Natural England Commissioned Report NECR023

Review of the evidence for organic pollution thresholds to protect rivers with special designations for wildlife

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Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Background

Natural England is responsible for overseeing the management and assessment of sites with national and international designations for wildlife, including Sites of Special Scientific Interest (SSSIs) and Special Areas of Conservation (SACs).

A key aspect of this work is defining the Conservation Objectives for each site. Conservation objectives define and identify favourable conditions relating to the site and inform management decisions.

Natural England commissioned this work to review key quantitative information on the response of the characteristic biological community of river types in England and the UK to organic pollution stress gradients.

The results will be used to reconsider the adequacy of the Conservation Objective targets set for protecting SSSI condition.

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Further information
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Review of the evidence for organic pollution thresholds to protect rivers with special designations for wildlife

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EXECUTIVE SUMMARY

Natural England is responsible for overseeing the management and assessment of sites with national and international designations for wildlife, including Sites of Special Scientific Interest (SSSIs) and Special Areas of Conservation (SACs). A key aspect of this work is the definition of Conservation Objectives for each site, that define favourable conditions and inform management decisions relating to the site. The purpose of this report is to review key quantitative information on the response of the characteristic biological community of river types in England and the UK to organic pollution stress gradients, in order to reconsider the adequacy of the targets set for protecting SSSI condition.

The specific stresses under consideration here are the toxic and physical effects caused either directly or indirectly by organic pollution, not the eutrophying effect (which in conservation objectives is dealt with by nutrient targets). In this context, organic pollution can result in oxygen depletion and increased ammonia concentrations with severe consequences for river organisms. Organic effluents frequently contain large quantities of suspended solids which reduce the light available and alter river bed characteristics rendering it unsuitable for many organisms.

Objective quantitative information on the sensitivity of river organisms to organic pollution has been derived using different approaches, carefully controlled laboratory assessments on component stressors (e.g. LC_{50}), field scale experimental manipulations, case histories and correlation of field survey data. The different approaches vary in the degree of control and realism. Evidence available from a variety of sources is reviewed and the reponse of the biological community to determinands associated with organic pollution presented. Fish are particularly prone to the toxic effects of unionised ammonia and of oxygen stress. Both unionised ammonia and oxygen stress can cause death of invertebrates, but they are typically less sensitive to ammonia than fish. Field scale simulated pollution events and exposure to polluted natural waters indicate that, whilst laboratory trials provide an indication of sensitivity, they do not accurately reflect the response of organisms in the field.

New analyses of field data were undertaken at both family and species level to determine the response of macroinvertebrates to organic pollution. The approach was to develop a ranking of taxa based on their tolerance to chemical determinands associated with organic pollution, as measured by a combination of BOD, oxygen and ammonium concentration based on partial ordination. Infrequent taxa were included in the analyses passively, to give an indication of their sensitivity without biasing the results. The three macroinvertebrate families most sensitive to organic pollution were identified as Odontoceridae, Goeridae and Rhyacophilidae (incl. Glossosomatidae). The species level analysis was compromised by a lack of data from more polluted sites. It is recommended that more species level data are collected from organically polluted sites before a repeat of this analysis is attempted.

Management thresholds of organic pollution for rivers SSSIs should be set to protect the biological communities characteristic of the habitat, including the most sensitive taxa, and correspondingly thresholds should differ among sites according to the nature of the characteristic biota. The tolerance of the most sensitive taxa typically present can then be used to establish the thresholds for each river type. RIVPACS 9-endgroup river types predict the fauna and mean abundance in such rivers; these were matched to NE (and JNCC) river typologies. Thresholds are set corresponding to concentrations where 80% of the occurrences of the most sensitive macoinvertebrate familes are in less polluted sites. Two thresholds are proposed:

I: 10^{th} %ile DO = 85%, Mean BOD = 1.8 mg l^{-1}, 90^{th} %ile Total Ammonia (NH_3 -N) = 0.23 mg l^{-1}

II: 10^{th} %ile DO = 79%, Mean BOD = 2.0 mg l^{-1}, 90^{th} %ile Total Ammonia (NH_3 -N) = 0.29 mg l^{-1}

Data are compiled from SSSI sites where available and compliance with these thresholds investigated. Data on various determinands associated with organic pollution are presented for SSSI sites where available.

1. Background and Objectives

This report was produced by the Centre for Ecology and Hydrology under contract to Natural England as a "Review of the evidence of organic pollution thresholds to protect rivers with special designations for wildlife" (Contract No. SAE03-02-060).

As part of its statutory remit, Natural England is responsible for overseeing the management and assessment of sites with national and international designations for wildlife, including Sites of Special Scientific Interest (SSSIs) and Special Areas of Conservation (SACs). A key aspect of this work is the definition of Conservation Objectives for each site, based on generic guidance for each habitat type and, where applicable, for particular designated species. Sites designated for wildlife conservation may suffer from a number of different stressors, any of which could render conditions at the site less than favourable for conservation of the habitats or species for which it was designated. Conservation Objectives lay out a series of environmental and biological targets that define favourable conditions for the site, which drive the assessment of site condition and inform management decisions relating to the site. Work in England is informed by development of Common Standards guidance on setting conservation objectives at UK level, produced by joint working groups under the auspices of the Joint Nature Conservation Committee (JNCC).

Generic Favourable Condition Targets for SSSI rivers were first defined by English Nature in 2003, relating to general water quality, hydrology and physical conditions (i.e. describing the main potential stressors of designated rivers). Targets for most indicators varied according to natural variations in environmental conditions between river types. With respect to water quality, targets were set *inter alia* for a suite of organic pollution indictors. Since this time these indicators have been modified for use in UK Common Standards guidance for SSSI and SAC rivers. Various concerns have been raised about different generic targets, relating to the possibility of both over- and under-precaution. UK Water Framework Directive Technical Advisory Group (UKTAG) has proposed organic pollution standards to support both Good and High Ecological Status under the Water Framework Directive, based on an analysis of a large UK dataset on benthic macroinvertebrates (Guthrie *et al*. 2006).

Natural England now needs an objective reappraisal of the evidence base, to inform decisions about the adequacy of existing Favorable Condition targets and the need for revisions. UK TAG analyses are useful but do not adequately characterise the biological response to organic pollution stress in conservation and ecological terms, and provide no linkage back to the wealth of literature that exists on the subject. Natural England and the other UK conservation agencies need to establish targets for Favourable Condition that are demonstrably protective of characteristic biological assemblages. Any thresholds of organic pollution need to be set at levels, within a suitable compliance regime, that gives adequate confidence in creating suitable conditions for the long-term conservation of populations of characteristic flora and fauna, including the most sensitive species.

The purpose of this report is to review key quantitative information on the response of the characteristic biological community of river types in England and the UK to organic pollution stress gradients, in order to reconsider the adequacy of the targets set for protecting SSSI condition. The stresses under consideration here are the toxic and physical effects caused either directly or indirectly by organic pollution, not the eutrophying effect of increased nutrient (nitrogen and phosphorus) loading. Eutrophication effects tend to be masked by toxic and physical effects, and relationships are further confounded by contributions to nutrient loadings from ostensibly inorganic sources. The effect of eutrophication on rivers is beyond the scope of this review, and should be dealt with elsewhere.

This report will review the available literature on the impact of organic pollution stress on rivers; particularly the evidence based on the response of natural streams or stream mesocosms to controlled dosing and will consider the biological impacts of episodic events, in terms of recovery times. Further, the report will present new analyses of primary data detailing the response of macroinvertebrates to organic pollution stress, and use this evidence to derive thresholds of organic pollution for different river types. The thresholds will be placed in the context of concentration profile statistics for organic pollution indicators for designated rivers where sufficient data are available, to determine compliance with these thresholds.

This report is intended to achieve the project objectives, namely:

1. To identify the most appropriate indicators of organic pollution stress for use in Favourable Condition Tables for SSSI/SAC rivers.
2. To provide quantitative characterisation of changes to the characteristic biological communities of UK river types along the gradient of organic pollution stress.
3. To propose suitable values for the chosen indicators to protect the whole biological community characteristic of each river type.

2. Review of Published Information

2.1 Introduction

The impact of pollution on rivers has long been noted. Early works (Kolkwitz & Marsson, 1908, 1909) described the biological degradation and recovery of rivers from sewage pollution. With continuous discharge from point sources such as sewage outfalls maintaining steady-state conditions downstream, impact and recovery was seen in spatial terms. Since then, the description of reduced impact downstream, associated with dilution and degradation, has been confirmed by numerous studies (Streeter & Phelps, 1925; Hynes, 1960; Whitton & Say, 1975). These and similar works provide the basis for much of our understanding of the impact of pollution on river organisms, and this understanding underlies the tools that have been developed to assess the extent of biological degradation through biological monitoring.

Using an understanding of the relationship between the distribution of river organisms and the extent of pollution, various systems have been developed to classify organisms according to their sensitivity to organic pollution (e.g. saprobien index, Trent Biotic Index, Chandler Score, BMWP score). These scores can then be used to assess the extent of pollution in novel test sites. Historically the development of such scoring systems has relied heavily on organisms' perceived tolerance of pollution as assessed by expert judgement (Biological Monitoring Working Party, 1978), a process that is vulnerable to inaccuracies (Walley & Hawkes, 1996). Furthermore, the scores are typically designed to assess pollution in a generic sense and, although gross organic pollution has usually been the main focus in the development of such scoring systems, they are not necessarily sensitive to organic pollution *per se*. Much of the perceived sensitivity of river organisms to pollution is based on distance from point sources of pollution, such as sewage discharges. Yet sewage discharges introduce a variety of different pollutants from both industrial and domestic sources into rivers together with organic matter, e.g. heavy metals, detergents, pesticides. Hence, there is a need to reassess the sensitivity of river organisms to organic pollution.

