressed that the values plotted are mid-tide corrected, indicating the general salinity regime experienced at each location and so allowing valid comparison. At high tide, the salinity levels would be greater.

3.1.7 For comparison, the corresponding measurements for 1976 are provided (Fig. 5), with direct comparisons for three sites (Fig. 6). The latter figure highlights the difference in the salinity regimes, 1976 with a dramatic peak and a quick return to near-normal conditions. 1989 remained at an elevated level for a few weeks more, reaching a salinity peak at weeks 40-42. Fig. 6 also gives mean salinity values for a non-drought year (1986) to demonstrate the extent of the elevated values for 1989 and 1976.

Temperature.

3.1.8 Fig. 7 displays the on-site temperature readings for the five survey sites below Teddington Weir. The current NRATR standard for maximum estuary water temperature is 25°C. All sites therefore exceeded this value between weeks 28-33, a maximum of 28°C being reached at both Kew and Cadogan Pier. Temperatures remained relatively high (>18°C) until October, when cooler air temperature reduced the river temperature.

## 3.2. Macrobenthos Community Structure.

**u/s Teddington Weir.**

3.2.1 Figures 8 and 9 illustrate the changes in BMWP and ASPT respectively for the four benthos sites above the weir. It would appear that extraction had no noticeable effect on the general level of either score. There was, however, a slight decline in BMWP score for u/s T, due to the disappearance of some caddis families (Psychomyiidae, Hydroptilidae), bugs and beetles (Corixidae, Dytiscidae) and molluscs (Viviparidae, Unionidae). The available area for kick sampling at this site was very limited (3 $m^2$), so the decrease in BMWP is probably due to the stresses of frequent sampling rather than any effect of changing flows/water quality.

3.2.2 Table 3 and Appendix 4 contain a full list of scoring taxa recorded at each non-tidal site.

**d/s Teddington Weir.**

3.2.3 Figures 10 and 11 display the BMWP and ASPT values recorded at the five estuarine sites over the sample period. Under normal abstraction conditions, d/sT tended to score between 70-90 (similar to u/sT), Kew 30-50 and the other sites 20-35. The comparatively low value for Isleworth, which is further up the river than Kew, may be due to the influence of the discharge from Mogden STW, which enters the river just upstream of the sample site.

3.2.4 During week 32, abstraction was increased to a target flow over Teddington Weir of 300 tcm/d. As the flow over the weir decreased, the salinity at all sites increased (Figs. 3 and 4) and there was a noticeable decline in BMWP scores at all sites. The fall was most dramatic at Teddington (Fig 12a), having the largest number of sensitive taxa to lose, decreasing from 89 to 25 in three weeks. At

the other four sites there was a more steady decline from week 32 to week 39. By week 39, all five sites scored below the current NRATR standard of 25. Table 3 and Appendix 5 detail variations in the composition of macrofauna community at each estuarine site.

3.2.5 ASPT showed a slightly different trend to BMWP score (Fig. 11). The ASPT for Teddington decreased as for BMWP indicating the disappearance of high scoring taxa with a decrease in flow (Table 4, Fig. 12b). The ASPT for the other four sites remained steady, with no general downward trend. At these sites, with naturally higher salinities than Teddington, sensitive taxa are normally excluded. A fall in BMWP without a corresponding fall in ASPT suggests that the increases in salinity remove taxa regardless of BMWP score, e.g. Gammaridae (6 points) were omnipresent, whereas at some sites Glossiphoniidae, Asellidae, Sphaeriidae (3 points) and even Chironomidae (2 points) and Oligochaeta (1 point) disappeared over the abstraction period.

Non-scoring Taxa.

3.2.6 Table 5 lists the occurrence of non-scoring taxa that under non-drought conditions are restricted to mid-estuary regions of higher salinity. The appearance of these species in kick samples indicates the level of saline encroachment into the upper reaches of the estuary following flow reductions. These species were caught at low tide, the period of minimum salinity, so it can safely be assumed that at high tide they would penetrate even further up the estuary.

3.2.7 The estuarine sites will be monitored monthly to chart any recovery of the macrofauna community upon a return to normal flow conditions.

## 3.3. Phytoplankton.

3.3.1 Table 6 details the phytoplankton genera recorded at each site over the whole of the sample period. As would be expected, salinity limited the distribution of several genera to the freshwater sites upstream of

the weir. All estuarine sites showed a similar range of flora, with Kew recording the most genera. Only Scenedesmus, flagellates and centric and pennate diatoms were recorded from all sites. Appendix 6 details the generic composition of the diatoms and flagellates upstream of the weir.

3.3.2 Abundance of phytoplankton cells remained relatively low over the whole survey period, never approaching bloom proportions even during periods of low flows and high temperatures. Blue-green algae (Myxophyceae) were recorded sporadically at all sites above Teddington Weir, but always in low numbers.

3.3.3 It can therefore be stated that phytoplankton blooms did not pose a problem during the low flows of 1989.

## 3.4. Coliform Bacteria.

3.4.1 Figures 14 and 15 illustrate respectively the variations in E. coli levels at sites upstream and downstream of Teddington weir. It would appear that reduction in flows had no obvious effect on the bacteria counts. Storm discharges, Sewage Treatment Works outfalls and rainfall have the greatest influence on the coliform levels.

3.4.2 For Egham, Kingston and all sites in the estuary, E. coli counts reached peaks of >20,000 cells/100ml. Sites from Isleworth to Cadogan Pier had a constant high level of contamination, the maximum being >150,000 cells/100ml for Isleworth (week 37). This site is influenced by the discharges from Mogden STW. Likewise, Hogsmill STW is influencing the river between Hampton Court and Kingston, and is the likely cause of high levels recorded at Kingston. Appendix 7 details the maximum, mean and minimum coliform counts for each site.

3.4.3 The elevated levels of coliform contamination may have consequences for public health, particularly as the region of the Thames covered by the Teddington Flow Survey is popular for water contact recreations, such as fishing, rowing, boating and even swimming. For comparison, the EC mandatory level for designated bathing waters is 2000 E. coli cells/100ml. The mean E.coli levels for Egham, Kingston, d/s Teddington weir, Isleworth, Kew, Hammersmith and Cadogan exceeded this level by up to 20 times (Appendix 7). Not one site was constantly under 2000 cells/100ml.

## 3.5. Macrophytes.

3.5.1 During August 1989, a survey of wetland vegetation in the Thames river corridor between Sunbury Weir and Putney Bridge was undertaken by Pond Action for the NRATR (Pond Action, 1989a,b). The species of floating macrophyte recorded during these surveys were:

Sites u/s Teddington - Lemna gibba (Gibbous duckweed), L. minor (Common duckweed), L. polyrhiza (Great duckweed) and Azolla filiculoides (Water fern).

Sites d/s Teddington - Lemna minor, L. polyrhiza.

Azolla filiculoides was recorded below Teddington Weir during the Teddington Flow Survey.

3.5.2 Table 7 details the presence and proliferation of floating macrophytes (principally Lemna spp.) over the Teddington Flow Survey period.

3.5.3 Unlike 1976, when floating vegetation was not a problem, 1989 saw a dramatic increase in the plant cover, with an unbroken blanket cover developing over many sections of the river by October (see Appendix 8). This was a cause of public concern, with complaints being received from members of the public such as rowers and fishermen, some fishing contests having to be cancelled.

3.5.4 It is likely that initial Lemna infestation resulted from plants being washed down from areas in the Mole catchment, which had a substantial

Lemna load. Under normal flow conditions these plants would wash down the Thames and be unable to form substantial beds, except in "still backwaters" (TWA40), and it was stated that even at low river flows the plants should be dispersed (TWA40, TWA75). This was not the case under the low flow regime of 1989, flows being insufficient to disperse the large mats of Lemna that had formed, particularly above Teddington Weir.

3.5.5 Hypertrophication is a possible explanation for the increased Lemna cover, but available boat run data indicates no evidence of a general increase in nitrogen levels between 1977 and 1988 (Fig. 13). Equivalent long term phosphorus levels are not available.

## 3.6. Benthic Algae.

3.6.1 There was a slight increase in benthic diatom cover at all estuarine sites over the survey period, as would be expected over summer, particularly exploiting temporary areas of deposited sediment. A large area of such material was present at Kew until flows returned.

3.6.2 Benthic algae did not become a problem during 1989, most steps, slipways, etc. remaining relatively clear.

# 4. RECOMMENDATIONS

## 4.1. Further Survey Programmes.

4.1.1 It is suggested that the Teddington Flow Survey should continue during normal extraction and increased extraction conditions. However, several modifications to the sampling procedure should be adopted.

4.1.2 Background surveillance should be undertaken at all estuary sites on a monthly basis, allowing data collection for non-drought periods. This will provide information on the general condition of the river environment, allow comparison with any future drought situations and chart any recovery of sites on return to normal flow conditions. Less frequent sampling is adequate for freshwater sites, where effects are less severe and the small available area for benthic samples is limiting.

4.1.3 During periods of increased abstraction, estuarine sampling should be increased to fortnightly visits, to monitor any effects of low flows.

4.1.4 There should be consistency of sampling, with all parameters being investigated at each site during the same visit, so minimising temporal and spatial variation. Sites therefore need to be selected above the weir to achieve such consistency.

4.1.5 Samples should be taken at all sites with in a 1-3 day period to allow direct comparison. The timing of samples will be dictated by the sites below the weir due to the added complication of sampling at low tides.

4.1.6 The following parameters should be measured/obtained at each visit:
All sites - macrobenthic community structure, phytoplankton community structure, macrophyte proliferation, coliform bacteria, temperature.
Estuary sites only - benthic algal cover, presence of estuarine organisms, salinity.

4.1.7 Methodology should be as outlined in this report.

## 4.2. Teddington Flow Proposal.

4.2.1 The major problem occurring during the implementation of the TFP during 1989 was the proliferation of Lemna spp., forming extensive mats across the river. It is therefore suggested that regular "flushing" could be undertaken, increasing flows for a period sufficient to disperse and prevent any large build-up of Lemna beds. The feasibility of such a flushing programme should be investigated.

4.2.2 It is anticipated that the macrofauna community will recover at the sites below the weir once flows are restored. Long periods of low flows would prevent this.

## 5. CONCLUSIONS.

5.1. Increased water abstraction causing a decrease in flows over Teddington weir resulted in salinity increases at all sites in the Thames estuary.

5.2. Low flows and salinity levels were not as severe as 1976, but in 1989 the low flows continued until December. In 1976 rain returned in October.

5.3. There was a noticeable post-abstraction effect on the macrobenthic invertebrate community, with a dramatic fall in BMWP score at the site below Teddington weir and a steady decrease at other estuarine sites.

5.4. There was no such effect at sites above the weir.

5.5. There was an increase in the occurrence of estuarine fauna at the sites below the weir following an increase in abstraction. This indicated the extent of saline encroachment up the estuary.

5.6. Phytoplankton blooms did not occur under the low-flow conditions in the area of the Thames studied.

5.7. There was a dramatic increase in the extent of Lemna cover during the low flow period, resulting in the river being totally covered by duckweed at several locations. This did not occur in 1976.

5.8. Coliform bacteria levels were often found to be typically very high, with a maximum of >150,000 E.coli cells/100 ml at Isleworth (week 37). Low flows appeared not to influence bacteria levels, variations due to flow being minimal when compared to the effect of contamination arising from storm drains and sewage treatment works (e.g. Mogden and Hogsmill STW).

5.9. It is suggested that monitoring should continue, monthly during non-drought periods and every two weeks during times of low flow. There should be greater consistency of sampling.

5.10. To prevent the build up of Lemna beds, it is suggested that possibility of a periodic flushing programme should be investigated, increasing flows over the weir to disperse the plants.

## 6. REFERENCES.

### 6.1. Thames Water Reports.


TWA1 Thames Water Teddington Flow Proposal Statement of Case

TWA7 Draft Variation Number 2 to TWA2, submitted to the Secretary of State on 13 February 1984.

TWA28 Extracts from relevant minutes of Thames Water.

TWA32 Report by Natural Environmental Research Council entitled "Predicted effects of proposed changes in patterns of water abstraction on the ecosystems of the lower River Thames and its tidal estuary", dated September 1984.

TWA33 Report by Sir William Halcrow and Partners entitled "Teddington weir tidal hydraulics study", dated September 1985.

TWA40 Report entitled "Teddington Flow Proposal: possible ecological effects", by M.J.Andrews, Thames Water, dated April 1986.

TWA75 Teddington Flow Proposal. Proof of evidence of M.J.Andrews.


### 6.2. Others.


**Biological Monitoring Working Party** (1980). The 1978 national testing exercise.
Department of the Environment Technical Memorandum No. 19. 37 pp.

HMSO (1982). The bacteriological examination of drinking water supplies 1982. Report on Public Health and Medical Subjects No. 71. 111 pp.

Pond Action (1989a). River Thames - Sunbury weir to Teddington lock. Survey of wetland vegetation in the river corridor.
Oxford Polytechnic Report to NRATR.

Pond Action (1989b). River Thames - Teddington weir to Putney Bridge. Survey of wetland vegetation in the river corridor.
Oxford Polytechnic Report to NRATR.

## 7. TABLES.

## List of Tables.

Table 1.
Details of Teddington Flow Survey Sample Sites.

| Site | Abbrv. | NGR | km from Weir | No. Sampling Occasions Benthos | Phyto. | Bacteria |
|---|---|---|---|---|---|---|
| Egham | E | 023718 | -27.91 | 0 | 5 | 18 |
| Littleton | L | 046694 | -23.54 | 5 | 0 | 0 |
| Chertsey | C | 049679 | -22.13 | 0 | 6 | 18 |
| Walton | W | 075659 | -17.19 | 6 | 7 | 18 |
| Hampton Court | HC | 154685 | -07.36 | 0 | 7 | 16 |
| Raven's Ait | RA | 174677 | -04.49 | 6 | 0 | 0 |
| Kingston | KI | 177697 | -02.51 | 0 | 5 | 16 |
| U/s Teddington Weir | u/sT | 170713 | -00.26 | 6 | 8 | 18 |
| D/s Teddington Weir | d/sT | 167715 | +00.10 | 15 | 15 | 15 |
| Isleworth | IW | 169761 | +06.10 | 15 | 15 | 15 |
| Kew | K | 193778 | +09.93 | 15 | 15 | 15 |
| Hammersmith Bridge | HB | 228782 | +15.44 | 15 | 15 | 15 |
| Cadogan Pier | CP | 275776 | +22.79 | 15 | 15 | 15 |

Table 2.

List of sampling dates, with parameters investigated at each visit.

| Date | Week No | Site Name. E | L | C | W | HC | RA | KI | u/sT | d/sT | IW | K | HB | CP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 04.07.89 | 27 | | | | | | | | | BPC | BPC | BPC | BPC | BPC |
| 06.07.89 | 27 | | B | | B | | B | | B | | | | | |
| 11.07.89 | 28 | PC | | PC | PC | P | | | PC | BPC | BPC | BPC | BPC | BPC |
| 19.07.89 | 29 | | | | | | | | | BPC | BPC | BPC | BPC | BPC |
| 25.07.89 | 30 | C | | C | PC | PC | | | PC | BPC | BPC | BPC | BPC | BPC |
| 27.07.89 | 30 | | B | | B | | B | | B | | | | | |
| 31.07.89 | 31 | C | | C | C | C | | C | C | | | | | |
| 01.08.89 | 31 | | | | | | | | | BPC | BPC | BPC | BPC | BPC |
| 04.08.89 | 31 | P | | P | P | P | | P | P | | | | | |
| 07.08.89 | 32 | C | | C | C | | | C | C | | | | | |
| 08.08.89 | 32 | | | | | | | | | BPC | BPC | BPC | BPC | BPC |
| 10.08.89 | 32 | | | | B | | B | | B | | | | | |
| 14.08.89 | 33 | C | | C | C | C | | C | C | | | | | |
| 16.08.89 | 33 | | | | | | | | | BPC | BPC | BPC | BPC | BPC |
| 21.08.89 | 34 | | B | | B | | B | | B | | | | | |
| 22.08.89 | 34 | C | | PC | PC | PC | | C | PC | BPC | BPC | BPC | BPC | BPC |
| 28.08.89 | 35 | P | | P | P | P | | P | P | | | | | |
| 29.08.89 | 35 | C | | C | C | C | | C | C | | | | | |
| 30.08.89 | 35 | | | | | | | | | BPC | BPC | BPC | BPC | BPC |
| 04.09.89 | 36 | C | | C | C | PC | | PC | PC | | | | | |
| 07.09.89 | 36 | | | | | | | | | BPC | BPC | BPC | BPC | BPC |
| 11.09.89 | 37 | C | | C | C | | | C | C | | | | | |
| 13.09.89 | 37 | | | | | | | | | BPC | BPC | BPC | BPC | BPC |
| 18.09.89 | 38 | C | B | C | BC | C | B | C | BC | | | | | |
| 20.09.89 | 38 | | | | | | | | | BPC | BPC | BPC | BPC | BPC |
| 25.09.89 | 39 | C | | C | C | C | | C | C | | | | | |
| 27.09.89 | 39 | | | | | | | | | BPC | BPC | BPC | BPC | BPC |
| 03.10.89 | 40 | PC | | PC | PC | PC | | PC | PC | | | | | |
| 05.10.89 | 40 | | | | | | | | | BPC | BPC | BPC | BPC | BPC |
| 09.10.89 | 41 | P | | P | P | P | | P | P | | | | | |
| 10.10.89 | 41 | C | | C | C | C | | C | C | | | | | |
| 16.10.89 | 42 | C | | C | C | C | | C | C | | | | | |
| 23.10.89 | 43 | C | B | C | BC | C | B | C | BC | | | | | |
| 02.11.89 | 44 | C | | C | C | C | | C | C | | | | | |
| 06.11.89 | 45 | | | | | | | | | BPC | BPC | BPC | BPC | BPC |

Key.