The need to reassess the sensitivity of river organisms to organic pollution is heightened by developments in sewage treatment and agriculture since the early 20th Century that have resulted in changes to the distribution of sources of organic pollution. Most sewage now receives secondary treatment, and the frequency of continuously flowing, urban point sources of gross pollution through the discharge of raw sewage has declined. Organic pollution events now tend to occur as pulses, often in response to heavy rainfall, either as storm water discharges from combined sewerage systems or washout from farm waste storage facilities. Furthermore, diffuse agricultural sources now contribute a significant proportion of the load of organic pollution to rivers (Mainstone *et al.*, 1991; Hooda *et al.*, 2000). The quantification of the impact of such diffuse sources on rivers will require an understanding of the sensitivity of organisms to organic pollution.

2.2 Effects of Organic Pollution on River Biota

Organic pollution occurs when large amounts of organic matter enter a water course. The organic matter acts as a substrate for decomposition by micro-organisms, which can result in oxygen being used up at a greater rate than it can be replenished. The resultant oxygen depletion has severe consequences for river organisms. The extent of potential depletion is summarised as Biochemical Oxygen Demand (BOD; See Table 1). Ammonia is often present in the inflowing effluent, or is produced during the process of breakdown of organic matter, which is toxic to many organisms. Nitrate and phosphate are also released from organic matter during the breakdown process, potentially increasing the production of algae and plants and increasing eutrophication.

Organic effluents frequently contain large quantities of suspended solids which reduce the light available to photosynthetic organisms, and on settling out on the river bed alter its characteristics rendering it unsuitable for many organisms.

Table 1. Ranges of BOD concentrations for various wastes.

Source	BOD (mg l^{-1})
Silage effluents	30 000-80 000
Pig slurry	20 000-30 000
Cattle slurry	10 000-20 000
Liquid effluents draining from slurry stores	1000-12 000
Dilute dairy parlour and yard washing (dirty water)	1000-5000
Milk	140-1000
Untreated domestic sewage	300-600
Treated domestic sewage	20-60
Clean river water	<5

Source: (MAFF, 1998)

2.3 Quantification of Organic Pollution

Organic pollution occurs as a consequence of a waterbody receiving an increased amount of putresible material above natural background levels. This material comes from a variety of sources, typically untreated and partially treated domestic sewage, farm waste, food-processing waste and wastes from certain industries. The nature of the organic material (e.g. solid, liquid, oil), its chemical composition and the associated pollutants (e.g. metals, salts, pesticides, nutrients, pharmaceuticals) varies dependent upon the source. Furthermore, the impact of increased inputs of organic matter will depend on the natural background levels for the receiving water body. As a consequence it is not possible to accurately define organic pollution by chemical determinands alone. Nevertheless, certain chemical determinands are correlated with, and do give some measure of, the extent of organic pollution suffered by a water course. Determinands typically measured are BOD, a measure of the rate of oxygen consumption by biological and chemical activity in the water, oxygen saturation and the concentration of oxygen, ammonia/um, nitrate, phosphate, and suspended solids in the water. Other determinands that can be measured include pH, and the concentration of metals and other pollutants. It should be remembered that none of these determinands actually quantify the amount of organic matter received by a water body, or the impact that any additional (above background) organic material has on the biological community of the receiving water body. However, in order for organic pollution thresholds to be defensible it is important that there is a clear link between the determinands that are used to define the thresholds and the impact that organic pollution has on the biota.

Key message: It is important that the determinand(s) chosen to set organic pollution thresholds have a clear relationship with the biological impact of organic pollution.

Furthermore, there are often different ways to measure the same chemical determinand. Oxygen can be measured as rate of consumption under various standardised (e.g. 5 day, 5 day ATU inhibited) conditions (BOD), concentration or % saturation. Ammonia can be measured as the concentration of free unionised ammonia (NH_3), of ionised ammonium (NH_4^+), or of both combined. Ammonia changes between these different chemical forms dependent upon environmental conditions (particularly pH) and, most importantly, the different forms vary in their toxicity to biota: biota are particularly sensitive to unionised ammonium (Mainstone & Gulson, 1990; Schubauerberigan *et al.*, 1995; Alonso & Camargo, 2003). Similarly, nitrate and phosphate can occur as a number of different forms with various relationships with biological impacts. In setting organic pollution thresholds it is important that, as far as possible, the determinands chosen are of a form that has a clear link to the effects of organic pollution on the biota.

Key message: It is important that the determinand(s) chosen to set organic pollution thresholds are of a form that has a clear relationship with any toxic (or other biological) effects.

These chemical determinands fluctuate both spatially and temporally in the natural environment, and are influenced by sampling variation. Hence, there are number of ways in which they can be expressed, to account for this variation and provide information on the severity of the pollution. The measures often used are maximum (or minimum dependent upon the impact of the determinand on the biota), mean, median, or 90th percentile concentrations. The relationship between these different measures is determined by the spatial and temporal variation in the determinand, and hence in part by the nature of the pollution event. Measures from pulsed pollution events will be more variable than from pollution arising from a continuous discharge. Correspondingly, the biota will have more opportunity to recover from, or avoid, a pulsed pollution event than one arising from a continuous discharge. The choice of which measure to use is determined, in part, by the impact of the determinand on the biota; a single occurrence of a highly toxic event may have a larger impact on the biota than a long period of more moderate toxicity.

Key message: Both frequency of occurrence and the recovery time of the system influence the choice of the measure used to determine organic pollution thresholds.

2.4 Sources of Quantitative Information

Objective quantitative information on the sensitivity of river organisms to organic pollution can be derived using different approaches. The constraints on the general applicability of the information are dependent upon the approach used. The approaches used are

i) laboratory assessments (e.g. LC_{50}),
ii) field scale experimental manipulations (experimental channels and simulated pollution events),
iii) case studies of pollution events, and
iv) correlation of field survey data.

The approaches differ in the degree of experimental control possible (decreasing from i to iv), and in scale and general applicability to the natural environment (increasing from i to iv). Any information derived from these different sources should be viewed with these constraints in mind.

i) Laboratory Assessment

In laboratory trials sensitivity to pollutants is derived through assessments of chronic, or incipient, toxicity to continuous exposure by tests which typically establish the concentration which causes mortality of 50% of the test organisms (Lethal Concentration 50 or LC_{50}) conducted under controlled conditions. Behavioural responses can also be assessed using this methodology. Whilst clearly of some use in predicting the biological impact of continuous discharges of pollutants, it is difficult to extrapolate and use the information based on laboratory exposures at constant concentrations to predict the impact of pulsed pollution events under natural conditions where the concentration-time course of pulses of pollutants passing downstream are subject to attenuation both vertically in the sediments and longitudinally in the flowing water (Pascoe, 1988). Furthermore, LC_{50} values derived under controlled conditions and continuous exposure, whilst defining absolute limits, are likely to be over-prescriptive for variable natural conditions, where spatial patchiness and behaviour of organisms can influence exposure (Kimball & Levin, 1985). In addition, LC_{50} tests are typically performed on a few, widespread and well understood species, e.g. *Daphnia magna* and *Gammarus pulex*, and therefore are difficult to extrapolate to whole communities.

Nevertheless, the results of such bioassays are the basis for most policy regulating the release of chemicals to the environment. Since there is uncertainty associated with the extrapolation of laboratory results to natural ecosystems, various uncertainty factors or statistical extrapolations are used when the potential risk of the test chemical to the environment is determined (see Belanger, 1992). The range of single species results for any test chemical can span an order of magnitude, dependent on laboratory conditions. Additional orders of magnitude can be included in the calculations from the uncertainty factors and/or extrapolations. Thus, it is common for a range of concentrations to be predicted over which there is the potential for biological impact.

The response to pulsed events, and increased "naturalness", can be simulated under laboratory conditions using artificial re-circulating streams, which may provide a bridge between laboratory and field (Lamberti & Steinman, 1993; Brooks *et al.*, 1996). Nevertheless, only the largest such artificial laboratory streams come close to approximating the full scale and complexity of natural systems (Belanger, 1997). This is especially true of larger (e.g. fish, macrophytes) and longer lived organisms (including whole life cycles); community level responses, complete with complicated interactions and feedbacks between different species and organism groups, are rarely tested (Lamberti & Steinman, 1993; Belanger, 1997).

ii) Field scale manipulations

Larger experimental channels approximate to the field scale, particularly flow-through channels fed by river water where natural colonisation by a range of organisms is possible. Such flow-through artificial channels also enable some behavioural responses to be expressed and quantified, such as drift and re-colonisation by invertebrates. There are some constraints on the range of substances that can be tested using flow through channels, as flow-through experimental streams have a high water demand and the output water usually cannot be transported or treated to remove excess toxic pollutants before return to a water course. There are also logistic constraints on the number of treatment concentrations that can be tested; large-scale, typically out door, channels require considerable manpower to maintain and the number of replicate channels available constrains experimental designs

(Lamberti & Steinman, 1993; Belanger, 1997). A further constraint arises from the scarcity of such large-scale experimental facilities; it is only possible to use such facilities to test the impact on the few river types (and hence water chemistry and community types) where the facilities are sited. Hence, the impacts predicted using such channels may not be applicable to many sites and species. Nevertheless, studies using such facilities can provide valuable information at the population (Watton & Hawkes, 1984) or community level.