B = Benthos
P = Phytoplankton
C = Coliform Bacteria

# Table 3.

**List of taxa found at all sites on the Thames during the Teddington Flow Survey**

Percentage occurrence of each BMWP taxon at each site, Littleton to Cadogan Pier, July to Noveaber 1989.

| BMWP Group. | L | W | RA | u/sT | d/sT | IW | K | HB | CP |
|---|---|---|---|---|---|---|---|---|---|
| Phryganaeidae | • | | | | | | | | |
| Molannidae | ••• | • | • | | | | | | |
| Ephemeridae | | | ••• | | | | | | |
| Aphelocheiridae | | • | | | | | | | |
| Leptoceridae | ••••• | ••••• | ••••• | ••••• | ••• | | | | |
| Calopterygidae | •••• | • | •• | | | | | | |
| Psychomyiidae | • | ••• | ••••• | ••• | • | | | | |
| Caenidae | •• | •••• | ••••• | ••••• | •• | | | | |
| Polycentropidae | ••••• | •••• | ••• | ••• | •• | | | | |
| Limnephilidae | •• | • | ••••• | | | | | | |
| Neritidae | ••••• | •••• | ••••• | | | | | | |
| Ancylidae | • | •••• | ••••• | ••••• | ••• | ••• | •• | • | •••• |
| Hydroptilidae | ••• | ••• | ••••• | ••• | •• | | | | |
| Unionidae | ••••• | ••••• | ••••• | •••• | ••• | •• | • | | |
| Corophiidae | ••••• | •••• | ••••• | ••••• | •• | | | | • |
| Gammaridae | ••••• | ••••• | ••••• | ••••• | ••••• | ••••• | ••••• | ••••• | ••••• |
| Viviparidae | | ••• | •• | •• | | | •• | | |
| Coenagrionidae | • | ••• | •• | | | | | | |
| Corixidae | ••• | •••• | • | • | | | | | • |
| Haliplidae | ••• | ••••• | • | | | | | | |
| Dytiscidae | ••••• | ••••• | ••• | • | • | | | | |
| Elmidae | ••• | • | ••••• | | •• | | | | |
| Nepidae | | • | | | | | | | |
| Planariidae | ••••• | ••••• | ••••• | ••••• | •• | | • | • | |
| Dendrocoelidae | ••••• | ••••• | ••••• | ••••• | •••• | ••• | •• | • | |
| Baetidae | ••••• | ••••• | ••• | • | • | | | | |
| Sialidae | ••••• | | | | | | | | |
| Piscicolidae | ••• | •• | ••• | • | • | | | | |
| Valvatidae | ••••• | ••••• | ••••• | ••••• | • | | | | |
| Hydrobiidae | ••••• | ••••• | ••••• | •••• | ••••• | • | •••• | | ••••• |
| Lymnaeidae | ••••• | ••••• | ••••• | ••••• | ••• | ••••• | ••••• | •••• | ••••• |
| Physidae | ••••• | ••••• | ••• | | | | | | |
| Planorbidae | •• | ••••• | ••• | • | • | | • | | |
| Sphaeriidae | ••••• | ••••• | ••••• | ••••• | ••••• | •••• | ••••• | • | ••• |
| Glossiphoniidae | ••••• | ••••• | ••••• | ••••• | ••••• | •••• | ••••• | ••• | •• |
| Erpobdellidae | •••• | ••••• | ••••• | ••••• | ••• | ••••• | ••••• | ••••• | •••• |
| Asellidae | ••••• | ••••• | ••••• | ••••• | •• | | • | • | |
| Chironomidae | ••••• | ••••• | ••••• | ••••• | ••••• | •• | •• | • | • |
| Oligochaeta | ••••• | ••••• | ••••• | ••••• | ••••• | ••••• | ••••• | •••• | ••••• |
| Non-scoring taxa (below Teddington Weir only) | | | | | | | | | |
| Nematoda | | | | | • | | | | |
| Ostracoda | | | | | ••• | | | | |
| Hydracarina | | | | | ••• | | | | |
| Nematomorpha | | | | | • | | | | |
| Ceratopogonidae | | | | | = | | | | |
| Bryozoa | | | | | ••• | •••• | •••• | •••• | ••• |
| Porifera | | | | | •• | ••• | ••••• | • | • |
| Acanthocephala | | | | | | • | | | |
| Mysidacea | | | | | | | • | | |
| Dreissenidae | | | | | | | | | • |
| Palaemonidae | | | | | | | | | • |
| Crangonidae | | | | | | | | • | • |

**Key**

• = taxon recorded in <20% of samples taken
•• = 20-40%.
••• = 40-60%.
•••• = 60-80%.
••••• = 80-100%.
blank = taxon not recorded.

L = Littleton, W = Walton, RA = Ravens Ait, u/sT = upstream of Teddington Weir, d/sT = downstream of Teddington Weir, IW = Isleworth, K = Kew, HB = Hammersmith Bridge, CP = Cadogan Pier.

Table 4.

Comparison of taxa recorded at sites u/s and d/s of Teddington Weir.

x = u/s Teddington Weir, o = d/s Teddington Weir.

| Taxon. | Week No. 27 | 30 | 32 | 34 | 38 | 43/45 |
|---|---|---|---|---|---|---|
| Leptoceridae | x o | x o | x o | x o | x o | x |
| Psychomyiidae | | x | x o | x | | |
| Caenidae | x o | x o | x o | x | x | x |
| Polycentropidae | | x | | x | | x |
| Viviparidae | x | | x | | | |
| Ancylidae | x o | x | x o | x o | x o | x |
| Hydroptilidae | x | x | o | x | x | |
| Unionidae | x o | x o | x o | x o | x | |
| Corophiidae | x | x | x o | x o | x | x |
| Gammaridae | x o | x o | x o | x o | x o | x o |
| Corixidae | x | | | | | |
| Dytiscidae | x | o | | | | |
| Elmidae | | o | | | o | |
| Planariidae | x o | x | x o | x | x | x |
| Dendrocoelidae | x | x o | x o | x o | x | x |
| Baetidae | x o | o | | | | |
| Piscicolidae | | | | x | | |
| Valvatidae | x | x o | x o | x | x o | x |
| Hydrobiidae | x o | x o | x o | o | x o | x o |
| Lymnaeidae | x | x o | x o | x o | x | x |
| Planorbidae | | | | | x | |
| Sphaeriidae | x o | x o | x o | x o | x o | x o |
| Glossiphoniidae | x o | x o | x o | x | x o | x o |
| Erpobdellidae | x o | x o | x o | x | x | x |
| Asellidae | x o | x o | x o | x | x | x |
| Chironomidae | x o | x o | x o | x o | x o | x o |
| Oligochaeta | x o | x o | x o | x o | x | x o |
| BMWP u/s:d/s | 101/62 | 96/70 | 89/89 | 97/54 | 84/41 | 76/18 |
| ASPT u/s:d/s | 4.59/4.43 | 4.80/4.38 | 4.68/4.68 | 4.85/4.50 | 4.42/4.60 | 4.47/3.00 |

Table 5.
Estuarine species recorded during Teddington Flow Survey.

| Species | Sites Recorded | Week No. Recorded |
|---|---|---|
| Palaemon longirostris<br>Estuarine Prawn | Cadogan | 30,33,38,39 |
| Crangon crangon<br>Brown shrimp | Cadogan<br>Hammersmith | 39<br>39 |
| Corophium lacustre | Cadogan | 31,32,33 |
| Neomysis integer<br>Opossum shrimp | Kew | 45 |
| Pomatoschistus microps<br>Common goby | Cadogan<br>Hammersmith<br>Teddington | 30,32<br>40<br>40,45 |

# Table 6.

## List of Phytoplankton recorded at all sites on the Thames during the Teddington Flow Survey

Percentage occurrence of each phytoplankton genus/group at each site, Egham to Cadogan Pier, July to November 1989.

| Phytoplankton | E | C | W | HC | KI | u/sT | d/sT | IW | K | HB | CP |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Myxophyceae. | | | | | | | | | | | |
| Microcystis | | | • | •• | | | | | | | |
| Anabaena | • | | • | | • | • | | | | | |
| Chroococcus | | • | | | | | | | | | |
| Oscillatoria | | • | | • | | • | | | | | |
| Chlorophyceae. | | | | | | | | | | | |
| Scenedesmus | ••• | ••••• | •••• | ••• | •• | ••• | •• | •• | ••• | •• | ••• |
| Coelastrum | | | • | | | | | | • | • | • |
| Dictyosphaerium | | | | | | | | | • | • | |
| Actinastrum | | •• | | | • | • | | • | • | • | • |
| Pediastrum | • | • | •• | •• | •• | ••• | • | | • | | • |
| Tribonema | | | • | | • | • | • | | • | • | •• |
| Ankistrodesmus | • | •• | •• | ••• | •• | •••• | | • | • | | • |
| Crucigenia | | | | • | | • | • | | • | | |
| Chlamydomonas | | | | •• | | | | | | | |
| Chlorella | •• | | •• | • | • | | | | | | |
| Pandorina | | | | • | | • | | | | | |
| Oedogonium | | | | • | | | | | | | |
| Spirogyra | | | • | | | | | | | | |
| Stichococcus | | | | • | • | | | | | | |
| Chrysophyceae. | | | | | | | | | | | |
| Synura | • | | | | | | | | | | |
| Bacillariophyceae. | | | | | | | | | | | |
| Centric Diatoms | • | •••• | •• | ••• | •• | ••• | •• | ••• | •••• | ••••• | •••• |
| Pennate Diatoms | •• | ••• | •• | •• | •• | ••• | •••• | •••• | •••• | •••• | ••••• |
| Flagellates | •• | ••• | •••• | •• | ••• | •• | •••• | •••• | ••••• | •••• | ••••• |

Key

* = group recorded in <20% of samples taken
•• = 20-40%
••• = 40-60%
•••• = 60-80%
••••• = 80-100%

## Table 7.
## Proliferation of Lemna/Azolla during Teddington Flow Survey.

The approximate composition of most patches of floating vegetation recorded was 99% Lemna spp., 1% Azolla filiculoides. For the purposes of the following timetable, all such records will therefore be called "Lemna".

| Date | Week No. | Comments. |
|---|---|---|
| 25.07.89 | 30 | Individual plants present at Isleworth and Kew. |
| 01.08.89 | 31 | Plants also present at d/s Teddington Weir. |
| 10.08.89 | 32 | Large patches of Lemna present at Raven's Ait. |
| 16.08.89 | 33 | Heavy covering of Lemna at Kew along both banks. Plants recorded down to Cadogan Pier. Very heavy covering of Lemna u/s of Teddington Weir. |
| 22.08.89 | 34 | Heavy covering of Lemna from Hampton Court to u/s Teddington. Lemna covering full width of river at Kingston. Plants recorded as far down the estuary as Gravesend. |
| 30.08.89 | 35 | Heavy Lemna growth on river below Richmond Bridge. |
| 13.09.89 | 37 | Whole river covered by Lemna between Richmond and Petersham. |
| 05.10.89 | 40 | Thick blanket of Lemna covering large section of river u/s Teddington Weir. |
| 23.10.89 | 43 | Lemna abundant at Walton for first time (NB u/s River Mole). |
| 06.11.89 | 45 | Lemna covering disappeared from u/s and d/s Teddington Weir. Only few plants recorded at Teddington and Kew. |

## 8. FIGURES.

## List of Figures.

Figure 1.

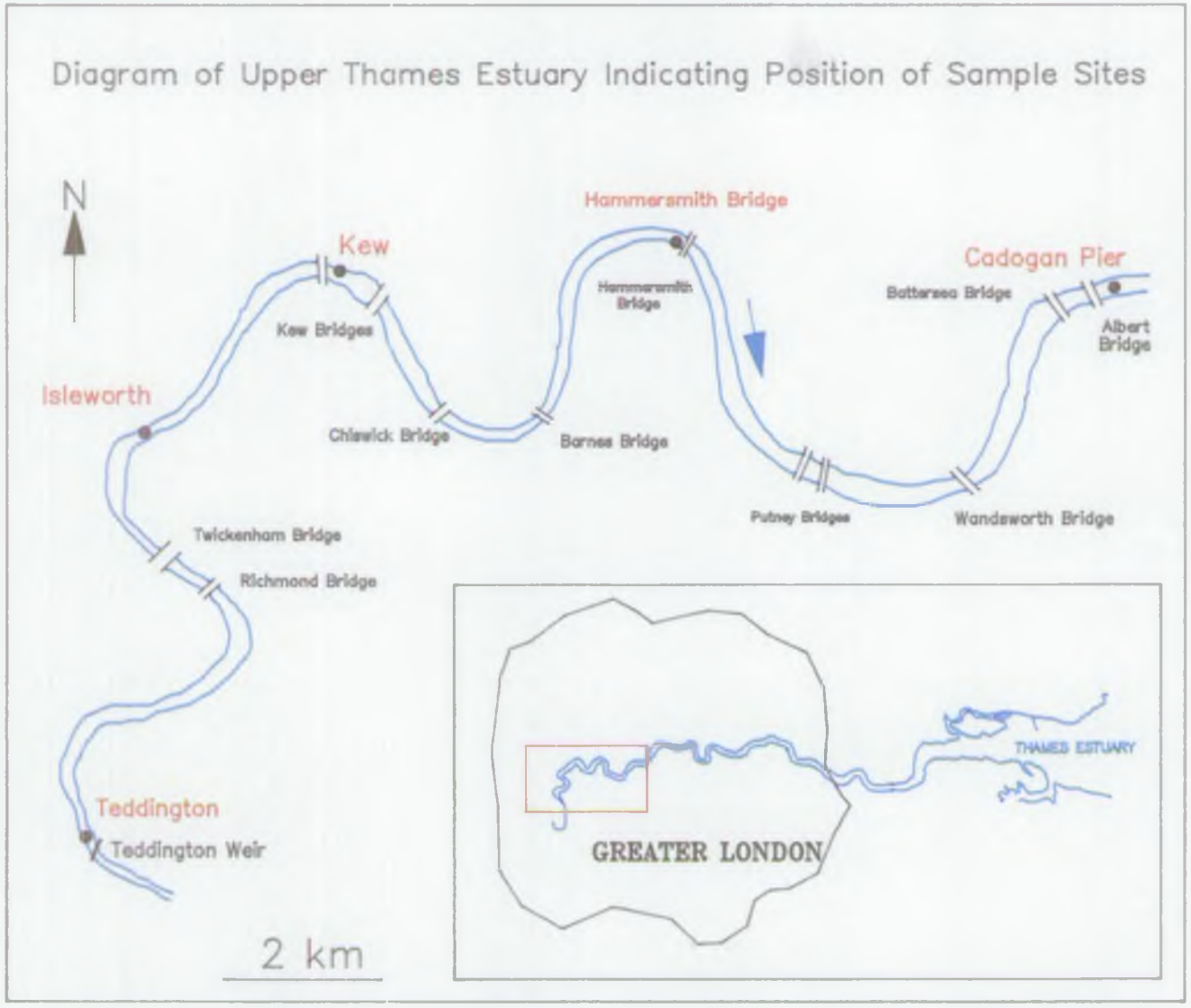


Diagram of Upper Thames Estuary Indicating Position of Sample Sites
N
Hammersmith Bridge
Kew
Cadogan Pier
Hammersmith Bridge
Battersea Bridge
Albert Bridge
Kew Bridges
Isleworth
Chiswick Bridge
Barnes Bridge
Putney Bridges
Wandsworth Bridge
Twickenham Bridge
Richmond Bridge
Teddington
Teddington Weir
2 km
THAMES ESTUARY
GREATER LONDON

Figure 2.