An alternative approach is to simulate pulsed pollution events by experimental dosing of real rivers. Here sites, chosen carefully so that any damage does not influence substantial lengths of river downstream, are dosed with a pollutant and the consequence of its passage downstream are followed. Controlled manipulation allows the impact of known concentrations of specific pollutants (e.g. unionised ammonia, sulphide and oxygen concentration,) independently or in combination to be assessed. The treatment can be applied as a single pulse or as increasing increments where the point at which impact occurs can be monitored. Thus, it is possible to assess the concentration of pollutants that causes an impact, at a scale that allows behavioural responses of the biota. Fish can move up or downstream to avoid pulses of pollution. Invertebrates can also drift downstream to avoid pulses, with this response typical of sub-lethal concentrations of pollutants (Edwards, Ormerod & Turner, 1991). Invertebrates have been shown to burrow into the sediment to avoid sediment pulses also (Turner, 1992), and adults of certain taxa, e.g. Coleoptera, Hemiptera, Gerridae, may leave the aquatic phase under adverse conditions (Turner, 1992). Workers at Cardiff University conducted seven manipulations relevant to organic pollution which are reported by Turner (1992) and elsewhere (Edwards *et al.*, 1991; McCahon *et al.*, 1991), four of which reduced dissolved oxygen, one increased ammonia, one combined increased ammonia and reduced oxygen, and one increased sulphide.

Such controlled dosing experiments provide the most direct information for assessing the toxic and physical effects of organic pollution on rivers. However, the logistics involved in undertaking such large scale manipulations are such that they have not been undertaken often. Hence, only a few river types and certain determinands associated with organic pollution have been investigated.

iii) Case Studies of Pollution Events

Most case studies report the impact of organic pollution from continuous discharges of effluent, with the description of the consequences for the biota confined to spatial patterns (Hynes, 1960). Due to the pulsed and unpredictable nature of episodic organic pollution events, there are few case studies reporting their impact. Unless there is continuous chemical monitoring, peaks of pollutants are often missed (Rueda *et al.*, 2002). Whilst peaks of organic pollution from agriculture can occur as a consequence of routine daily activity, such as cleaning of dairy parlours, they often occur as a consequence of rainfall events flushing organic matter from impermeable yard surfaces and land that has received slurry applications (NRA, 1992). The difficulties of accurate quantification of the chemical consequences of pulsed pollution events are compounded by a frequent lack of biological information from both before and after an event. As a consequence it is rarely possible to draw accurate conclusions from case studies (Rueda *et al.*, 2002).

iv) Correlation

Wide applicability across river types can be achieved using correlation techniques, to assess relationships between large scale biological and chemical sampling data. Here data on the occurrence of biota and the environmental conditions of those sites are analysed together. Whilst any analyses are constrained by the quality of the data, and pulsed pollution events are unlikely to be sampled, by using a large number of samples the likelihood of an accurate description of the sensitivity of biota to organic pollution can be increased. Two approaches are possible:

i) Correlation or regression techniques, which provide a description of the conditions where taxa occur. Taxa occurrence can be related to the extent of pollution at the sites where they occur. However, as the measures of pollution are absolute, taxa restricted to certain river types where organic pollution is limited will appear to occur over a limited range of organic pollution.

ii) Use of weighted averaging techniques where the influence of the pollution insensitive characteristics of the site are partialled (i.e. their influence removed) leaving only the effect of the pollution. Here the occurrences of taxa are ranked according to the relative level of organic pollution across all river types in the analysis.

As well as being influenced by the quality of the data, these techniques are influenced by the frequency of occurrence of the taxa within the data set used. Confidence in the predicted range of conditions that a taxon can tolerate increases with the frequency of that taxon within the data set. This is particularly true when min/max values of determinands are derived using these techniques; it is not possible to tell if an infrequently occurring taxon cannot tolerate a wider range of conditions or just was not observed. Weighted averaging techniques are less sensitive to the frequency of a taxon within the data, as the calculated ecological amplitude (range of conditions covering 95% of occurrence) is influenced by the number of observations; taxa that occur less frequently will have wider ecological amplitudes.

The use of weighted averaging techniques removes many complications which confound techniques based on regression/correlation, namely that certain taxa may be insensitive to organic pollution relative to co-occurring species but appear sensitive as they tend to occur in rarely polluted river types. However, the use of any technique that relies on field derived data is inherently problematic. Field sites vary in many different ways which influence the biological community and may or may not have been quantified. These factors have not been controlled and often co-vary, and whilst they can be included as covariables if measured, they inherently introduce noise into the data set. As such care must be taken when selecting sites and environmental variables to be included in any analysis, and interpretation of the results should be cautious as any analyses based on correlation and do not necessarily reflect cause and effect. Further noise is introduced into field data by the landscape context of sites. The occurrence of a taxon at any site is influenced not only by local conditions, but by the relationship with associated populations (i.e. the meta-population context). The occurrence of a taxon will differ among sites dependent upon how well connected the site is with sources of potential colonists; of specific issue here, recovery from a pollution event will be more rapid if there is an unaffected population upstream than if there is not.

2.5 Quantitative Evidence of Response of Biota to Organic Pollution

Fish

Fish are particularly prone to the toxic effects of unionised ammonia and of oxygen stress and have been the subject of many standard laboratory tests. Most of these tests involve the generation of so-called LC_{50} values, defined as the concentration at which 50% of exposed individuals die within a defined period (normally 48 to 96 hours). It is not within the remit of this project to detail LC_{50} values for all determinands associated with organic pollution for all fish species although a few pertinent values are presented in Table 2. Values are available for many species from Fish Base (http://www.fishbase.org/Topic/List.cfm) and Pesticide Info (http://www.pesticideinfo.org/List).

Table 2a. Unionised ammonia LC_{50} values for select fish species.

	Species	mg l^{-1}	Time
Salmon	*Salmo salar*	0.12 – 0.29	24 hr
Roach	*Rutilus rutilus*	0.310	96 hr
Carp	*Cyprinus carpio* Fry	0.44	96 hr
Rainbow Trout	*Onchorhynchus mykiss*	0.61	96 hr
Carp	*Cyprinus carpio* Embryos	0.66	96 hr
Stickleback	*Gasterosteus aculeatus*	1.4 – 3.35	96 hr

b. Time to induce a behavioural response to stated concentration of unionised ammonia for select fish species.

	Species	Time	mg l^{-1}
Brook trout	*Salvelinus fontinalis*	4.83 hr	0.4
Ide	*Leuciscus idus*	2.4 hr	1.2
Brook trout	*Salvelinus fontinalis*	0.83 hr	2.5
Chub	*Leuciscus cephalus*	immediate	44.0

Due to the large size of individuals, experiments with fish have to be conducted in large experimental channels to be informative, and even these are often not at a scale that can allow expression of behavioural or population level responses. An alternative approach has been the use of caged fish placed into sites of known pollution. Brown *et al*. (1970) used this technique together with analysis of the data of Herbert *et al.* (1965), to assess the effect of pollution in four rivers (Don, Erewash, Tees and Billingham Beck) on rainbow trout, brown trout, roach, and dace, and concluded that the toxic effect of exposure in situ was considerably greater than predicted from laboratory derived LC_{50} data (using the method of Brown (1968) assuming an additive effect of common pollutants): in freshwater in situ 48 hr median lethal concentrations, of clean-water dilutions of the polluted fresh waters were between 0.6-0.7 that predicted from laboratory derived LC_{50} values and in saline waters 0.3-0.4. The conclusions may reflect the presence of toxins not accounted for in estimation of LC_{50} values or synergistic effects among the pollutants experienced by the fish (Lloyd, 1987). Dace were the most tolerant, followed by roach and then trout. Alabaster *et al*. (1972) extended this approach by comparing chemical condition (but not oxygen) against fish survey data and similarly found toxic effects in situ to be greater than expected from laboratory derived LC_{50} values (median concentrations to produce an estimated 50% mortality were 0.1 laboratory derived LC_{50} values for game fish and 0.2 laboratory derived LC_{50} values for coarse fish). Similar studies on the Willow Brook by Solbe (1973) found considerable day-to-day fluctuations of predicted toxic concentrations, and suggested that the fish may be able to survive short tem exposure to potentially lethal concentrations. Nevertheless, the site showing the highest median and 95% predicted toxicity (0.45 and 2.35 of laboratory derived 48hr LC_{50} for Rainbow trout respectively) was fishless. A good mixed fishery was maintained downstream at a site with median and 95% predicted toxicity of 0.17 and 0.62 respectively. Sticklebacks were the most tolerant of the species present, followed by roach, tench and gudgeon which persisted at a median toxicity of 0.34, then dace, chub and minnow, and finally rainbow trout which were not found at a median toxicity above 0.17.

Using caged fish in experimentally simulated pollution events in rivers, Turner (1992) assessed the sensitivity of fish to oxygen depletion and ammonia addition (Table 3).