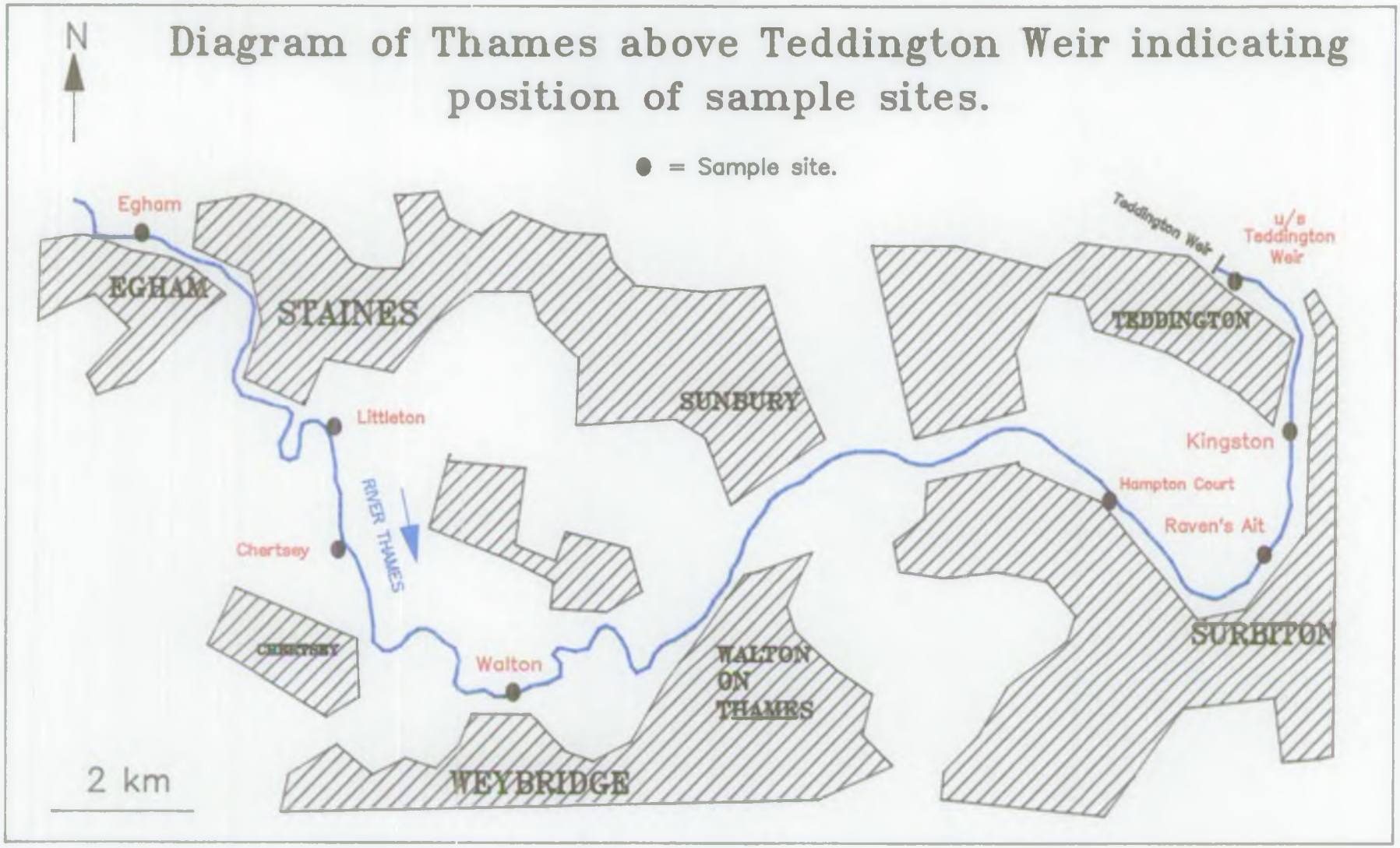


Diagram of Thames above Teddington Weir indicating position of sample sites.
N
● = Sample site.
Egham
EGHAM
STAINES
Littleton
SUNBURY
Chertsey
RIVER THAMES
CHERTSEY
Walton
WALTON ON THAMES
WEYBRIDGE
Teddington Weir
u/s Teddington Weir
TEDDINGTON
Kingston
Hampton Court
Raven's Ait
SURBITON
2 km

Figure 3.

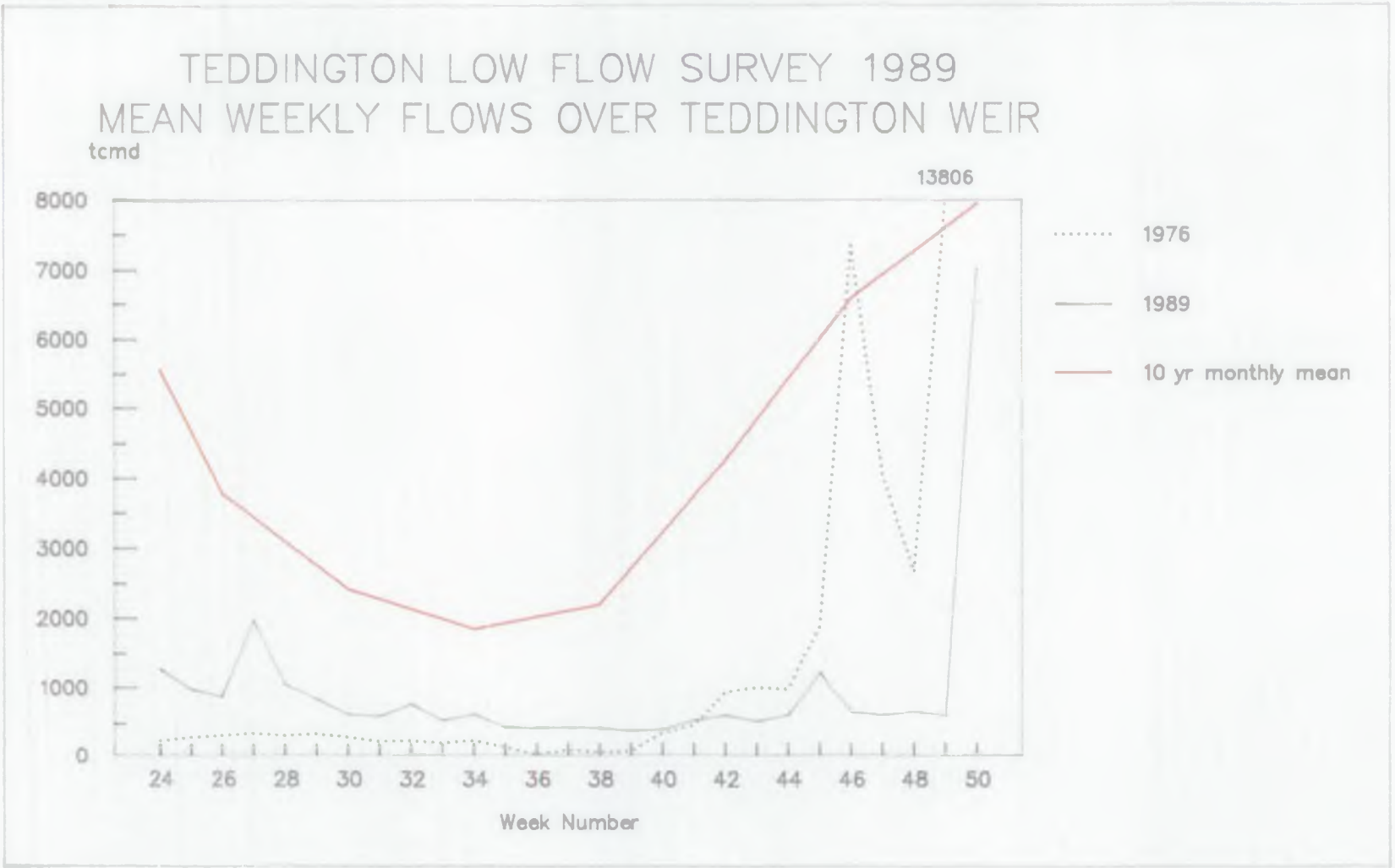
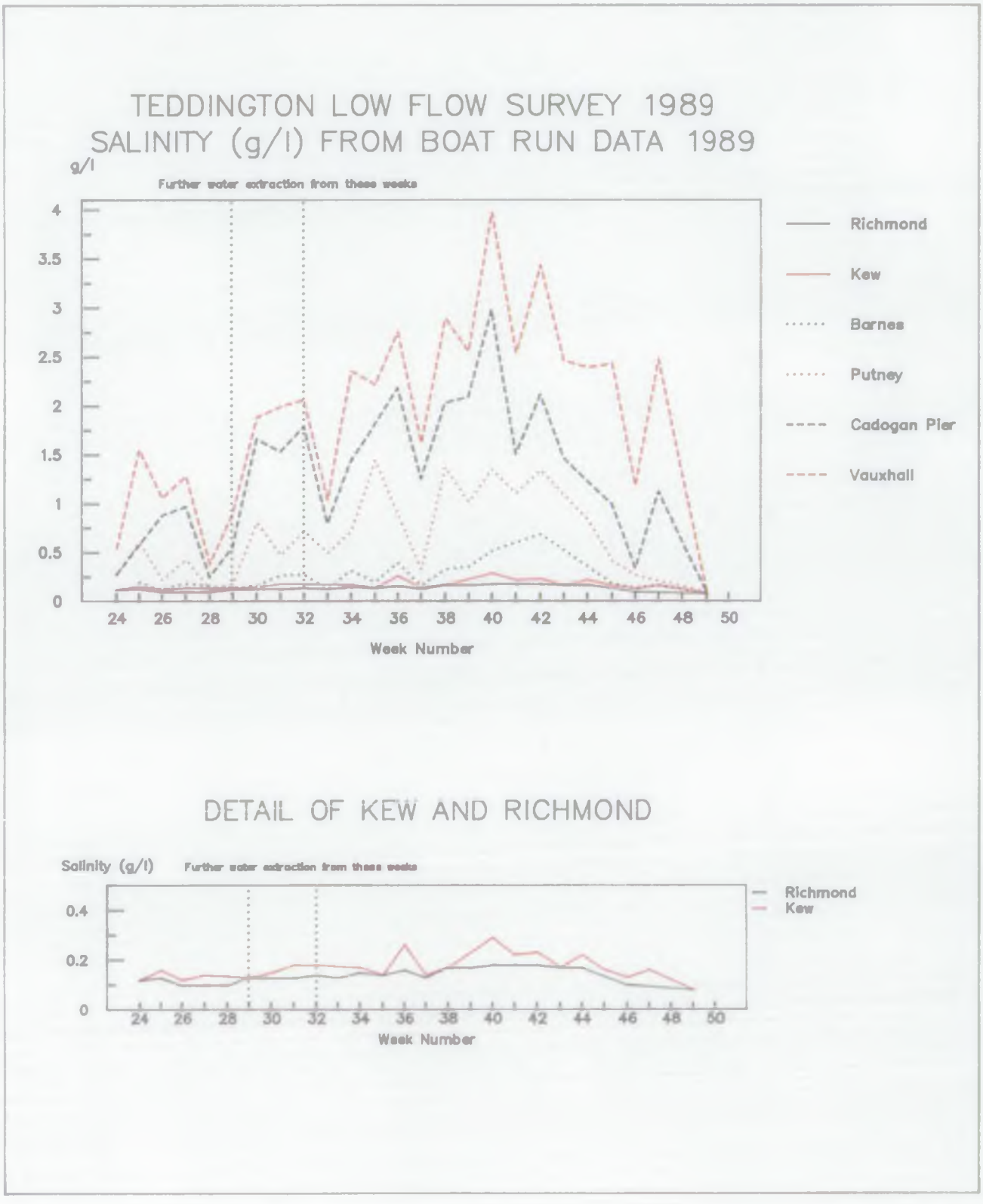
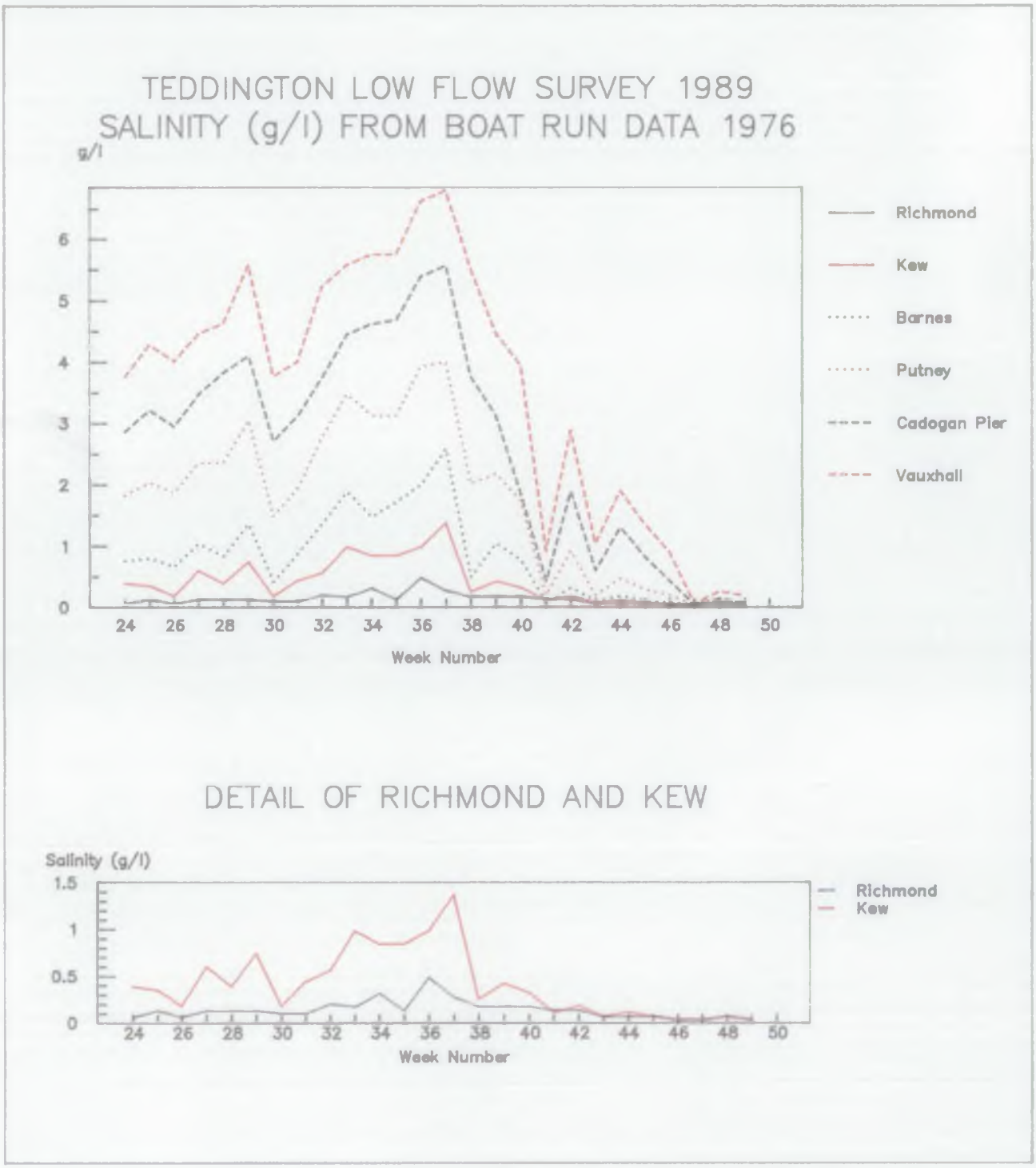

TEDDINGTON LOW FLOW SURVEY 1989
MEAN WEEKLY FLOWS OVER TEDDINGTON WEIR
tcmd
13806
8000
7000
6000
5000
4000
3000
2000
1000
0
24
26
28
30
32
34
36
38
40
42
44
46
48
50
Week Number
1976
1989
10 yr monthly mean

Figure 4.


TEDDINGTON LOW FLOW SURVEY 1989
SALINITY (g/l) FROM BOAT RUN DATA 1989
g/l
Further water extraction from these weeks
4
3.5
3
2.5
2
1.5
1
0.5
0
24 26 28 30 32 34 36 38 40 42 44 46 48 50
Week Number
Richmond
Kew
Barnes
Putney
Cadogan Pier
Vauxhall
DETAIL OF KEW AND RICHMOND
Salinity (g/l)
Further water extraction from these weeks
0.4
0.2
0
24 26 28 30 32 34 36 38 40 42 44 46 48 50
Week Number
Richmond
Kew

# Figure 5.


TEDDINGTON LOW FLOW SURVEY 1989
SALINITY (g/l) FROM BOAT RUN DATA 1976
g/l
0
1
2
3
4
5
6
24 26 28 30 32 34 36 38 40 42 44 46 48 50
Week Number
Richmond
Kew
Barnes
Putney
Cadogan Pier
Vauxhall
DETAIL OF RICHMOND AND KEW
Salinity (g/l)
0
0.5
1
1.5
24 26 28 30 32 34 36 38 40 42 44 46 48 50
Week Number
Richmond
Kew

# Figure 6.

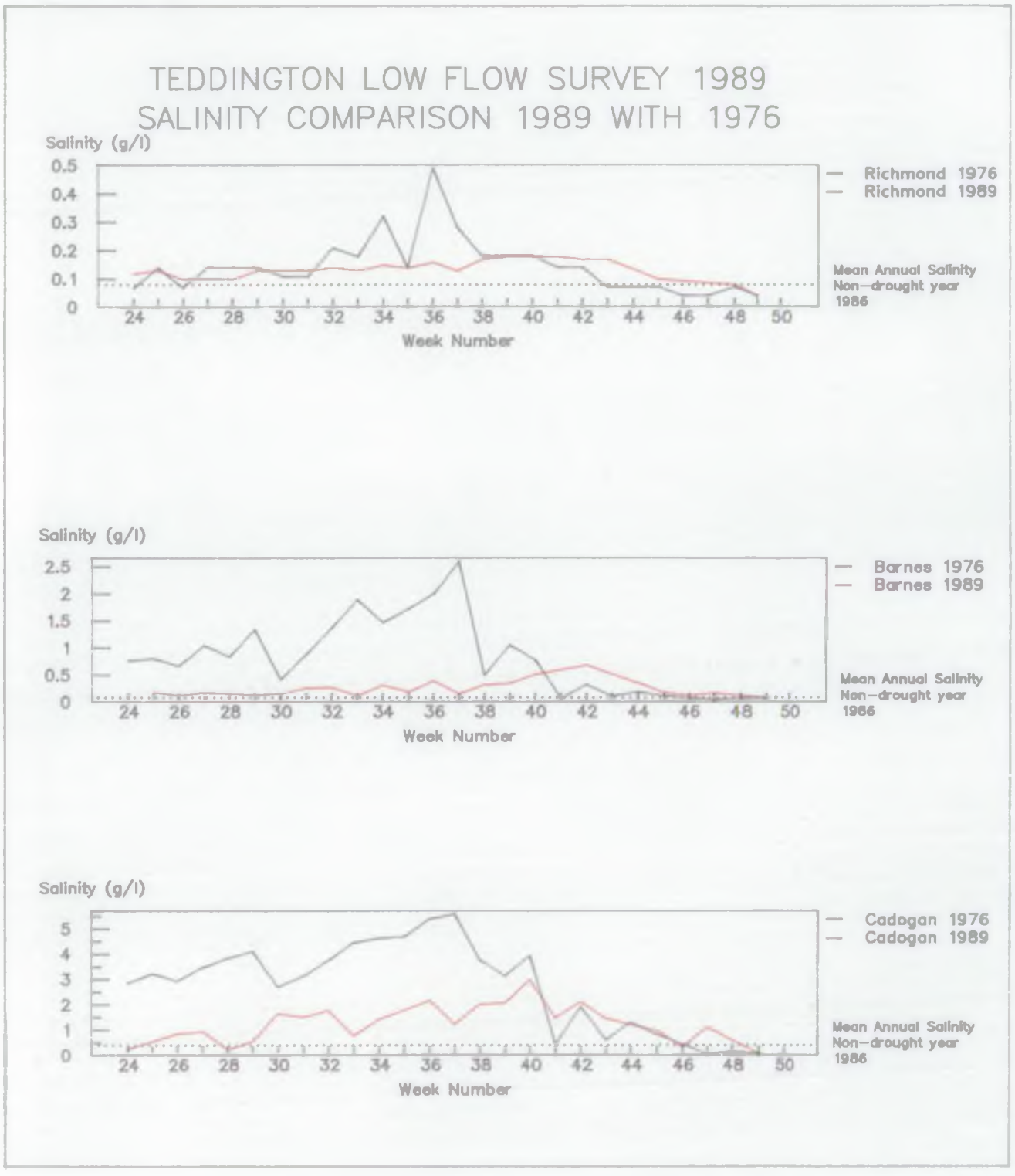

TEDDINGTON LOW FLOW SURVEY 1989
SALINITY COMPARISON 1989 WITH 1976
Salinity (g/l)
0.5
0.4
0.3
0.2
0.1
0
24 26 28 30 32 34 36 38 40 42 44 46 48 50
Week Number
Richmond 1976
Richmond 1989
Mean Annual Salinity
Non-drought year
1986
Salinity (g/l)
2.5
2
1.5
1
0.5
0
24 26 28 30 32 34 36 38 40 42 44 46 48 50
Week Number
Barnes 1976
Barnes 1989
Mean Annual Salinity
Non-drought year
1986
Salinity (g/l)
5
4
3
2
1
0
24 26 28 30 32 34 36 38 40 42 44 46 48 50
Week Number
Cadogan 1976
Cadogan 1989
Mean Annual Salinity
Non-drought year
1986

Figure 7.

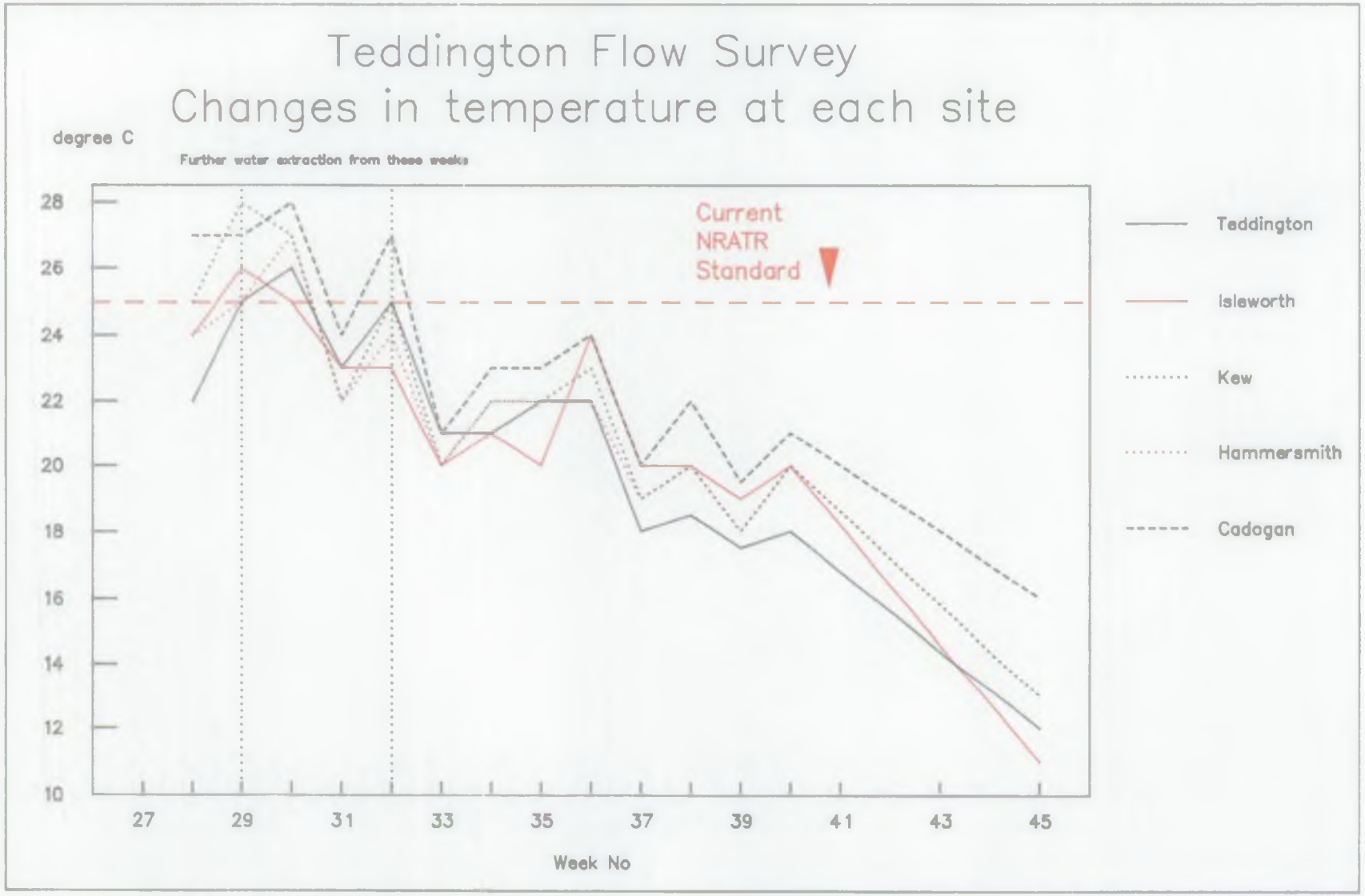

Teddington Flow Survey
Changes in temperature at each site
degree C
Further water extraction from these weeks
Current
NRATR
Standard
28
26
24
22
20
18
16
14
12
10
27
29
31
33
35
37
39
41
43
45
Week No
Teddington
Isleworth
Kew
Hammersmith
Cadogan

Figure 8.

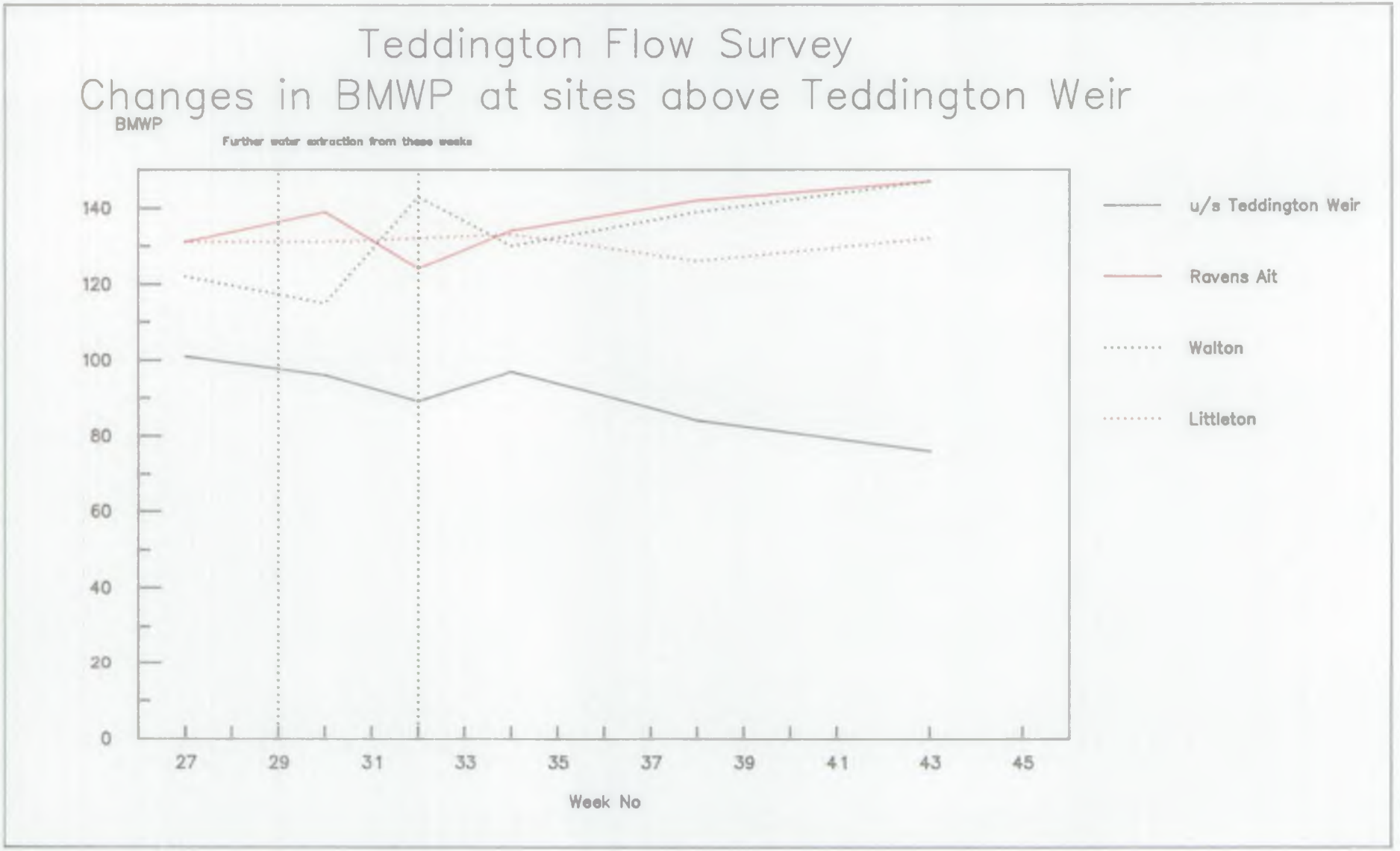
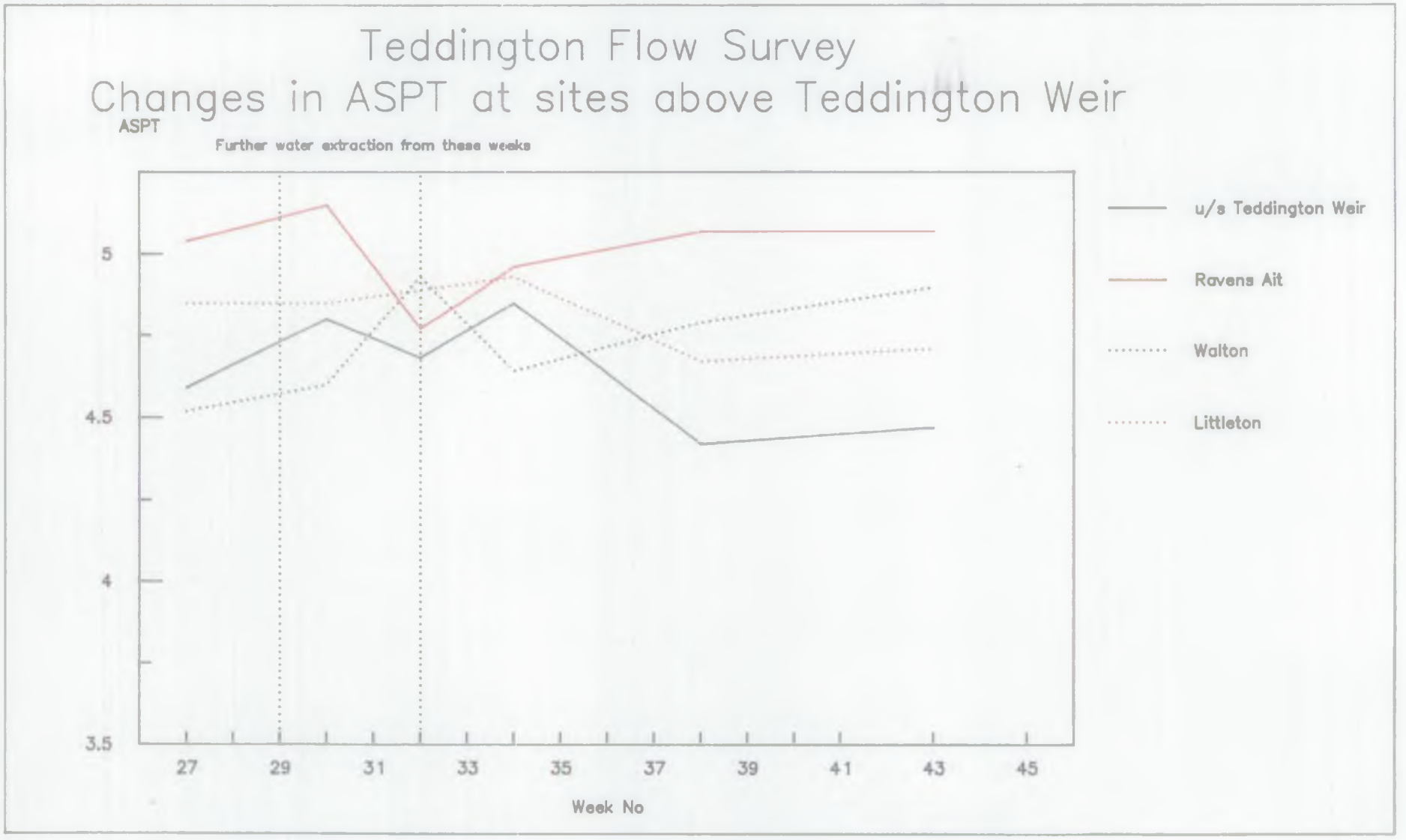
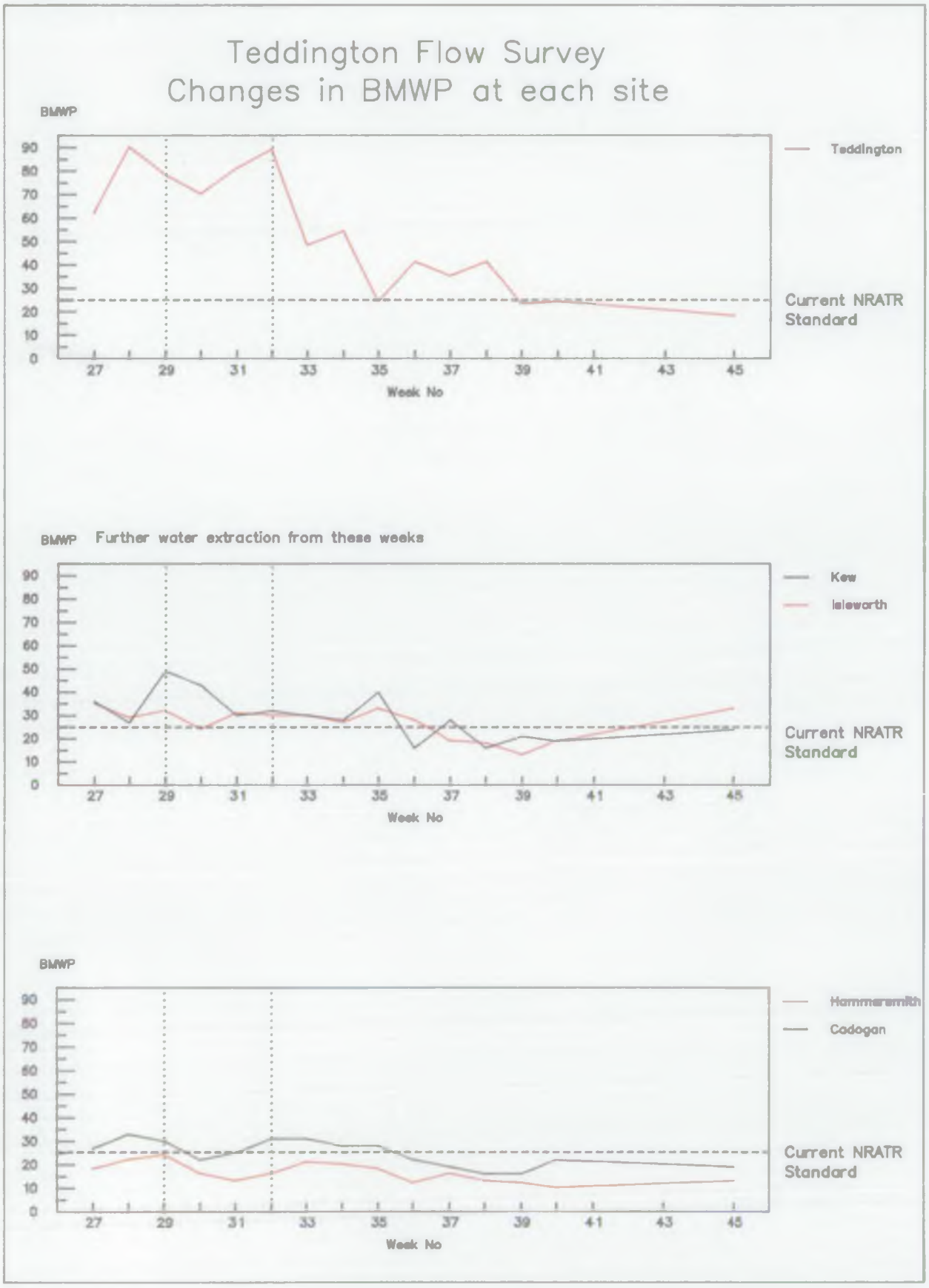

Teddington Flow Survey
Changes in BMWP at sites above Teddington Weir
BMWP
Further water extraction from these weeks
140
120
100
80
60
40
20
0
27
29
31
33
35
37
39
41
43
45
Week No
u/s Teddington Weir
Ravens Ait
Walton
Littleton

Figure 9.