Table 3. Ranked sensitivity of fish species to simulated pollution based on mortality of caged individuals (after Turner 1992).

5 mg l^{-1} Unionised Ammonia	1 mg l^{-1} Oxygen
0+ *Salmo trutta*	0+ *Salmo trutta*
0+ *Salmo salar*	0+ *Salmo salar*
Phoxinus phoxinus	*Cottus gobio*
Noemacheilus barbatulus	*Noemacheilus barbatulus*
Cottus gobio	
Gasterosteus aculeatus	

In a case study of anglers' catches in the river Trent over the period 1969-1984, Cowx and Broughton (1986) identified a change in dominance from roach and dace, to bream, chub, perch and eels, and suggested that changes in water quality were largely responsible: BOD, suspended solids and ammonia had declined over the period.

A study correlating chemical and physical conditions with fish survey data was conducted by Mainstone and Gulson (1990), concluded that together with habitat descriptors, variables associated with organic pollution (suspended solids, ammonia, dissolved oxygen and nitrate) were variously negatively associated with trout, salmon, pike, chub, dace, roach and gudgeon biomass. Toxicity scores, based on LC_{50} values for roach and rainbow trout, also explained some of the variance in trout, pike and gudgeon. These correlative techniques suggest that salmonid fish are more sensitive to the elevated ammonia concentrations and oxygen depletion associated with organic pollution than cyprinid fish, supporting the findings of ecotoxicological studies.

Invertebrates

Both unionised ammonia and oxygen stress can cause death of invertebrates, though LC_{50} values appear to indicate that many species are less sensitive to ammonia than fish (Table 4).

Table 4. Results from toxicity tests of unionised ammonia (as mg l^{-1} NH_3) for invertebrate species. Test response either LC_{50} values or minimum concentration to produce response.

Species	Family	Test response	mg l^{-1}	Time
Polycelis tenuis	Planariidae	LC_{50}	0.58	96 h
Polycelis tenuis	Planaridae	LC_{50}	0.71	96 h
Limnodrilus hoffmeisteri	Oligochaeta	LC_{50}	1.58	96 h
Limnodrilus hoffmeisteri	Oligochaeta	LC_{50}	1.92	96 h
Lumbriculus variegatus	Oligochaeta	LC_{50}	302	96 h
Lymnaea stagnalis	Lymnaeidae	LC_{50}	0.82	96 h
Physa fontinalis	Physidae	LC_{50}	1.4	96 h
Physa fontinalis	Physidae	LC_{50}	1.7	96 h
Asellus aquaticus	Asellidae	LC_{50}	1.9	96 h
Asellus aquaticus	Asellidae	LC_{50}	2.3	96 h
Gammarus pulex	Gammaridae	LC_{50}	1.69	96 h
Gammarus duebeni celticus	Gammaridae	LC_{50}	1.155	96 h
Gammarus pulex	Gammaridae	LC_{50}	1.544	96 h
Gammarus pulex	Gammaridae	LC_{50}	2.05	96 h
Grandidierella japonica	Aoridae (Amphipoda)	LC_{50}	154.7	96 h
Hyalella azteca	Hyalelliidae (Amphipoda)	LC_{50}	126	96 h
Pacifastacus leniusculus	Astacidae	LC_{50}	0.255	24 h
Artemia sp.	Artemidae	LC_{50}	399.1	96 h
Artemia sp.	Artemidae	LC_{50}	600.5	96 h
Baetis rhodani	Beatidae	LC_{50}	1.4	96 h
Baetis rhodani	Beatidae	LC_{50}	1.7	96 h
Stenacron interpunctatum	Heptageniidae	Zero	*0.03*	96 h
Acroneuria lycorias	Perlidae	Zero	*0.02*	96 h
Enallagma sp.	Coenagridae	LC_{50}	1.52	96 h
Calopteryx maculata	Calopterygidae	Zero	*0.03*	96 h
Stenelmis sexlineata	Elmidae	LC_{50}	6.59	96 h
Hydropsyche angustipennis	Hydropsychidae	LC_{50}	2.43	96 h
Hydropsyche angustipennis	Hydropsychidae	LC_{50}	2.95	96 h
Ceratopsyche slossonae	Hydropsychidae	Zero	*0.02*	96 h
Brachycentrus occidentalis	Brachycentridae	Zero	*0.03*	96 h
Chimarra aterrima	Philopotamidae	Zero	*0.03*	96 h
Pycnopsyche guttifer	Limnephilidae	Zero	*0.02*	96 h
Chironomus tentans	Chironomidae	LC_{50}	564	96 h
Chironomus tentans	Chironomidae	LC_{50}	430	96 h
Chironomus tentans	Chironomidae	Zero	*67.6*	10 d
Chironomus thummi	Chironomidae	LC_{50}	1.36	96 h
Chironomus riparius	Chironomidae	LC_{50}	1.65	96 h
Brachionus plicatilis	Rotifera	LC_{50}	569.4	96 h
Brachionus rubens	Rotifera	LC_{50}	3.21	24 h
Ceriodaphnia reticulata	Cladocera	LC_{50}	2.71	48 h
Daphnia magna	Cladocera	LC_{50}	4.18	48 h
Daphnia magna	Cladocera	LC_{50}	25.4	48 h
Moina rectirostris	Cladocera	LC_{50}	1.61	24 h
Simocephalus vetulus	Cladocera	LC_{50}	8.18	24 h
Nitocra spinipes	Copepoda	LC_{50}	57	96 h

Table 5. Results from toxicity tests of oxygen for invertebrate species. Test response time to 50% mortality (Davies, 1971).

Species	Family	Test response	mg O_2 l^{-1}	Time
Rhyacophila dorsalis	Rhyacophilidae	LT_{50}	1.0	20 min
Hydropsyche augustipennis	Hydropsychidae	LT_{50}	1.0	96 min
Gammarus pulex	Gammaridae	LT_{50}	1.0	2.25 hrs

Table 6. Minimum dissolved oxygen concentration survived by stream invertebrates for 12 hours (Surber & Bessy, 1974).

Species	Common name	Family	O_2 ppm
Sphaerium striatinum	Bivalve	Sphaeriidae	0.5
Goniobasis livescens	Snail	Pleuroceridae	0.5
Lirceus fontinalis	Isopod	Asellidae	1.5
Crangonyx setodactylus	Amphipod	Gammaridae	0.8
Gammarus fasciatus	Amphipod	Gammaridae	1.0
Cambarus ortmanni	Crayfish	Cambarinae	0.6
Orconectes rusticus	Crayfish	Cambarinae	1.0
Isonychia bicolour	Mayfly	Baetidae	3.0
Leptophlebia sp.	Mayfly	Leptophlebidae	1.2
Stenonema tripunctatum	Mayfly	Heptageniidae	2.0
Senonema heterotarsale	Mayfly	Heptageniidae	1.0
Stenonema vicarium	Mayfly	Heptageniidae	2.0
Stenonema areas	Mayfly	Heptageniidae	1.0
Stenonema femoratum	Mayfly	Heptageniidae	2.4
Heptagenia flavescens	Mayfly	Heptageniidae	2.5
Heptagenia maculipennis	Mayfly	Heptageniidae	2.0
Ephoron leukon	Mayfly	Ephemeridae	1.0
Hexagenia limbata	Mayfly	Ephemeridae	0.5
Acroneuria lycorias	Stonefly	Perlidae	1.4
Neoperla clymene	Stonefly	Perlidae	2.5
Phasganophora capitata	Stonefly	Perlidae	1.8
Psephenus herricki	Water Penny	Psphenidae	0.5
Corydalis cornutus	Hellgrammite	Corydalidae	1.0
Sialis sp.	Alderfly	Sialididae	0.3
Agrion maculatum	Damselfly	Agrionidae	1.6
Argia moesta	Damselfly	Coenagrionidae	1.6
Boyeria vinosa	Dragonfly	Aeschidae	2.5
Plathemis Lydia	Dragonfly	Aeschidae	2.5
Hydropsyche slossonae	Caddisfly	Hydropsychidae	3.5
Tipula sp.	Cranefly	Tipulidae	3.5

Dependent upon the river type and the focus organism group the results from large scale field experiments can be markedly different. In an experiment using artificial channels, diluted sewage effluent (0%, 25% and 50% sewage effluent) had no impact upon the mollusc *Lymnaea pergera* but did cause significant mortality of *Potamopyrgus antipodarium* (Watton & Hawkes, 1984). A similar result was found in ditch communities when rotting plant and algal organic matter were added experimentally (Daldorph & Thomas, 1991); pulmonate snail communities showed no significant change.

In contrast the experimental manipulations conducted by Turner and colleagues (Edwards *et al.*, 1991; McCahon *et al.*, 1991; Turner, 1992) indicated profound effects due to oxygen depletion. Low oxygen concentrations induced behavioural avoidance, i.e. increased drift (Tables 7 & 9), and death (Table 8). The impacts were more obvious in summer than in winter (Table 9). Unionised ammonia had less of an impact on invertebrates, both in terms of behavioural response and mortality, than oxygen depletion: Significant invertebrate mortalities were recorded only under conditions of reduced dissolved oxygen. (Table 7).

In common with other studies on the effects of low dissolved oxygen concentrations on freshwater invertebrates, the stonefly (*Dinocras cephalotes*) and mayfly (*E. danica*) were the most sensitive animals tested by McCahon et al. (1991). Surber and Bessey (1974) found the minimum dissolved oxygen concentrations for Plecoptera to survive for 12 hrs to be 1.9 mg O_2 l^{-1}, for Baetidae 2.1 mg O_2 l^{-1} and Heptageniidae 1.9 mg O_2 l^{-1}. Surber and Bessey (Table 6) reported the minimum dissolved oxygen concentration required by Amphipoda and Isopoda to survive for a 12 hour period to be 0.9 and 1.5 mg O_2 l^{-1} respectively, whilst Davies (1971) recorded 50% mortality of *G. pulex* at 1 mg O_2 l^{-1} in 2.25 hrs. However, neither *G. pulex* nor *A. aquaticus* suffered significant mortality in field tests of simulated pollution events at these concentrations (Turner, 1992); perhaps the lower water temperatures in these field experiments increased the ability of the animals to withstand low dissolved oxygen concentrations. Similarly, in field trials of simulated pollution events (Turner 1992), *Rhyacophila dorsalis* and *Hydropsyche augustipennis* did not suffer mortality after 6 hrs of 1.0 mg O_2 l^{-1} despite laboratory tests indicating 50% mortality of these species after 20 and 96 minutes respectively (Table 5). In another field trial where unionised ammonia concentrations were manipulated in rivers (Turner 1992), despite far exceeding LC_{50} values (Table 4) there were no effects on invertebrates (Tables 7 & 8).

Table 7 Ranked sensitivity of invertebrate species to simulated pollution based on increased drift of individuals (Turner, 1992). Also shown are the LC_{50} (or lowest effect concentration, in italics) from Table 4 and minimum dissolved oxygen concentration survived for 12 hours as derived by Surber & Bessy (1974) see Table 6, for species of the same family or order (in parentheses).

	Ranked sensitivity to 5 mg l^{-1} unionised ammonia (as NH_3)	LC_{50} NH_3 (mg l^{-1} NH_3)	Ranked sensitivity to 1 mg l^{-1} oxygen	Min O_2 survival (Surber & Bessey 1974)
Ephemerella ignita	No effect	(1.4)	1	(0.5-3.0)
Ecdyonurus venosus	No effect	*0.03*	1	2.5-1.0
Rhithrogena semicolorata	No effect	*0.03*	1	2.5-1.0
Beatis rhodani	No effect	1.4	1	3.0
Isoperla grammatica	No effect	*0.02*	1	(1.8-2.5)
Gammarus pulex	No effect	1.5-1.7	2	0.8-1.0
Ephemera danica	No effect	(1.4)	2	0.5-1.0
Limnius volkmari	No effect	6.59	2	
Simulidae	No effect		2	
Chironomidae	No effect	1.36-564	2	(3.5)

Table 8. Ranked sensitivity of invertebrate species in field trials of simulated pollution (Turner 1992) based on mortality of caged individuals (no effect on species in square brackets). Also shown are the LC_{50} (or lowest effect concentration, in italics) from Table 4 and minimum dissolved oxygen concentration survived for 12 hours as derived by Surber & Bessy (1974) see Table 6, for species of the same family or order (in parentheses).

	Ranked sensitivity to 5 mg l^{-1} unionised ammonia (as NH_3)	LC_{50} NH_3 (mg l^{-1} NH_3)	Ranked sensitivity to 1 mg l^{-1} oxygen	Min O_2 survival (Surber & Bessey 1974)
Dinocras cephalotes	No effect	*0.02*	1	(1.8-2.5)
Ephemera danica	No effect	(1.4)	2	0.5-1.0
Rhyacophila dorsalis	No effect	(2.43)	3	(3.5)
[*Gammarus pulex*]	No effect	1.5-1.7	No effect	0.8-1.0
[*Asellus aquaticus*]	No effect	1.9	No effect	1.5
[*Chironomus riparius*]	No effect	1.36-564	No effect	(3.5)

Table 9. Minimum oxygen concentrations to induce a significant increase in drift in July and November, and the magnitude of the response to decreased oxygen (density of peak drift *cf.* background), assessed through a stepped decrease in the oxygen concentration of a stream (Turner, 1992). Also shown are the minimum dissolved oxygen concentration survived for 12 hours for species of the same family or order (in parentheses) as derived by Surber & Bessy (1974).

		Min O_2 survival (Surber & Bessey 1974)	O_2 conc to induce drift July (mg l^{-1})	Magnitude of response July	O_2 conc to induce drift November (mg l^{-1})	Magnitude of response November
TOTAL DRIFT			4	25	6	4
P. tennuis	Planaridae		-		-	
G. pulex	Gammaridae	0.8-1.0	2	202	4	8
I. grammatica	Perlodidae	(1.8-2.5)	2	105	6	40
P. microcephala	Perlodidae	(1.8-2.5)	-		-	
P. meyeri	Nemouridae	(1.8-2.5)	-		6	40
B. rhodani	Beatidae	3.0	4	42	6	12
E. venosus	Heptageniidae	2.5-1.0	4	40	4	87
R. semicolorata	Heptageniidae	2.5-1.0	4	160	4	88
E. ignata	Ephemerellidae	(0.5-3.0)	4	97	-	
E. danica	Ephemeridae	0.5-1.0	1	29	1	57
H. augustispennis	Hydropsychidae	3.5	4	110	4	30
R. dorsalis	Rhyacophilidae	(3.5)	4	130	4	23
Limnophilus	Limnophilidae	(3.5)	-		2	22
Limoniinae			2	100	-	
E. aenea	Elmidae	(0.5)	2	15	2	28
L. volckmari	Elimidae	(0.5)	2	52	-	
Oreodytes spp.	Dytiscidae		4	40	-	
D. puberula	Dixidae	(3.5)	6	12	-	
Chironomidae		(3.5)	2	80	6	6
Simuliidae			2	15	2	8
Hydracarina			2	33	2	15

In a case study of organic pollution from farm waste Veerasingham and Crane (1992) recorded significantly fewer Leuctridae, Rhyacophilidae, Limmephilidae, *Limnius volckmari, Elmis aenaea, Potamopyrgus jenkinsi* and *G. pulex* in the contaminated Clarbeston Stream than the uncontaminated Deepford Brook. Sub-lethal effects on the amphipod Gammarus pulex were recorded also; the feeding rate of caged *G. pulex* was reduced. There was no significant reduction in either macroinvertebrate abundance or *G. pulex* feeding rate below the confluence of the contaminated and uncontaminated streams.

Davies and Hawkes (1981) found a shift in the invertebrate community of the river Cole from one dominated by *Erpobdella octoculatla*, *G. pulex, B. rhodani* and *H. augustipennis* with *Glossiphonia complanata, A. aquaticus*, and *Nemoura cinerea* to one dominated by Tubificidae with Enchytraeidae at the point that sewage effluent entered (stream concentrations: mean BOD 20.6 mg l^{-1}, range 6.8-46.8 mg l^{-1}; mean unionised ammonia 7.1 mg l^{-1} NH_3, range 2.6-16.2 mg l^{-1}).

The downstream re-occurrence of taxa followed the order *Erpobdella testacea, A. aquaticus* (mean BOD 12.0 mg l^{-1}, range 3.7-54.0 mg l^{-1}; mean unionised ammonia 5.2 mg l^{-1} NH_3, range 2.0-10.6 mg l^{-1}), *Helobdella stagnalis, Erpobdella octoculata* (mean BOD 11.9 mg l^{-1}, range 3.7-38.0 mg l^{-1}; mean unionised ammonia 3.7mg l^{-1} NH_3, range 2.0-6.4 mg l^{-1}), and *G.*

pulex (mean BOD 7.75 mg l^{-1}, range 2.6-27.4mg l^{-1}, mean unionised ammonia 3.2 mg l^{-1} NH_3, range 1.2-6.0 mg l^{-1}). *Chironomus riparius and Polypedilum arundineti* were the most tolerant chironomid species, peaking in abundance near the sewage outfall. *Paratrichocladius rufiventris, Brillia longifurca, Eukiefferiella claripennis* and *Conchapelopia melanops* had distinct distributions peaking further downstream where the water quality had improved.

Tolerances of invertebrate families to certain determinands associated with organic pollution have been described using correlative techniques (Walley & Hawkes, 1996) as part of a project to modify BMWP scores (Wally & Trigg, 1997). The chemical conditions at sites matched to data from the 1990 river quality survey of England and Wales were used to describe the tolerance limits of families by their occurrence at sites (see http://www.soc.staffs.ac.uk/research/groups/cies2). The mean of conditions across all sites where the taxon occurred are of limited use in understanding the impact of pollution on the taxon, as they are heavily influenced by the total range of conditions under which the taxon occurs. Median values are less sensitive, but still influenced by total range. A taxon such as the family chironomidae that occurs under all conditions, polluted and not polluted, will have a mean condition reflecting moderate pollution, similar to a taxon that only occurs under conditions of moderate pollution.