Teddington Flow Survey
Changes in ASPT at sites above Teddington Weir
ASPT
Further water extraction from these weeks
5
4.5
4
3.5
27
29
31
33
35
37
39
41
43
45
Week No
u/s Teddington Weir
Ravens Ait
Walton
Littleton

# Figure 10.


Teddington Flow Survey
Changes in BMWP at each site
BMWP
90
80
70
60
50
40
30
20
10
0
27
29
31
33
35
37
39
41
43
45
Week No
Teddington
Current NRATR Standard
BMWP
Further water extraction from these weeks
Kew
Isleworth
Current NRATR Standard
Week No
BMWP
Hammersmith
Chiswick
Current NRATR Standard
Week No

# Figure 11.

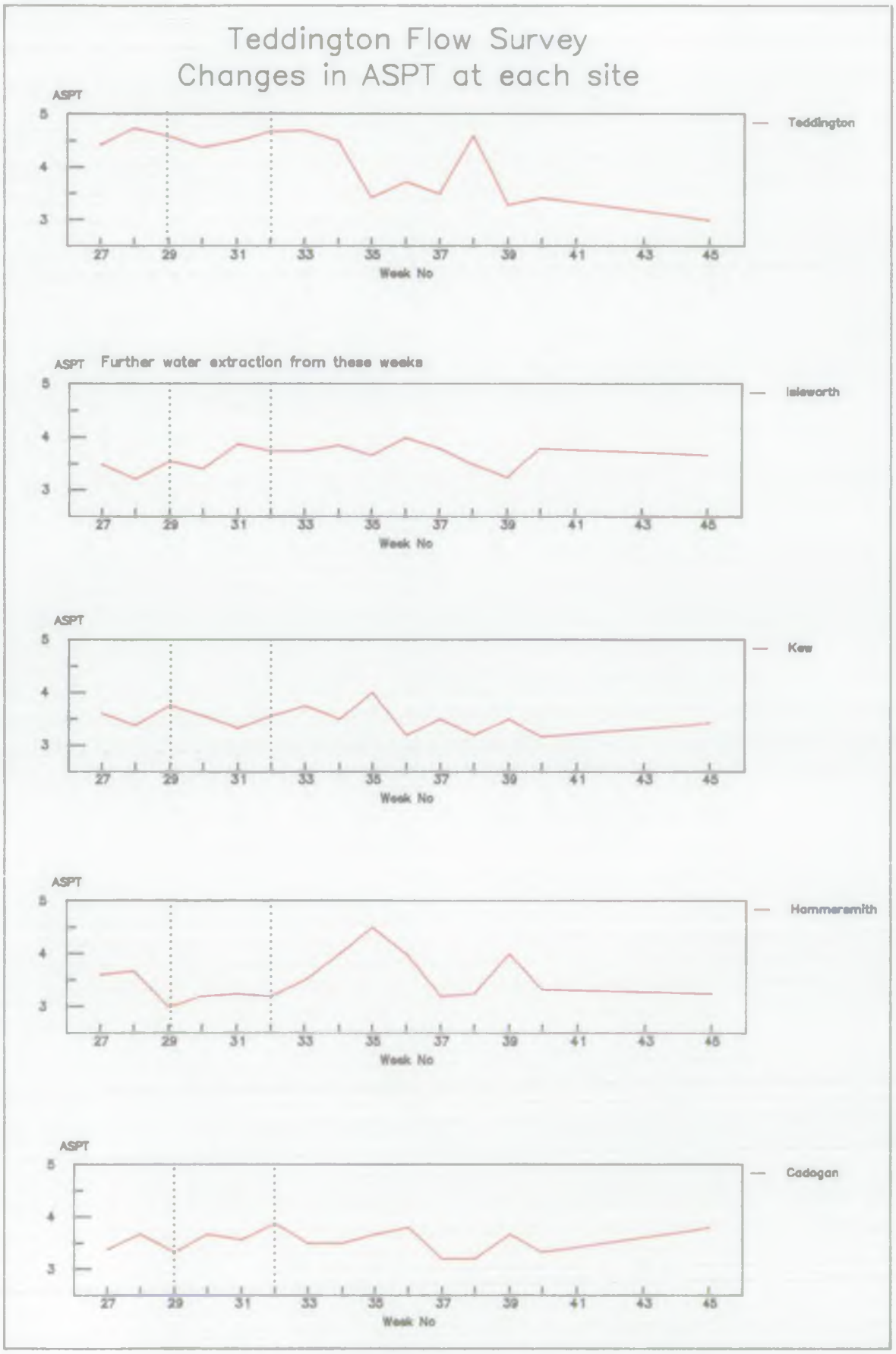
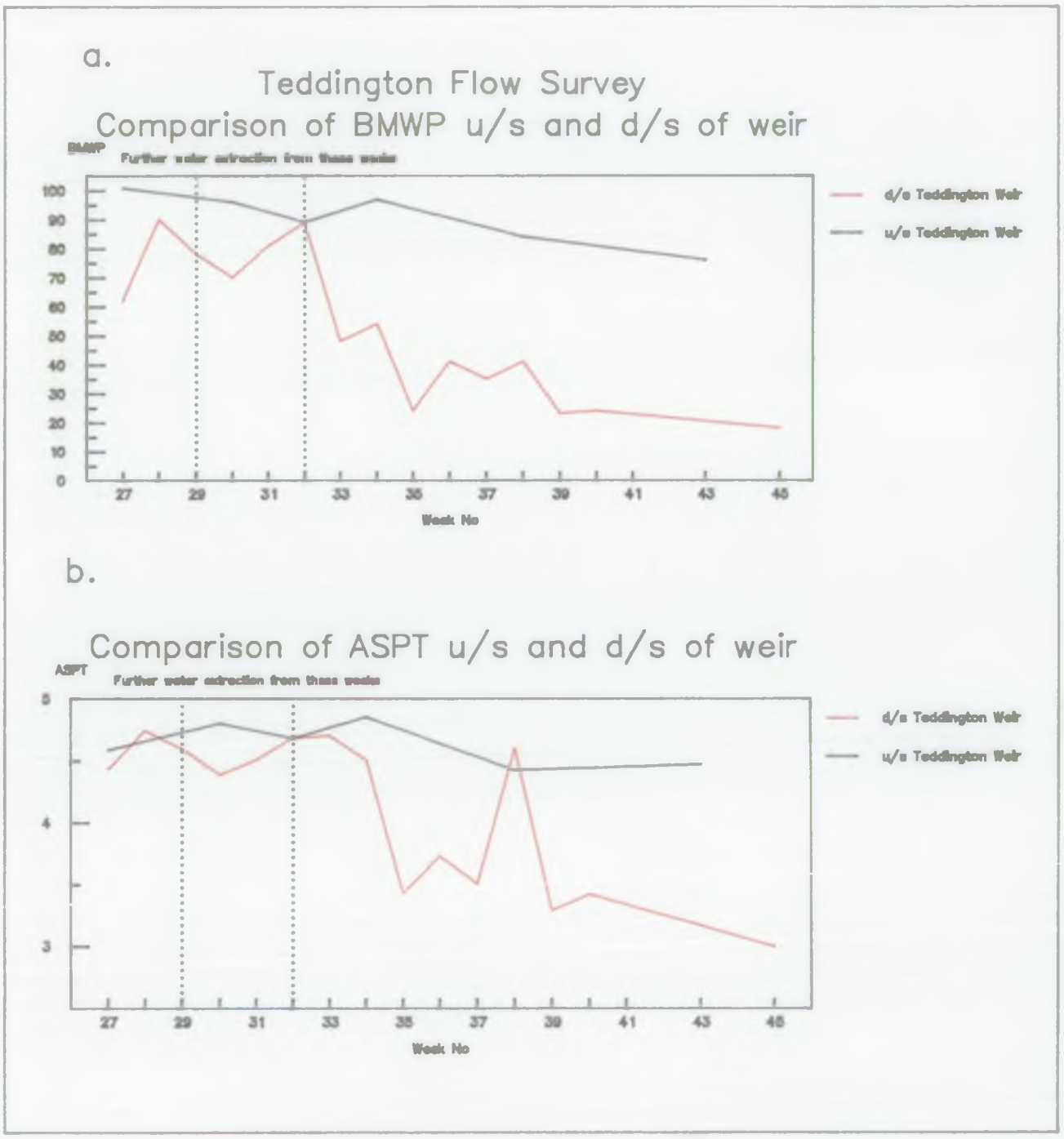
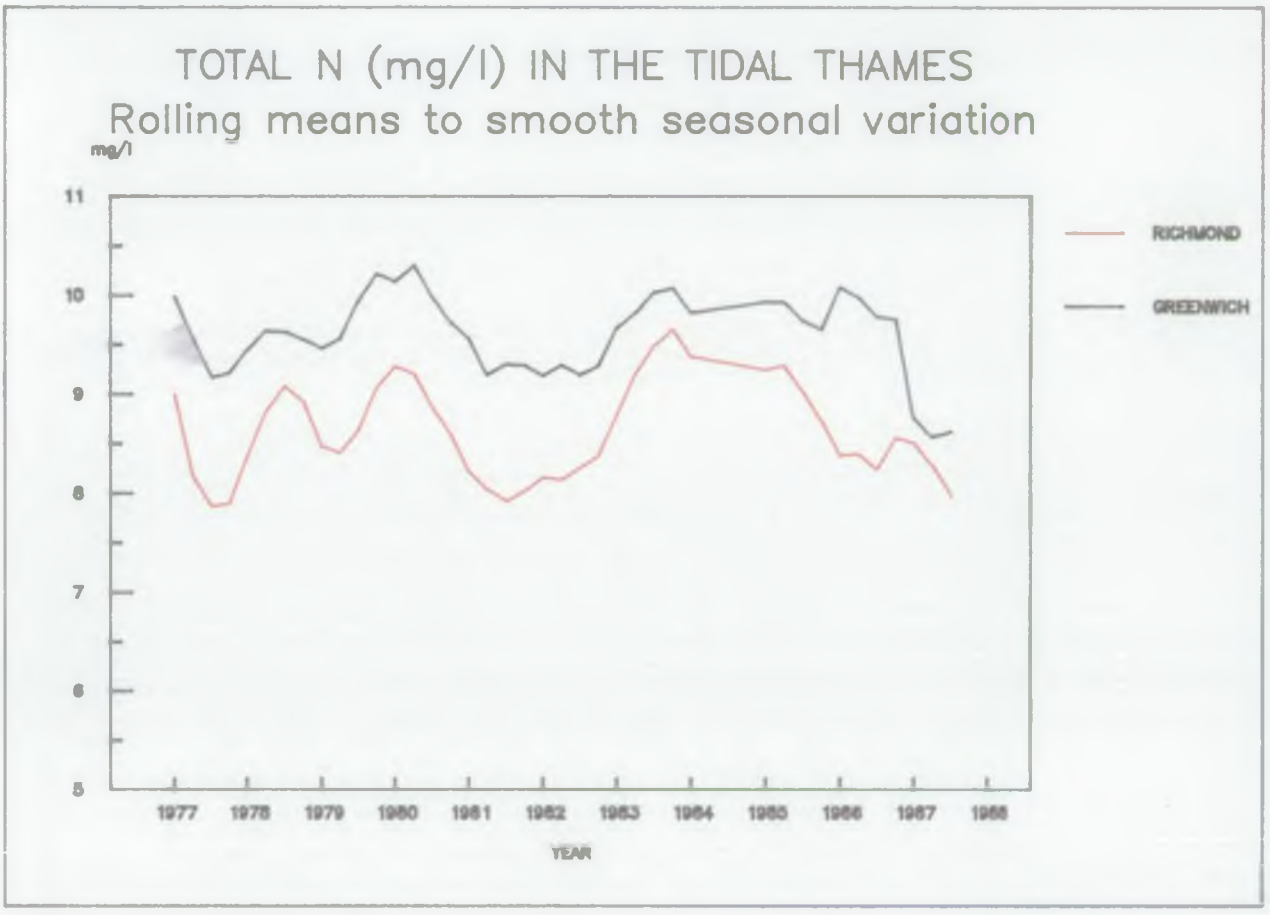

Teddington Flow Survey
Changes in ASPT at each site
ASPT
5
4
3
27
29
31
33
35
37
39
41
43
45
Week No
Teddington
ASPT
Further water extraction from these weeks
Isleworth
Kew
Hammersmith
Cadogan

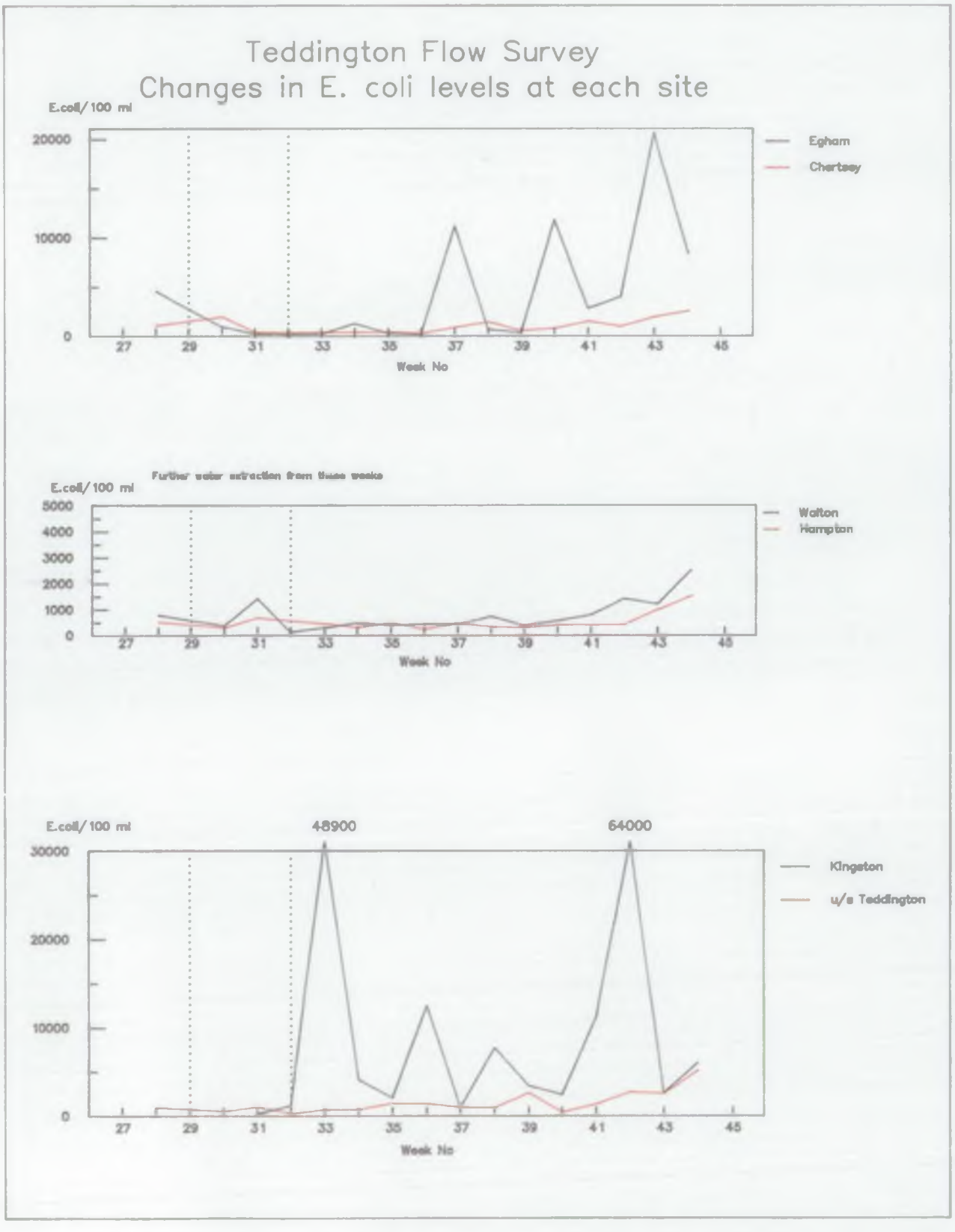
Figure 12.