The tolerance to ammonia, BOD, and dissolved oxygen depletion, determined as the maximum or minimum conditions under which the taxon was found in the database used by Walley and Hawkes (1996), are listed in Tables 10 and 11. There appears to be a poor correlation between laboratory toxicity tests and the tolerance of conditions in the field for both ammonia (Table 10) and dissolved oxygen (Table 11), and there appears to be an order of magnitude difference between field based measures of free ammonia and laboratory based LC_{50} tests. This would compare with experiments with fish, where toxicities of river water were 0.1 – 0.7 those determined by laboratory trials (Herbert *et al.*, 1965; Alabaster *et al.*, 1972; Solbe, 1973). Laboratory derived lowest observed effect (mortality) concentrations of free ammonia were more in line with field derived tolerance, but there appeared to be little discrimination between low and high ranked taxa for this laboratory derived measure. Nevertheless, the rank order of tolerance to BOD, ammonia and dissolved oxygen does appear to be largely in line with what would be expected from perceived tolerance of organic pollution (BMWP).

In order to compare the field derived tolerances to BMWP (and Modified BMWP), the difference was calculated between the BMWP score and a rank score based on tolerance distributed in the same classes as BMWP (calculated as the mean rank for all 5 determinands, BOD, unionised ammonia, total ammonia, dissolved oxygen saturation, dissolved oxygen concentration); see Table 12. As it was expected that the tolerance of infrequent taxa (within the dataset) would be poorly estimated (i.e. it is not possible to tell if a taxon could not persist under a wider range of conditions or just wasn't found there), the relationship between frequency (N obs) and the difference between rank score and BMWP, and Modified BMWP was investigated (Figure 1a and b). This indicated either that the tolerance limits of families that occurred infrequently in the data (N<1000) were overly prescriptive (indicated by a large positive difference between rank score and BMWP) e.g. Hirudididae (N = 20), Dryopidae (N = 26), Naucoridae (N = 52), Nepidae (N = 41), or that certain taxa are considerably more sensitive to organic pollution than was previously thought. Certain other taxa appear to be more tolerant of organic pollution than their BMWP would suggest (N > 1000, large negative difference) e.g. Leptophlebiidae, Leptoceridae, Heptageniidae, Sericostomatidae, Ephemeridae. Field conditions where invertebrate taxa were recorded in North America are included for comparison (Table 13). As well as an influence of the frequency of occurrence of taxa, there may be some influence of matching of biological and chemical data in the results of Walley and Hawkes (1996). Although considerable effort was put into matching biological and chemical sampling sites, the two datasets were not necessarily collected from the same sites and any differences in the conditions could lead to anomalies in the description of tolerance.

Figure 1. Relationship between frequency of occurrence and a) difference between rank score based on tolerance of NH_3, DO and BOD as determined by occurrence within the EA 1995 river survey data by Staffordshire University and BMWP, b) difference between rank score based on tolerance of NH_3, DO and BOD as determined by occurrence within the EA 1995 river survey data by Staffordshire University and Modified BMWP, c) difference between BMWP and Modified BMWP.

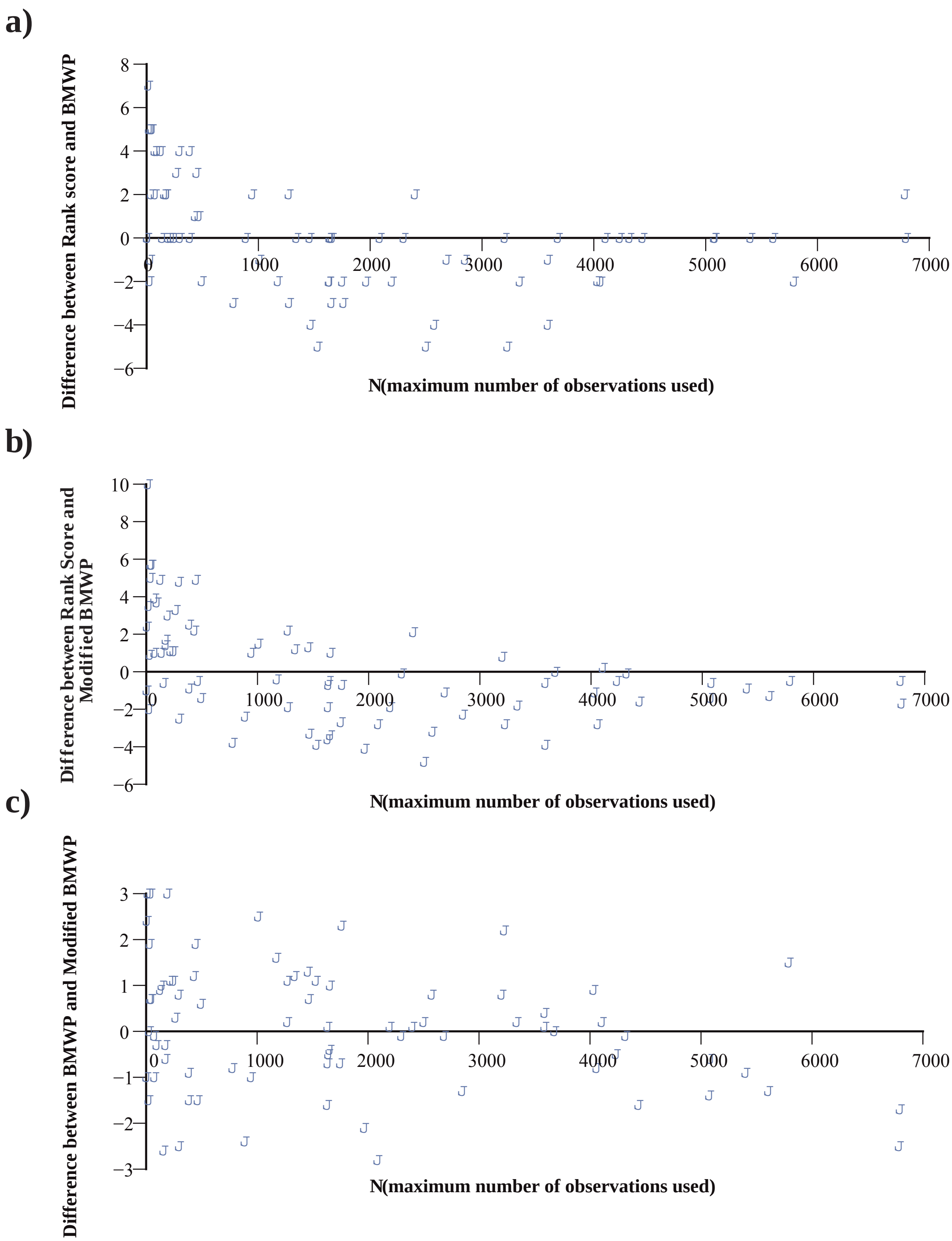


Table 10. Invertebrate families ranked by maximum tolerance of BOD and ammonia (unionised and total) as determined by occurrence within the EA 1990 river survey data by Staffordshire University. Also results of toxicity tests LC_{50} and lowest effect conc. (italic) for unionised ammonia (Table 4).

BOD (mg l^{-1})			Unionised ammonia (mg l^{-1} NH_3)				Total ammonia (mg l^{-1})		
Rank		Tolerance	Rank		Tolerance	Toxicity	Rank		Tolerance
1	Potamanthidae	2.37	1	Naucoridae	0.0065		1	Potamanthidae	0.053
2	Dryopidae	2.7	2	Philopotamidae	0.0086	*0.03*	2	Dryopidae	0.31
3	Siphlonuridae	3	3	Dryopidae	0.009		3	Capniidae	0.4
4	Perlidae	4.4	4	Capniidae	0.01		4	Siphlonuridae	0.47
5	Viviparidae	4.7	5	Corophiidae	0.011		5	Aphelocheiridae	0.48
6	Libellulidae	5.73	6	Aphelocheiridae	0.012		6	Corophiidae	0.51
7	Molannidae	5.75	7	Chloroperlidae	0.013		7	Perlidae	0.52
8	Astacidae	6.13	7	Cordulegasteridae	0.013		8	Naucoridae	0.62
9	Neritidae	6.15	7	Taeniopterygidae	0.013		8	Neritidae	0.62
10	Naucoridae	6.33	10	Neritidae	0.014		10	Platycnemidae	0.67
11	Corophiidae	6.8	11	Astacidae	0.015	0.255	11	Molannidae	0.79
12	Aphelocheiridae	6.83	12	Phryganeidae	0.016		12	Astacidae	0.98
12	Gerridae	6.83	13	Odontoceridae	0.017		13	Taeniopterygidae	1.46
12	Platycnemidae	6.83	13	Perlidae	0.017	*0.02*	14	Libellulidae	1.54
15	Capniidae	7	15	Beraeidae	0.02		15	Unionidae	1.69
15	Cordulegasteridae	7	15	Molannidae	0.02		16	Beraeidae	1.76
17	Unionidae	7.33	15	Platycnemidae	0.02		17	Phryganeidae	1.97
18	Hydrometridae	7.47	15	Unionidae	0.02		18	Aeshnidae	2.75
19	Dendrocoelidae	7.5	19	Nepidae	0.022		18	Notonectidae	2.75
20	Nepidae	8.03	20	Aeshnidae	0.025		20	Psychomyiidae	3.41
21	Beraeidae	8.25	21	Libellulidae	0.027		21	Philopotamidae	3.48
22	Calopterygidae	8.28	22	Brachycentridae	0.03	*0.03*	22	Valvatidae	3.83
23	Chloroperlidae	9.47	22	Goeridae	0.03		23	Scirtidae	4.31
23	Goeridae	9.47	22	Notonectidae	0.03		24	Nepidae	4.33
23	Lepidostomatidae	9.47	22	Rhyacophilidae	0.03		25	Coenagriidae	5.97
23	Odontoceridae	9.47	26	Dendrocoelidae	0.033		26	Piscicolidae	6.03
23	Philopotamidae	9.47	27	Ephemeridae	0.036		27	Dendrocoelidae	6.76
28	Brachycentridae	10.5	27	Gerridae	0.036		28	Hydrometridae	7.85
28	Hydroptilidae	10.5	27	Leuctridae	0.036		29	Haliplidae	9.69
28	Psychomyiidae	10.5	27	Caenidae	0.037		30	Ephemerellidae	11.68
28	Taeniopterygidae	10.5	27	Ephemerellidae	0.037		31	Erpobdellidae	15.2
32	Phryganeidae	11.65	27	Perlodidae	0.037		32	Brachycentridae	25.14
33	Elmidae	12.53	33	Piscicolidae	0.04		32	Hydroptilidae	25.14
33	Ephemerellidae	12.53	34	Psychomyiidae	0.047		32	Limnephilidae	25.14
33	Ephemeridae	12.53	35	Lepidostomatidae	0.05		32	Odontoceridae	25.14
33	Gyrinidae	12.53	36	Leptoceridae	0.078		36	Ancylidae	30.67
33	Heptageniidae	12.53	37	Hydrometridae	0.097		36	Baetidae	30.67
33	Leuctridae	12.53	38	Calopterygidae	0.098	*0.03*	36	Caenidae	30.67
33	Nemouridae	12.53	38	Coenagriidae	0.098	1.52	36	Calopterygidae	30.67
33	Perlodidae	12.53	40	Ancylidae	0.1		36	Chloroperlidae	30.67
33	Rhyacophilidae	12.53	40	Heptageniidae	0.1	*0.03*	36	Cordulegasteridae	30.67
33	Scirtidae	12.53	40	Hydropsychidae	0.1	2.95	36	Elmidae	30.67
33	Sericostomatidae	12.53	40	Hydroptilidae	0.1		36	Ephemeridae	30.67
44	Polycentropidae	15.18	40	Leptophlebiidae	0.1		36	Gammaridae	30.67
45	Hirudididae	17.5	40	Nemouridae	0.1		36	Gerridae	30.67
45	Simuliidae	17.5	40	Polycentropidae	0.1		36	Goeridae	30.67
47	Aeshnidae	17.9	40	Sericostomatidae	0.1		36	Gyrinidae	30.67
47	Caenidae	17.9	48	Elmidae	0.11	6.59	36	Heptageniidae	30.67
47	Leptoceridae	17.9	48	Tipulidae	0.11		36	Hydrobiidae	30.67
47	Leptophlebiidae	17.9	50	Corixidae	0.12		36	Hydrophilidae	30.67
47	Notonectidae	17.9	50	Gyrinidae	0.12		36	Hydropsychidae	30.67
47	Piscicolidae	17.9	50	Haliplidae	0.12		36	Lepidostomatidae	30.67
53	Hydropsychidae	18.5	50	Planariidae	0.12	0.71	36	Leptoceridae	30.67
54	Ancylidae	18.9	50	Simuliidae	0.12		36	Leptophlebiidae	30.67
54	Limnephilidae	18.9	51	Glossiphonidae	0.15		36	Leuctridae	30.67
54	Planariidae	18.9	52	Baetidae	0.16	1.7	36	Nemouridae	30.67
54	Valvatidae	18.9	52	Gammaridae	0.16	2.05	36	Perlodidae	30.67
58	Coenagriidae	21.13	52	Hydrophilidae	0.16		36	Planariidae	30.67
59	Baetidae	23.63	52	Sphaeriidae	0.16		36	Planorbiidae	30.67
59	Corixidae	23.63	60	Valvatidae	0.17		36	Polycentropidae	30.67
59	Dytiscidae	23.63	61	Erpobdellidae	0.18		36	Rhyacophilidae	30.67
59	Gammaridae	23.63	61	Hydrobiidae	0.18		36	Sericostomatidae	30.67
59	Glossiphonidae	23.63	61	Planorbiidae	0.18		36	Sialidae	30.67
59	Haliplidae	23.63	64	Chironomidae	0.5	1.65	36	Sphaeriidae	30.67
59	Hydrophilidae	23.63	64	Dytiscidae	0.5		36	Tipulidae	30.67
59	Planorbiidae	23.63	64	Limnephilidae	0.5	*0.02*	66	Corixidae	32.33
59	Sialidae	23.63	64	Sialidae	0.5			Asellidae	Not determined
68	Asellidae	41.7		Asellidae	Not determined	2.3		Chironomidae	Not determined
68	Chironomidae	41.7		Hirudididae	Not determined			Dytiscidae	Not determined
68	Erpobdellidae	41.7		Lymnaeidae	Not determined	0.82		Glossiphonidae	Not determined
68	Hydrobiidae	41.7		Oligochaeta	Not determined	1.92		Hirudididae	Not determined
68	Lymnaeidae	41.7		Physidae	Not determined	1.4		Lymnaeidae	Not determined
68	Oligochaeta	41.7		Potamanthidae	Not determined			Oligochaeta	Not determined
68	Physidae	41.7		Scirtidae	Not determined			Physidae	Not determined
68	Sphaeriidae	41.7		Siphlonuridae	Not determined			Simuliidae	Not determined
68	Tipulidae	41.7		Viviparidae	Not determined			Viviparidae	Not determined

Table 11. Invertebrate families ranked by minimum tolerance of Dissolved Oxygen (% saturation and concentration) from occurrence within the EA 1990 river survey data by Staffordshire University (Walley & Hawkes 1996), and minimum DO concentration survived for 12 hours for family or order (in parentheses) as derived by Surber & Bessy (1974).

Oxygen % Saturation			Dissolved Oxygen (mg l^{-1})			
Rank		Tolerance	Rank		Tolerance	Min O_2 survival
1	Potamanthidae	93.3	1	Siphlonuridae	10.1	
2	Siphlonuridae	79.1	2	Potamanthidae	9.35	
3	Philopotamidae	78.3	3	Philopotamidae	8.5	
4	Corophiidae	74	4	Hirudididae	7.72	
4	Astacidae	74	5	Beraeidae	7.67	
6	Hirudididae	71	6	Viviparidae	7.25	
7	Aphelocheiridae	69.5	7	Corophiidae	7	
8	Neritidae	67	7	Astacidae	7	(0.6-1.0)
9	Platycnemidae	63.03	9	Perlidae	6.95	1.4-2.5
10	Beraeidae	60.33	10	Odontoceridae	6.74	
11	Molannidae	57	11	Cordulegasteridae	6.55	
12	Perlidae	55.55	12	Neritidae	6.3	
13	Cordulegasteridae	54	12	Aphelocheiridae	6.3	
14	Dryopidae	52	14	Nepidae	6.16	
15	Unionidae	51.9	15	Naucoridae	6.05	
16	Perlodidae	50.12	16	Platycnemidae	6	
16	Odontoceridae	50.12	17	Brachycentridae	5.95	
16	Leuctridae	50.12	18	Perlodidae	5.9	
16	Lepidostomatidae	50.12	18	Leuctridae	5.9	
16	Goeridae	50.12	18	Dryopidae	5.9	(0.5)
16	Chloroperlidae	50.12	18	Chloroperlidae	5.9	
16	Brachycentridae	50.12	22	Molannidae	5.8	
23	Viviparidae	49.17	23	Unionidae	5.7	
24	Sericostomatidae	48.5	24	Sericostomatidae	5.35	
25	Phryganeidae	44.77	24	Goeridae	5.35	
26	Gerridae	44.6	26	Scirtidae	5.02	
27	Nepidae	43.83	27	Phryganeidae	4.5	
28	Naucoridae	40.7	27	Ephemeridae	4.5	0.5-1.0
28	Aeshnidae	40.7	27	Ephemerellidae	4.5	
30	Hydrometridae	39.13	30	Lepidostomatidae	4.35	
31	Libellulidae	38.83	30	Hydrometridae	4.35	
32	Calopterygidae	38.75	32	Leptoceridae	4.3	
33	Dendrocoelidae	36.83	32	Gerridae	4.3	
34	Hydroptilidae	35.55	32	Dendrocoelidae	4.3	
35	Ephemeridae	34.9	32	Caenidae	4.3	
35	Ephemerellidae	34.9	32	Aeshnidae	4.3	2.5
37	Gyrinidae	32.25	37	Notonectidae	3.9	
38	Piscicolidae	31.75	37	Libellulidae	3.9	0.8
38	Leptoceridae	31.75	37	Coenagriidae	3.9	1.6
38	Caenidae	31.75	40	Calopterygidae	3.6	
41	Notonectidae	31.13	41	Gyrinidae	3.45	
41	Corixidae	31.13	42	Piscicolidae	3.35	
43	Haliplidae	30.97	42	Hydroptilidae	3.35	
43	Coenagriidae	30.97	44	Lymnaeidae	3.15	
45	Sialidae	24	44	Hydrophilidae	3.15	
45	Planorbiidae	24	44	Haliplidae	3.15	
47	Taeniopterygidae	20.35	44	Corixidae	3.15	
47	Rhyacophilidae	20.35	48	Dytiscidae	2.88	
47	Polycentropidae	20.35	49	Tipulidae	2.58	3.5
47	Planariidae	20.35	49	Taeniopterygidae	2.58	
47	Nemouridae	20.35	49	Rhyacophilidae	2.58	
47	Leptophlebiidae	20.35	49	Polycentropidae	2.58	
47	Heptageniidae	20.35	49	Planariidae	2.58	
47	Capniidae	20.35	49	Nemouridae	2.58	
55	Scirtidae	15	49	Leptophlebiidae	2.58	1.2
55	Tipulidae	15	49	Heptageniidae	2.58	1-2.5
55	Lymnaeidae	15	49	Capniidae	2.58	
55	Hydrophilidae	15	58	Sialidae	2.5	0.3
55	Hydrobiidae	15	58	Planorbiidae	2.5	
55	Dytiscidae	15	58	Hydrobiidae	2.5	(0.5)
61	Valvatidae	6.5	61	Valvatidae	0.8	
61	Sphaeriidae	6.5	61	Sphaeriidae	0.8	0.5
61	Simuliidae	6.5	61	Simuliidae	0.8	
61	Psychomyiidae	6.5	61	Psychomyiidae	0.8	
61	Physidae	6.5	61	Physidae	0.8	
61	Oligochaeta	6.5	61	Oligochaeta	0.8	
61	Limnephilidae	6.5	61	Limnephilidae	0.8	
61	Hydropsychidae	6.5	61	Hydropsychidae	0.8	3.5
61	Glossiphonidae	6.5	61	Glossiphonidae	0.8	
61	Gammaridae	6.5	61	Gammaridae	0.8	0.8-1.0
61	Erpobdellidae	6.5	61	Erpobdellidae	0.8	
61	Elmidae	6.5	61	Elmidae	0.8	(0.5)
61	Chironomidae	6.5	61	Chironomidae	0.8	
61	Baetidae	6.5	61	Baetidae	0.8	3.0
61	Asellidae	6.5	61	Ancylidae	0.8	
61	Ancylidae	6.5	76	Asellidae	0.5	1.5