a.
Teddington Flow Survey
Comparison of BMWP u/s and d/s of weir
BMWP
Further water extraction from these weeks
100
90
80
70
60
50
40
30
20
10
0
27
29
31
33
35
37
39
41
43
45
Week No
d/s Teddington Weir
u/s Teddington Weir
b.
Comparison of ASPT u/s and d/s of weir
ASPT
Further water extraction from these weeks
5
4
3
27
29
31
33
35
37
39
41
43
45
Week No
d/s Teddington Weir
u/s Teddington Weir

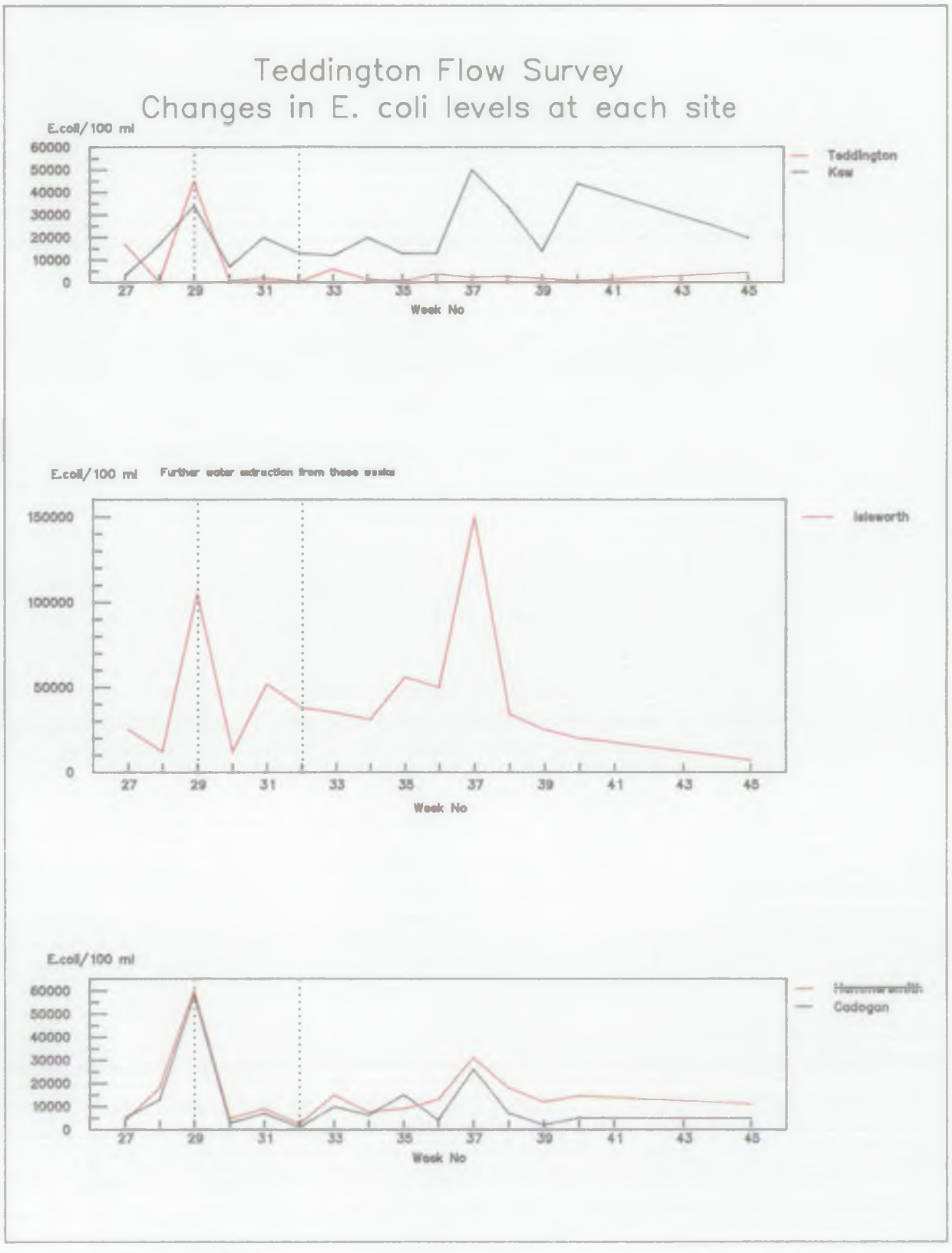
# Figure 13.


TOTAL N (mg/l) IN THE TIDAL THAMES
Rolling means to smooth seasonal variation
mg/l
11
10
9
8
7
6
5
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
YEAR
RICHMOND
GREENWICH

# Figure 14.


Teddington Flow Survey
Changes in E. coli levels at each site
E.coli/100 ml
20000
10000
0
27
29
31
33
35
37
39
41
43
45
Week No
Egham
Chertsey
Further water extraction from these weeks
E.coli/100 ml
5000
4000
3000
2000
1000
0
Week No
Walton
Hampton
E.coli/100 ml
48900
64000
30000
20000
10000
0
Week No
Kingston
u/s Teddington

# Figure 15.


Teddington Flow Survey
Changes in E. coli levels at each site
E.coli/100 ml
60000
50000
40000
30000
20000
10000
0
27
29
31
33
35
37
39
41
43
45
Week No
Teddington
Kew
E.coli/100 ml
Further water extraction from these weeks
150000
100000
50000
0
Isleworth
E.coli/100 ml
Hammersmith
Cadogan

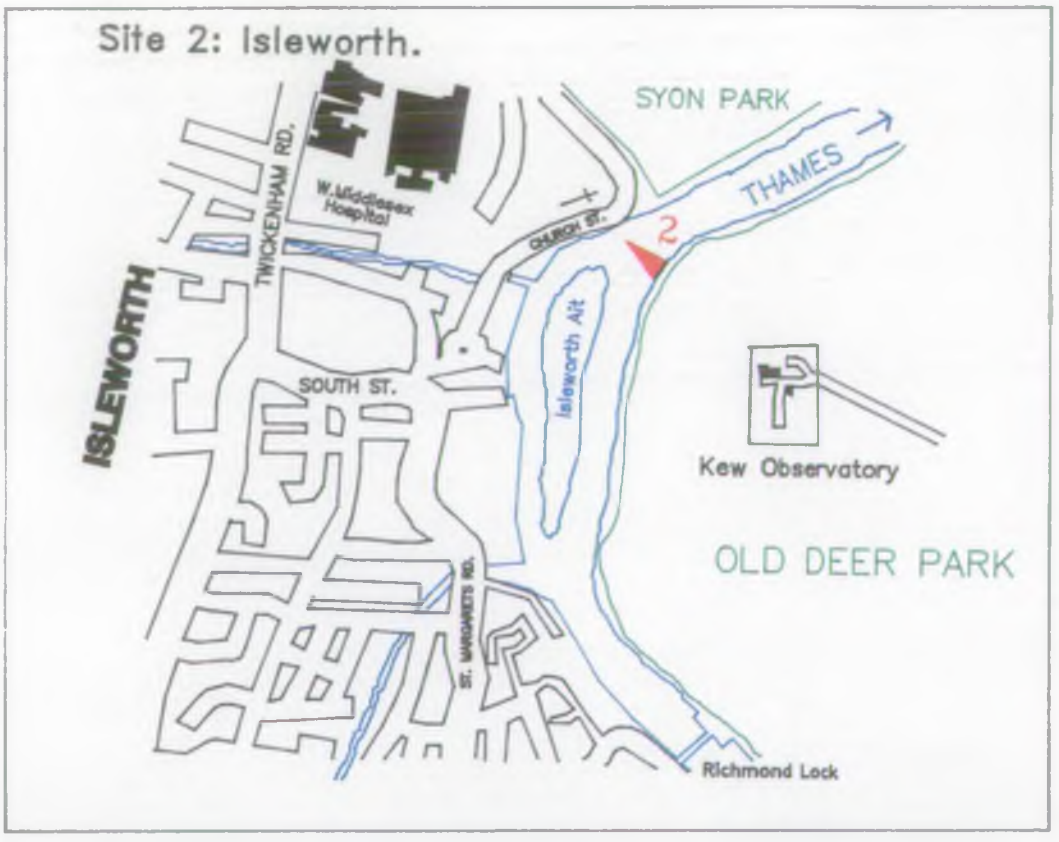
## 9. APPENDICES.

## APPENDIX 1.

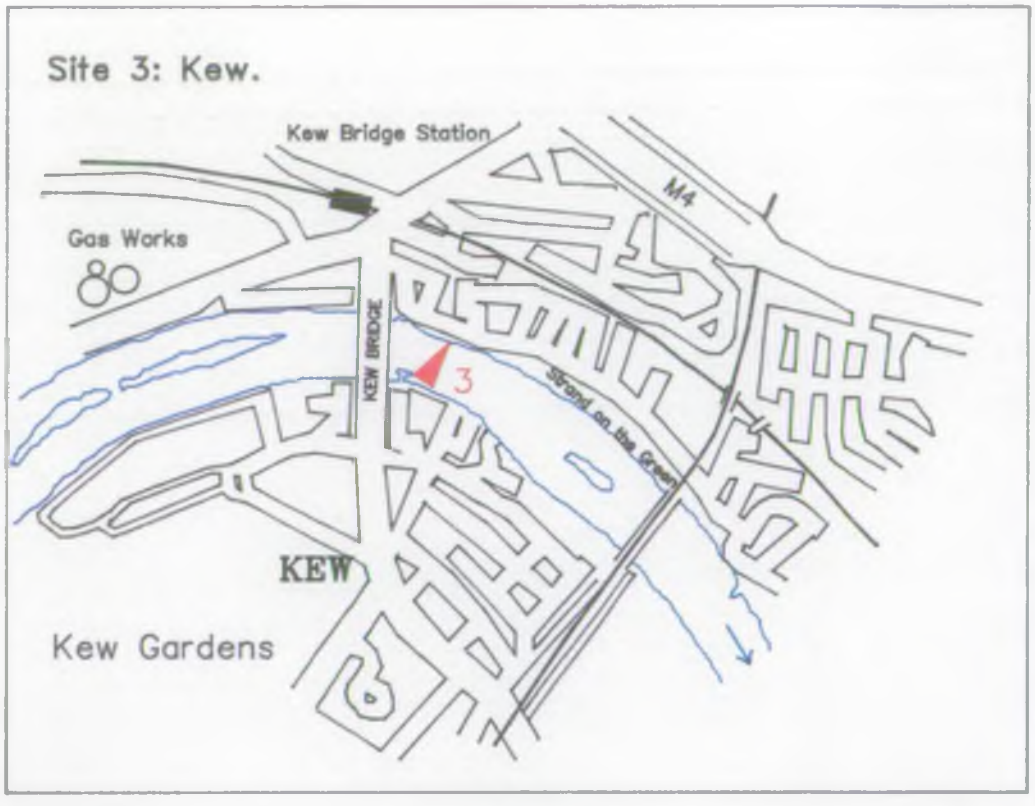
Details of Teddington Flow Survey sites in the Thames estuary.

1. Teddington
2. Isleworth
3. Kew
4. Hammersmith Bridge
5. Cadogan Pier

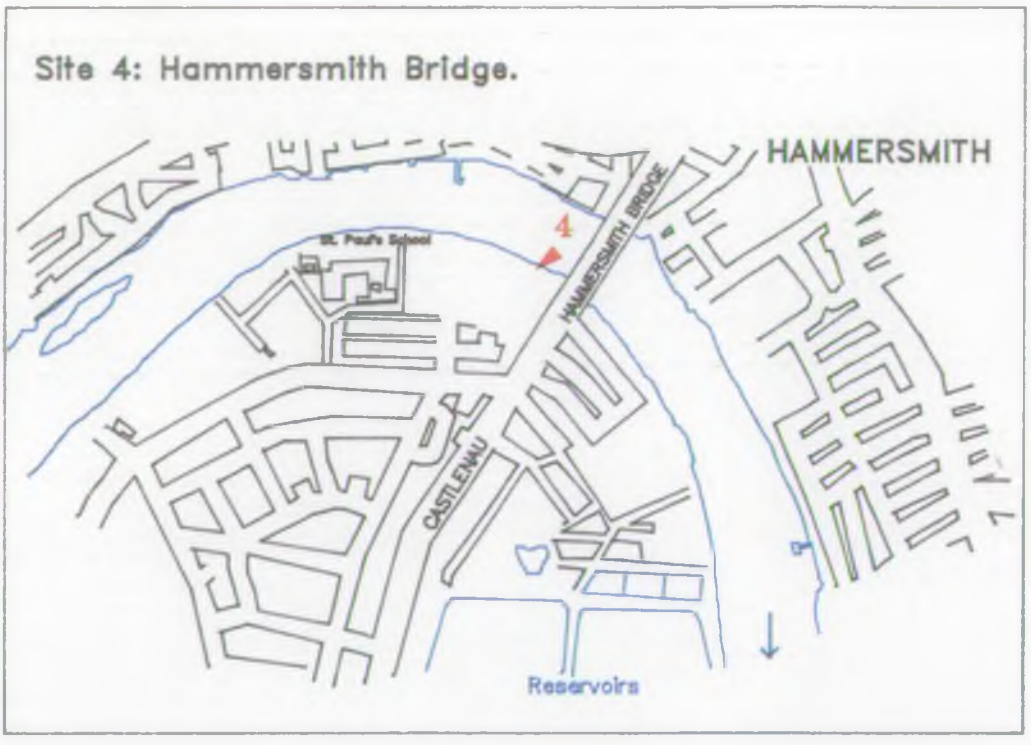

Teddington Site at low tide during period of low flows.




Isleworth site at low tide during period of low flows.




Kew site at low tide during period of low flows.




Hammersmith Bridge site at low tide during period of low flows.

Site 5: Cadogan Pier.


Cadogan Pier site at low tide during period of low flows.

## APPENDIX 2.

Details of BMWP score allocation.

## MACROINVERTEBRATE LIST (BMWP Score)

**GROUP 1 FAMILIES (10)**

- Siphlonuridae
- Heptageniidae
- Leptophlebiidae
- Ephemerellidae
- Potamanthidae
- Ephemeridae
- Taeniopterygidae
- Leuctridae
- Capniidae
- Perlodidae
- Perlidae
- Chloroperlidae
- Aphelocheiridae
- Phryganeidae
- Molannidae
- Beraeidae
- Odontoceridae
- Leptoceridae
- Goeridae
- Lepidostomatidae
- Brachycentridae
- Sericostomatidae

No. families

**GROUP 2 FAMILIES (8)**

- Astacidae
- Lestidae
- Agriidae
- Gomphidae
- Cordulegasteridae
- Aeshnidae
- Corduliidae
- Libellulidae
- Psychomyiidae (Ecnomidae)
- Philopotamidae

No. families

**GROUP 3 FAMILIES (7)**

- Caenidae
- Nemouridae
- Rhyacophilidae (Glossomatidae)
- Polycentropidae
- Limnephilidae

No. families

**GROUP 4 FAMILIES (6)**

- Neritidae
- Viviparidae
- Ancylidae (Acroloxidae)
- Hydroptilidae
- Unionidae
- Corophiidae
- Gammaridae (Crangonyctidae)
- Platycnemididae
- Coenagriidae

No. families

**GROUP 5 FAMILIES (5)**

- Mesoveliidae
- Hydrometridae
- Gerridae
- Nepidae
- Naucoridae
- Notonectidae
- Pleidae
- Corixidae
- Haliplidae
- Hygrobiidae
- Dytiscidae (Noteridae)
- Gyrinidae
- Hydrophilidae (Hydraenidae)
- Clambidae
- Scirtidae
- Dryopidae
- Elmidae
- Chrysomelidae
- Curculionidae
- Hydropsychidae
- Tipulidae
- Simuliidae
- Planariidae (Dugesiidae)
- Dendrocoelidae

No. families

Abundance Scale:
A = 1–9
B = 10–99
C = 100–999
D = 1000–9999
E = 10000+

**GROUP 6 FAMILIES (4)**

- Baetidae
- Sialidae
- Piscicolidae

No. families

**GROUP 7 FAMILIES (3)**

- Valvatidae
- Hydrobiidae (Bithyniidae)
- Lymnaeidae
- Physidae
- Planorbidae
- Sphaeriidae
- Glossiphoniidae
- Hirudinidae
- Erpobdellidae
- Asellidae

No families

**GROUP 8 FAMILIES (2)**

- Chironomidae

No. families

**GROUP 9 FAMILIES (1)**

- Oligochaeta

No. families

**TOTAL NO. FAMS.**

Other families found

## APPENDIX 3.

Flows over Teddington Weir:

Mean, maximum and mean weekly flows over Teddington Weir, 1989 and 1976.
Mean monthly flows for a 10 year period 1966-1975.

## Mean weekly flows over Teddington Weir, 1989 and 1976.

All values in thousand cubic meters per day (tcmd).

| Week No. | 1976 Mean | 1976 Maximum | 1976 Minimum | 1989 Mean | 1989 Maximum | 1989 Minimum |
|---|---|---|---|---|---|---|
| 24 | 232 | 279 | 200 | 1259 | 1832 | 899 |
| 25 | 282 | 412 | 233 | 968 | 1253 | 798 |
| 26 | 315 | 362 | 255 | 872 | 994 | 762 |
| 27 | 346 | 499 | 259 | 1975 | 3810 | 778 |
| 28 | 311 | 415 | 219 | 1050 | 2091 | 776 |
| 29 | 333 | 539 | 181 | 844 | 916 | 765 |
| 30 | 276 | 399 | 203 | 633 | 682 | 554 |
| 31 | 203 | 270 | 66 | 601 | 667 | 511 |
| 32 | 211 | 256 | 174 | 785 | 1996 | 487 |
| 33 | 173 | 259 | 86 | 531 | 705 | 452 |
| 34 | 213 | 242 | 190 | 629 | 1209 | 365 |
| 35 | 105 | 212 | 1 | 420 | 656 | 341 |
| 36 | 1 | 1 | 1 | 406 | 531 | 326 |
| 37 | 67 | 198 | 1 | 417 | 579 | 360 |
| 38 | 41 | 100 | 1 | 401 | 501 | 346 |
| 39 | 55 | 130 | 1 | 350 | 487 | 262 |
| 40 | 326 | 1322 | 52 | 376 | 438 | 296 |
| 41 | 454 | 1443 | 1 | 525 | 994 | 276 |
| 42 | 956 | 3862 | 1 | 603 | 1158 | 264 |
| 43 | 1026 | 1616 | 101 | 500 | 753 | 359 |
| 44 | 1002 | 1452 | 663 | 599 | 1218 | 409 |
| 45 | 1884 | 2609 | 1132 | 1232 | 3050 | 473 |
| 46 | 7353 | 13824 | 5365 | 646 | 1063 | 356 |
| 47 | 4050 | 5270 | 2713 | 589 | 8333 | 363 |
| 48 | 2659 | 3465 | 1996 | 650 | 747 | 553 |
| 49 | 13806 | 23846 | 5909 | 578 | 670 | 438 |
| 50 | 11102 | 17021 | 5806 | 7010 | 16157 | 552 |

## Mean monthly flows over Teddington Weir for a 10 year period 1966-1975.

| | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|
| tcmd | 6618 | 5547 | 3776 | 2419 | 1849 | 2203 | 4260 | 6584 | 7940 |

## APPENDIX 4.

Details of taxa recorded at each site above Teddington Weir on each sample occasion, together with abundances.

Abundance Key

* = 1-9
** = 10-99
*** = 100-999
**** = 1000-9999

Taxa List for PTHR.0073 Thames Above Mwd Intake., Littleton TQ04606940
Samples taken between 01/01/1989 and 08/01/1990

| Biology Area | 01 | 01 | 01 | 01 | 01 |
|---|---|---|---|---|---|
| Day | 06 | 27 | 21 | 18 | 23 |
| Month | Jul | Jul | Aug | Sep | Oct |
| Year | 1989 | 1989 | 1989 | 1989 | 1989 |
| *Non Routine Sample | | | | | |
| Sample Number | 0183 | 0201* | 0234* | 0286* | 0346* |
| PHRYGANEIDAE | | | * | | |
| MOLANNIDAE | * | * | * | | |
| LEPTOCERIDAE | ** | ** | ** | ** | * |
| CALOPTERYGIDAE | | * | ** | * | * |
| PSYCHOMYIIDAE | * | | | | |
| CAENIDAE | | | | ** | * |
| POLYCENTROPIDAE | * | * | * | * | * |
| LIMNEPHILIDAE | | * | | * | |
| NERITIDAE | * | * | * | * | * |
| ANCYLIDAE | | | | | * |
| HYDROPTILIDAE | * | * | | | ** |
| UNIONIDAE | * | * | * | * | * |
| COROPHIIDAE | ** | ** | * | ** | ** |
| GAMMARIDAE | ** | ** | ** | ** | ** |
| COENAGRIONIDAE | | | | | * |
| CORIXIDAE | ** | ** | * | | |
| HALIPLIDAE | ** | | * | * | |
| DYTISCIDAE | ** | ** | ** | * | ** |
| ELMIDAE | * | | | * | * |
| PLANARIIDAE | * | ** | ** | ** | ** |
| DENDROCOELIDAE | * | ** | * | ** | * |
| BAETIDAE | * | ** | ** | * | * |
| SIALIDAE | * | * | * | * | * |
| PISCICOLIDAE | * | * | * | | |
| VALVATIDAE | * | ** | * | ** | * |
| HYDROBIIDAE | ** | ** | ** | ** | * |
| LYMNAEIDAE | ** | ** | ** | ** | * |
| PHYSIDAE | ** | ** | * | ** | * |
| PLANORBIDAE | | | | * | * |
| SPHAERIIDAE | ** | ** | ** | ** | ** |
| GLOSSIPHONIIDAE | ** | ** | ** | ** | ** |
| ERPOBDELLIDAE | | ** | * | ** | * |
| ASELLIDAE | ** | ** | ** | *** | ** |
| CHIRONOMIDAE | ** | ** | ** | ** | ** |
| OLIGOCHAETA | ** | ** | ** | ** | ** |
| BMWP Score | 131 | 131 | 133 | 126 | 132 |
| Pred. BMWP Score | 185 | 185 | 185 | 185 | 185 |
| BMWP/Pred BMWP | 0.71 | 0.71 | 0.72 | 0.68 | 0.71 |
| ASPT | 4.85 | 4.85 | 4.93 | 4.67 | 4.71 |
| Predicted ASPT | 5.46 | 5.46 | 5.46 | 5.46 | 5.46 |
| ASPT/Pred ASPT | 0.89 | 0.89 | 0.90 | 0.86 | 0.86 |
| Biotic Class | B | B | B | B | B |

Taxa List for PTHR.0094 Thames At Mwd Intake, Walton TQ10506810
Samples taken between 01/01/1989 and 08/01/1990

| Biology Area | 01 | 01 | 01 | 01 | 01 | 01 |
|---|---|---|---|---|---|---|
| Day | 06 | 27 | 09 | 21 | 18 | 23 |
| Month | Jul | Jul | Aug | Aug | Sep | Oct |
| Year | 1989 | 1989 | 1989 | 1989 | 1989 | 1989 |
| *Non Routine Sample | | | | | | |
| Sample Number | 0182 | 0200* | 0228* | 0233* | 0287* | 0345* |
| APHELOCHEIRIDAE | | | * | | | |
| MOLANNIDAE | | | | | | * |
| LEPTOCERIDAE | ** | ** | ** | * | ** | ** |
| CALOPTERYGIDAE | | | | | * | |
| PSYCHOMYIIDAE | | * | * | | | * |
| CAENIDAE | | * | ** | * | ** | ** |
| POLYCENTROPIDAE | * | | * | * | * | ** |
| LIMNEPHILIDAE | | * | | | | |
| NERITIDAE | * | | ** | ** | * | * |
| VIVIPARIDAE | * | * | * | * | * | |
| ANCYLIDAE | * | * | | * | * | ** |
| HYDROPTILIDAE | * | | * | | * | * |
| UNIONIDAE | * | * | * | * | * | * |
| COROPHIIDAE | ** | | * | * | ** | ** |
| GAMMARIDAE | ** | * | ** | ** | ** | ** |
| COENAGRIONIDAE | | | * | * | * | * |
| NEPIDAE | | | | * | | |
| CORIXIDAE | ** | ** | ** | * | * | |
| HALIPLIDAE | ** | * | ** | * | * | * |
| DYTISCIDAE | ** | * | ** | * | * | * |
| ELMIDAE | | | | | | * |
| PLANARIIDAE | * | ** | ** | ** | * | ** |
| DENDROCOELIDAE | * | ** | * | ** | * | * |
| BAETIDAE | ** | ** | ** | ** | * | ** |
| PISCICOLIDAE | * | | | | | * |
| VALVATIDAE | * | ** | ** | ** | * | ** |
| HYDROBIIDAE | ** | ** | ** | ** | ** | ** |
| LYMNAEIDAE | ** | ** | ** | ** | ** | ** |
| PHYSIDAE | ** | ** | ** | ** | ** | * |
| PLANORBIDAE | * | * | ** | ** | * | * |
| SPHAERIIDAE | ** | ** | ** | ** | ** | ** |
| GLOSSIPHONIIDAE | * | ** | ** | ** | ** | ** |
| ERPOBDELLIDAE | * | * | ** | ** | ** | * |
| ASELLIDAE | ** | ** | ** | ** | ** | ** |
| CHIRONOMIDAE | ** | ** | ** | ** | ** | ** |
| OLIGOCHAETA | ** | ** | ** | ** | ** | ** |
| BMWP Score | 122 | 115 | 143 | 130 | 139 | 147 |
| Pred. BMWP Score | 185 | 185 | 185 | 185 | 185 | 185 |
| BMWP/Pred BMWP | 0.66 | 0.62 | 0.77 | 0.70 | 0.75 | 0.79 |
| ASPT | 4.52 | 4.60 | 4.93 | 4.64 | 4.79 | 4.90 |
| Predicted ASPT | 5.58 | 5.55 | 5.55 | 5.55 | 5.55 | 5.55 |
| ASPT/Pred ASPT | 0.81 | 0.83 | 0.89 | 0.84 | 0.86 | 0.88 |
| Biotic Class | B | B | B | B | B | B |

Taxa List for PTHR.0076 Thames Above Ravens Ait. Surbiton TQ17406770
Samples taken between 01/01/1989 and 08/01/1990

| Biology Area | 01 | 01 | 01 | 01 | 01 | 01 |
|---|---|---|---|---|---|---|
| Day | 06 | 27 | 10 | 21 | 18 | 23 |
| Month | Jul | Jul | Aug | Aug | Sep | Oct |
| Year | 1989 | 1989 | 1989 | 1989 | 1989 | 1989 |
| *Non Routine Sample | | | | | | |
| Sample Number | 0181 | 0199* | 0227* | 0232* | 0285* | 0344* |
| EPHEMERIDAE | | * | | | * | * |
| MOLANNIDAE | | * | | | | |
| LEPTOCERIDAE | ** | ** | ** | ** | ** | ** |
| CALOPTERYGIDAE | * | | | * | | |
| PSYCHOMYIIDAE | ** | ** | ** | ** | *** | ** |
| CAENIDAE | * | ** | ** | ** | *** | *** |
| POLYCENTROPIDAE | ** | | * | | * | * |
| LIMNEPHILIDAE | * | * | * | * | * | * |
| NERITIDAE | * | * | * | * | * | * |
| VIVIPARIDAE | | | | * | | * |
| ANCYLIDAE | * | * | * | ** | * | * |
| HYDROPTILIDAE | * | * | ** | * | * | ** |
| UNIONIDAE | * | * | * | * | * | * |
| COROPHIIDAE | ** | ** | ** | ** | ** | ** |
| GAMMARIDAE | ** | * | ** | ** | ** | *** |
| COENAGRIONIDAE | | | | | * | * |
| CORIXIDAE | | | | | | * |
| HALIPLIDAE | * | | | | | |
| DYTISCIDAE | | * | | * | * | |
| ELMIDAE | * | * | * | * | * | * |
| PLANARIIDAE | ** | ** | ** | ** | * | * |
| DENDROCOELIDAE | ** | ** | * | * | * | * |
| BAETIDAE | | | * | * | * | |
| PISCICOLIDAE | * | * | | * | | |
| VALVATIDAE | * | ** | * | ** | * | * |
| HYDROBIIDAE | ** | ** | ** | ** | ** | * |
| LYMNAEIDAE | ** | ** | ** | ** | ** | * |
| PHYSIDAE | | * | * | | | * |
| PLANORBIDAE | | | * | | * | * |
| SPHAERIIDAE | ** | ** | ** | * | ** | ** |
| GLOSSIPHONIIDAE | ** | ** | ** | ** | ** | ** |
| ERPOBDELLIDAE | * | * | * | ** | ** | * |
| ASELLIDAE | * | ** | ** | ** | ** | * |
| CHIRONOMIDAE | ** | ** | ** | ** | ** | * |
| OLIGOCHAETA | ** | ** | ** | ** | ** | ** |
| BMWP Score | 131 | 139 | 124 | 134 | 142 | 147 |
| Pred. BMWP Score | 185 | 185 | 185 | 185 | 185 | 185 |
| BMWP/Pred BMWP | 0.71 | 0.75 | 0.67 | 0.72 | 0.77 | 0.79 |
| ASPT | 5.04 | 5.15 | 4.77 | 4.96 | 5.07 | 5.07 |
| Predicted ASPT | 5.63 | 5.63 | 5.63 | 5.63 | 5.63 | 5.63 |
| ASPT/Pred ASPT | 0.90 | 0.91 | 0.85 | 0.88 | 0.90 | 0.90 |
| Biotic Class | B | B | B | B | B | B |

Taxa List for PTHR.0107 Thames At Teddington Weir TQ17007130
Samples taken between 01/01/1989 and 08/01/1990

| Biology Area | 01 | 01 | 01 | 01 | 01 | 01 |
|---|---|---|---|---|---|---|
| Day | 06 | 27 | 10 | 21 | 18 | 23 |
| Month | Jul | Jul | Aug | Aug | Sep | Oct |
| Year | 1989 | 1989 | 1989 | 1989 | 1989 | 1989 |
| *Non Routine Sample | | | | | | |
| Sample Number | 0180 | 0198* | 0226* | 0231* | 0284* | 0343* |
| LEPTOCERIDAE | ** | ** | ** | * | ** | * |
| PSYCHOMYIIDAE | | * | * | * | | |
| CAENIDAE | ** | ** | * | ** | * | * |
| POLYCENTROPIDAE | | * | | * | | * |
| VIVIPARIDAE | * | | * | | | |
| ANCYLIDAE | * | * | * | * | * | ** |
| HYDROPTILIDAE | * | * | | * | * | |
| UNIONIDAE | * | * | ** | * | * | |
| COROPHIIDAE | * | * | * | ** | ** | ** |
| GAMMARIDAE | *** | * | *** | ** | **** | *** |
| CORIXIDAE | * | | | | | |
| DYTISCIDAE | * | | | | | |
| PLANARIIDAE | * | * | * | ** | * | ** |
| DENDROCOELIDAE | ** | * | * | ** | * | * |
| BAETIDAE | ** | | | | | |
| PISCICOLIDAE | | | | * | | |
| VALVATIDAE | * | * | * | * | * | * |
| HYDROBIIDAE | ** | * | ** | | * | * |
| LYMNAEIDAE | ** | * | * | ** | * | * |
| PLANORBIDAE | | | | | * | |
| SPHAERIIDAE | ** | * | ** | ** | ** | ** |
| GLOSSIPHONIIDAE | ** | * | ** | ** | ** | * |
| ERPOBDELLIDAE | * | * | * | ** | ** | * |
| ASELLIDAE | ** | * | ** | ** | * | * |
| CHIRONOMIDAE | ** | ** | ** | ** | ** | * |
| OLIGOCHAETA | * | ** | ** | ** | * | ** |
| BMWP Score | 101 | 96 | 89 | 97 | 84 | 76 |
| Pred. BMWP Score | 185 | 185 | 185 | 185 | 185 | 185 |
| BMWP/Pred BMWP | 0.55 | 0.52 | 0.48 | 0.52 | 0.45 | 0.41 |
| ASPT | 4.59 | 4.80 | 4.68 | 4.85 | 4.42 | 4.47 |
| Predicted ASPT | 5.41 | 5.41 | 5.42 | 5.41 | 5.41 | 5.41 |
| ASPT/Pred ASPT | 0.85 | 0.89 | 0.86 | 0.90 | 0.82 | 0.83 |
| Biotic Class | B | C | C | C | C | C |

## APPENDIX 5.

Details of taxa recorded at each site below Teddington Weir on each sample occasion, together with abundances.

Abundance Key

* = 1-9
** = 10-99
*** = 100-999
**** = 1000-9999

1. Taxa recorded at d/s Teddington Weir, with relative abundances.

| Taxon. | Week No. 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Leptoceridae | * | * | * | PRES | * | * | PRES | * | | | | * | | | |
| Psychomyiidae | | * | * | | | PRES | | | | | | | | | |
| Caenidae | * | ** | ** | * | * | ** | | | | | | | | | |
| Ancylidae | ** | | | | * | PRES | * | * | PRES | PRES | | * | | | |
| Hydroptilidae | | * | ** | | PRES | * | | | | | | | | | |
| Unionidae | ** | ** | ** | ** | * | * | * | * | | | * | | | | |
| Corophiidae | | * | ** | | * | * | | * | | * | | | | | |
| Gammaridae | **** | *** | *** | *** | **** | *** | *** | ** | **** | **** | *** | *** | *** | *** | **** |
| Dytiscidae | | | | PRES | PRES | | | | | | | | | | |
| Elmidae | | * | | * | | | | | | | | * | | * | |
| Planariidae | * | PRES | | PRES | | PRES | PRES | | | | | | | | |
| Dendrocoelidae | | ** | * | PRES | * | PRES | PRES | PRES | | PRES | PRES | | PRES | | |
| Baetidae | ** | * | | | | | | | | | | | | | |
| Piscicolidae | | PRES | | | | | | | | | | | | | |
| Valvatidae | | | | * | | * | | | | | | * | | | |
| Hydrobiidae | ** | PRES | PRES | PRES | ** | ** | PRES | PRES | ** | PRES | * | ** | * | * | PRES |
| Lymnaeidae | | | PRES | * | PRES | PRES | | PRES | | PRES | * | | | PRES | |
| Planorbidae | | | * | | PRES | | | | | | | | | | |
| Sphaeriidae | *** | ** | ** | ** | ** | ** | * | ** | ** | * | * | ** | * | ** | *** |
| Glossiphoniidae | ** | ** | ** | ** | ** | ** | PRES | | * | * | * | * | * | * | PRES |
| Erpobdellidae | * | ** | PRES | PRES | PRES | PRES | | | | * | | | | | |
| Asellidae | ** | ** | ** | * | * | PRES | | | | | | | | | |
| Chironomidae | *** | ** | *** | ** | ** | ** | | * | * | * | * | * | * | | ** |
| Oligochaeta | ** | ** | *** | ** | ** | ** | PRES | PRES | * | * | * | | * | PRES | ** |
| Hydracarina | * | ** | * | * | | | | | * | | | ** | | | |
| Ostracoda | * | ** | ** | * | ** | * | | * | ** | | | | | | |
| Nematoda | * | | | | | | | | | | | | | | |
| Nematomorpha | | | | | | | | * | | | | | | | |
| BMWP | 62 | 90 | 78 | 70 | 81 | 89 | 48 | 54 | 24 | 41 | 35 | 41 | 23 | 24 | 18 |
| ASPT | 4.43 | 4.74 | 4.59 | 4.38 | 4.50 | 4.68 | 4.70 | 4.50 | 3.43 | 3.73 | 3.50 | 4.60 | 3.29 | 3.42 | 3.00 |

## 2. Taxa recorded at Isleworth, with relative abundances.

| Taxon. | Week No. 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ancylidae | ** | | * | | PRES | PRES | * | | PRES | PRES | | | | * | PRES |
| Unionidae | | | | | PRES | PRES | | PRES | | PRES | PRES | | | | |
| Gammaridae | **** | **** | **** | **** | *** | **** | *** | *** | **** | **** | **** | **** | *** | **** | **** |
| Dendrocoelidae | PRES | PRES | PRES | PRES | | | PRES | PRES | PRES | | | | | | PRES |
| Hydrobiidae | * | * | | | | | | | PRES | | | | | | |
| Lymnaeidae | * | * | * | * | * | * | * | * | * | * | | PRES | PRES | * | ** |
| Sphaeriidae | * | ** | * | * | ** | | * | * | * | | | * | * | | ** |
| Glossiphoniidae | * | * | * | * | PRES | * | PRES | | PRES | PRES | * | | | | * |
| Erpobdellidae | ** | ** | * | * | ** | * | * | * | * | * | * | * | | * | ** |
| Chironomidae | ** | * | * | | | * | | | | | | * | | | |
| Oligochaeta | *** | *** | ** | * | *** | *** | PRES | ** | * | ** | * | ** | ** | ** | **** |
| Acanthocephala | | | | | | ** | | | | | | | | | |
| BMWP | 35 | 29 | 32 | 24 | 31 | 30 | 30 | 27 | 33 | 28 | 19 | 18 | 13 | 19 | 33 |
| ASPT | 3.50 | 3.22 | 3.56 | 3.42 | 3.88 | 3.75 | 3.75 | 3.86 | 3.67 | 4.00 | 3.80 | 3.50 | 3.25 | 3.80 | 3.67 |

3. Taxa recorded at Kew, with relative abundances.

| Taxon. | Week No. 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ancylidae | PRES | * | PRES | | | PRES | | | PRES | | * | | | | |
| Unionidae | | | | | | | | | PRES | | | | | | |
| Gammaridae | **** | **** | **** | *** | *** | *** | *** | *** | **** | *** | **** | *** | *** | *** | *** |
| Viviparidae | * | | * | * | | | * | * | PRES | | | | | | |
| Planariidae | | | PRES | PRES | | | | | | | | | | | PRES |
| Dendrocoelidae | | | PRES | PRES | PRES | PRES | PRES | | | | | | | | |
| Hydrobiidae | | | PRES | PRES | * | | | PRES | PRES | PRES | * | | PRES | * | ** |
| Lymnaeidae | * | * | * | PRES | * | PRES | * | * | PRES | * | * | * | PRES | * | * |
| Planorbidae | | | | PRES | | | | | | | | | | | |
| Sphaeriidae | ** | * | ** | ** | ** | * | * | * | * | * | * | | * | * | * |
| Glossiphoniidae | * | * | PRES | * | * | * | PRES | PRES | * | | * | * | * | | * |
| Erpobdellidae | * | * | * | * | * | PRES | PRES | PRES | * | | * | * | * | PRES | PRES |
| Asellidae | * | | PRES | | PRES | | | | | | | | | | |
| Chironomidae | ** | * | ** | * | | ** | | | | | | | | | |
| Oligochaeta | *** | *** | *** | *** | *** | *** | *** | *** | ** | *** | *** | * | | *** | **** |
| Mysidacea | | | | | | | | | | | | | | | * |
| BMWP | 36 | 27 | 49 | 43 | 30 | 32 | 30 | 28 | 40 | 16 | 28 | 16 | 21 | 19 | 24 |
| ASPT | 3.60 | 3.38 | 3.76 | 3.58 | 3.33 | 3.56 | 3.75 | 3.50 | 4.00 | 3.20 | 3.50 | 3.20 | 3.50 | 3.17 | 3.43 |

4. Taxa recorded at Hammersmith Bridge, with relative abundances.

| Taxon. | Week No. 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ancylidae | | PRES | | | | | | | PRES | | | | | | |
| Gammaridae | **** | **** | **** | *** | *** | *** | *** | *** | *** | *** | *** | *** | *** | ** | *** |
| Planariidae | * | | | | | | | | | | | | | | |
| Dendrocoelidae | | | | | | | PRES | PRES | | | | | | | |
| Lymnaeidae | | * | PRES | * | | PRES | PRES | PRES | PRES | PRES | * | PRES | PRES | | PRES |
| Sphaeriidae | * | | * | | | | | | | | | | | | |
| Glossiphoniidae | * | | * | PRES | PRES | * | PRES | PRES | | | * | | | * | |
| Erpobdellidae | | * | * | * | * | PRES | PRES | PRES | * | * | PRES | * | PRES | | PRES |
| Asellidae | | * | * | | | | | | | | | | | | |
| Chironomidae | | | PRES | | | | | | | | | | | | |
| Oligochaeta | PRES | PRES | * | * | * | PRES | PRES | | | | * | * | | * | ** |
| Crangonidae | | | | | | | | | | | | | * | | |
| BMWP | 18 | 22 | 24 | 16 | 13 | 16 | 21 | 20 | 18 | 12 | 16 | 13 | 12 | 10 | 13 |
| ASPT | 3.60 | 3.67 | 3.00 | 3.20 | 3.25 | 3.20 | 3.50 | 4.00 | 4.50 | 4.00 | 3.20 | 3.25 | 4.00 | 3.33 | 3.25 |

5. Taxa recorded at Cadogan Pier, with relative abundances.

| Taxon. | Week No. 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ancylidae | * | * | * | PRES | | PRES | PRES | * | * | | PRES | | | * | ** |
| Gammaridae | *** | ** | **** | *** | *** | **** | *** | *** | *** | *** | ** | *** | *** | ** | *** |
| Corophiidae | | | | | * | * | PRES | | | | | | | | |
| Corixidae | | * | | | | | | | | | | | | | |
| Hydrobiidae | ** | PRES | * | * | * | ** | * | ** | * | ** | * | * | ** | * | *** |
| Lymnaeidae | * | * | * | * | * | ** | PRES | * | * | * | PRES | * | PRES | * | ** |
| Sphaeriidae | * | * | ** | | * | ** | * | PRES | PRES | | | ** | | | |
| Glossiphoniidae | | PRES | * | | | | | * | PRES | * | | | | | |
| Erpobdellidae | * | * | * | * | * | * | * | * | * | PRES | | | * | ** | |
| Chironomidae | * | | ** | | | | | | | | | | | | |
| Oligochaeta | *** | *** | *** | *** | *** | **** | **** | *** | *** | **** | **** | *** | *** | **** | **** |
| Crangonidae | | | | | | | | | | | | | * | | |
| Palaemonidae | | | | ** | | | * | | | | | * | ** | | |
| Dreissenidae | | | | * | | | | | | | | | | | |
| BMWP | 27 | 33 | 30 | 22 | 25 | 31 | 31 | 28 | 28 | 22 | 19 | 16 | 16 | 22 | 19 |
| ASPT | 3.38 | 3.67 | 3.33 | 3.67 | 3.57 | 3.88 | 3.88 | 3.50 | 3.50 | 3.67 | 3.80 | 3.20 | 3.20 | 3.67 | 3.80 |

## APPENDIX 6.

Details of diatom and flagellate genera recorded at sites above Teddington Weir

## Details of diatom and flagellate genera u/s Teddington Weir.

Percentage occurrence of each phytoplankton genus at each site, Egham to Teddington, July to November 1989.

| Phytoplankton | E | C | W | HC | KI | u/sT |
|---|---|---|---|---|---|---|
| **Bacillariophyceae.** | | | | | | |
| Melosira | | *** | * | ** | ** | ** |
| Stephanodiscus | * | ** | ** | ** | * | * |
| Fragillaria | | | | | * | * |
| Nitzschia | * | | * | * | * | * |
| Cymbella | | * | | | | |
| Gomphonema | | | | * | | |
| Cymatopleura | * | | | | | |
| Synedra | * | | * | * | * | |
| Asterionella | | * | | | | |
| Navicula | * | * | * | * | * | * |
| **Cryptophyceae.** | | | | | | |
| Rhodomonas | | *** | ** | ** | * | * |
| Cryptomonas | ** | ** | ** | * | ** | * |
| **Euglenophyceae.** | | | | | | |
| Euglena | | | | * | * | |

Key

* = group recorded in <20% of samples taken
** = 20-40%
*** = 40-60%
**** = 60-80%
***** = 80-100%

## APPENDIX 7.

Mean, maximum and minimum coliform levels recorded at each site Egham-Cadogan Pier during Teddington Flow Survey, 1989.

## Mean, maximum and minimum coliform levels recorded at each site during Teddington Flow Survey 1989.

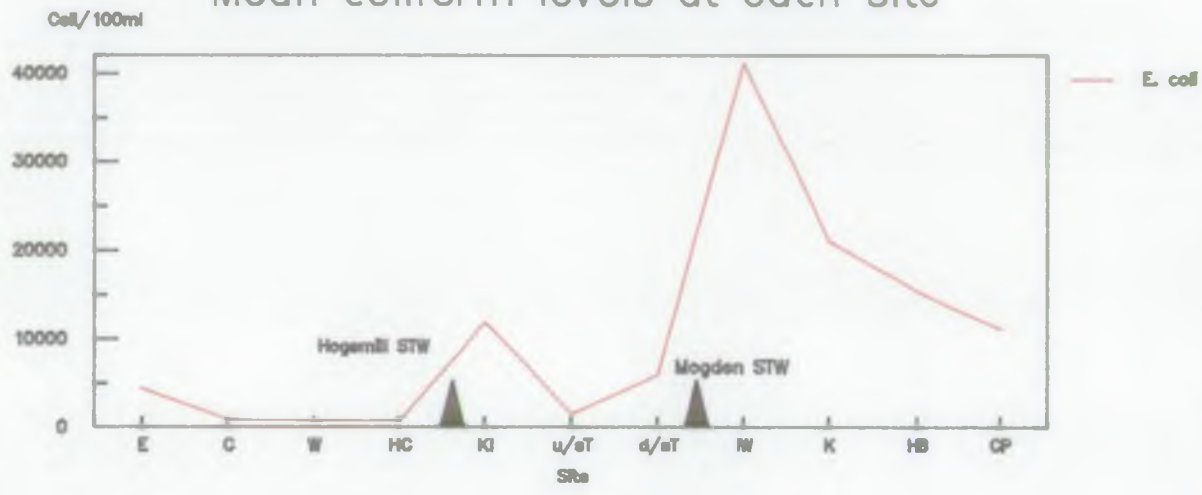
All values in cells/100 ml.

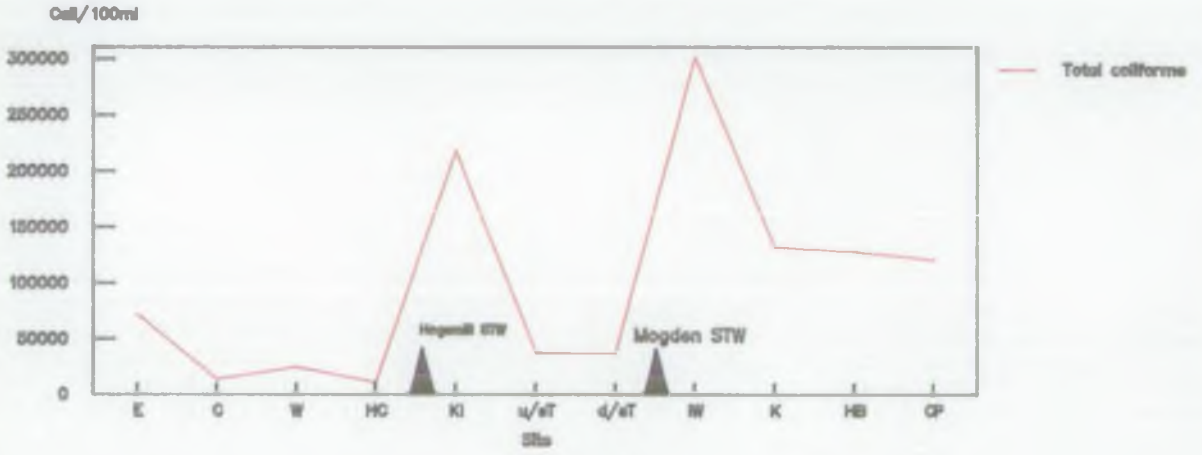
| Site. | E. coli Maximum | E. coli Mean | E. coli Minimum | Total Coliforms Maximum | Total Coliforms Mean | Total Coliforms Minimum |
|---|---|---|---|---|---|---|
| E | 20,600 | 4,456 | 200 | 768,000 | 70,807 | 2,700 |
| C | 2,600 | 940 | 310 | 70,000 | 13,567 | 1,400 |
| W | 2,500 | 802 | 140 | 227,000 | 24,327 | 1,300 |
| HC | 4,500 | 835 | 220 | 96,000 | 10,850 | 1,100 |
| KI | 64,000 | 11,947 | 270 | 1,113,000 | 218,520 | 1,100 |
| u/sT | 5,100 | 1,574 | 270 | 103,000 | 37,600 | 1,100 |
| d/sT | 45,000 | 6,007 | 400 | 250,000 | 36,933 | 2,000 |
| IW | >150,000 | 41,130 | 3,800 | 800,000 | 301,867 | 49,000 |
| K | 50,000 | 20,967 | 3,500 | 310,000 | 131,600 | 41,000 |
| HB | 60,000 | 15,320 | 3,900 | 280,000 | 127,467 | 30,000 |
| CP | 58,000 | 11,140 | 1,000 | 630,000 | 119,933 | 19,000 |

For Comparison.

EC mandatory levels for bathing waters are:
E. coli - 2,000 cells/100ml, Total coliforms 10,000 cells/100ml.

# Teddington Flow Survey 1989
## Mean coliform levels at each site



# APPENDIX 8.

Examples of *Lemna* beds formed on the Thames during periods of low flows.

a) Hampton Court.

b) u/s Teddington Weir.

Cover of Lemna established during period of low flow (both 17.8.89)