Table 12. Invertebrate families by mean rank tolerance of BOD and ammonia and frequency of occurrence (N obs) in the EA 1995 river survey data. Ranks are scored in classes of the same size and numbering as the BMWP system and the difference with BMWP and Modified BMWP calculated.

	Mean Rank	Rank score	BMWP score	BMWP Difference	Modified BMWP	Mod BMWP Difference	N obs
Potamanthidae	1.3	10	10	0	7.6	2.4	11
Siphlonuridae	2.5	10	10	0	11	-1	8
Corophiidae	6.6	10	6	4	6.1	3.9	77
Dryopidae	7.8	10	5	5	6.5	3.5	26
Aphelocheiridae	8.4	10	10	0	8.9	1.1	223
Astacidae	8.4	10	8	2	9	1	79
Perlidae	9.0	10	10	0	12.5	-2.5	302
Neritidae	9.4	10	6	4	7.5	2.5	391
Philopotamidae	10.4	10	8	2	10.6	-0.6	161
Viviparidae	11.3	10	6	4	6.3	3.7	99
Naucoridae	12.4	10	5	5	4.3	5.7	52
Platycnemidae	12.4	10	6	4	5.1	4.9	132
Molannidae	13.2	10	10	0	8.9	1.1	250
Beraeidae	13.4	10	10	0	9	1	144
Cordulegasteridae	16.4	10	8	2	8.6	1.4	180
Unionidae	17.0	10	6	4	5.2	4.8	299
Hirudididae	18.3	10	3	7	0	10	20
Odontoceridae	18.8	10	10	0	10.9	-0.9	392
Chloroperlidae	20.0	10	10	0	12.4	-2.4	893
Nepidae	20.8	10	5	5	4.3	5.7	41
Libellulidae	21.8	10	8	2	5	5	44
Phryganeidae	22.6	10	10	0	7	3	197
Brachycentridae	23.0	8	10	-2	9.4	-1.4	499
Capniidae	23.6	8	10	-2	10	-2	31
Goeridae	24.2	8	10	-2	9.9	-1.9	1639
Leuctridae	26.0	8	10	-2	9.9	-1.9	2199
Perlodidae	26.0	8	10	-2	10.7	-2.7	1754
Gerridae	26.6	8	5	3	4.7	3.3	270
Dendrocoelidae	27.4	8	5	3	3.1	4.9	452
Lepidostomatidae	28.0	7	10	-3	10.4	-3.4	1658
Hydrometridae	28.6	7	5	2	5.3	1.7	179
Taeniopterygidae	28.8	7	10	-3	10.8	-3.8	783
Aeshnidae	29.0	7	8	-1	6.1	0.9	37
Ephemerellidae	30.4	7	10	-3	7.7	-0.7	1766
Sericostomatidae	31.4	6	10	-4	9.2	-3.2	2578
Ephemeridae	31.6	6	10	-4	9.3	-3.3	1472
Notonectidae	33.0	6	5	1	3.8	2.2	437
Calopterygidae	33.6	6	8	-2	6.4	-0.4	1179
Scirtidae	34.3	6	5	1	6.5	-0.5	470
Hydroptilidae	35.2	6	6	0	6.7	-0.7	1641
Caenidae	36.0	6	7	-1	7.1	-1.1	2689
Piscicolidae	37.2	6	4	2	5	1	950
Rhyacophilidae	37.4	6	7	-1	8.3	-2.3	2853
Leptoceridae	37.8	5	10	-5	7.8	-2.8	3231
Gyrinidae	39.4	5	5	0	7.8	-2.8	2090
Coenagriidae	40.2	5	6	-1	3.5	1.5	1015
Psychomyiidae	40.8	5	8	-3	6.9	-1.9	1280
Heptageniidae	41.0	5	10	-5	9.8	-4.8	2504
Nemouridae	41.0	5	7	-2	9.1	-4.1	1969
Polycentropidae	43.2	5	7	-2	8.6	-3.6	1635
Leptophlebiidae	43.8	5	10	-5	8.9	-3.9	1535
Haliplidae	45.0	5	5	0	4	1	1662
Planariidae	47.2	5	5	0	4.2	0.8	3208
Elmidae	47.8	5	5	0	6.4	-1.4	5079
Hydrophilidae	49.2	5	5	0	5.1	-0.1	2304
Hydropsychidae	50.2	5	5	0	6.6	-1.6	4441
Ancylidae	50.4	5	6	-1	5.6	-0.6	3595
Tipulidae	51.2	5	5	0	5.5	-0.5	4238
Valvatidae	51.6	5	3	2	2.8	2.2	1277
Planorbiidae	51.8	5	3	2	2.9	2.1	2405
Corixidae	52.0	5	5	0	3.7	1.3	1463
Sialidae	52.4	4	4	0	4.5	-0.5	1646
Baetidae	53.8	4	4	0	5.3	-1.3	5610
Gammaridae	53.8	4	6	-2	4.5	-0.5	5795
Simuliidae	54.3	3	5	-2	5.8	-2.8	4064
Limnephilidae	54.4	3	7	-4	6.9	-3.9	3594
Hydrobiidae	55.6	3	3	0	3.9	-0.9	5406

Sphaeriidae	55.6	3	3	0	3.6	-0.6	5087
Lymnaeidae	55.7	3	3	0	3	0	3684
Erpobdellidae	56.4	3	3	0	2.8	0.2	4111
Dytiscidae	56.5	3	5	-2	4.8	-1.8	3343
Glossiphoniidae	58.0	3	3	0	3.1	-0.1	4323
Oligochaeta	63.3	3	1	2	3.5	-0.5	6788
Physidae	63.3	3	3	0	1.8	1.2	1344
Chironomidae	63.5	2	2	0	3.7	-1.7	6797
Asellidae	68.3	1	3	-2	2.1	-1.1	4036

Table 13. Dissolved oxygen, unionised ammonia and BOD conditions under which insect taxa were recorded as present in North America (after Roback, 1974). The number and frequency of samples used to determine these values is not known.

Family	Genus	Dissolved Oxygen (ppm)	Unionised ammonia (NH_3 ppm)	BOD (ppm)
Odonata				
Calopterygidae	*Calopteryx*	4-12		0.1-7.9
Lestidae		4-6		0.6-4.0
Coenagrionidae	*Agria*	5-12		0.1-7.9
	Enallagama	4-12		0.1-6.0
	Ischnura	1-12		0.4-29.0
Protoneuridae		6-7		
Corulegasteridae	*Cordulegaster*	7-9		0.2-2.2
Gomphidae	*Gomphus*	4-12		0.1-6.0
Aeshnidae		4-12		0.2-6.7
Macromiidae		5-10		1.4-6.3
Corduliidae		4-11		0.1-6.0
Libellulidae	*Libellula*	4-12		0.3-6.7
	Sympetrum	4-6		0.6-3.9
Ephemeroptera				
Siphlonuridae		4-14	0.01-0.97	0.6-6.0
Oligoneuridae		3-14	0.01-5.00	0.4-6.0
Baetidae	*Beatis*	4-14	0.01-5.00	0.3-15.4
	Cloeon	7	0.97	
Leptophlebiidae	*Leptophlebia*	7-10	0.02-0.85	0.8-1.1
	Paraleptophlebia	3-11	0.08-0.97	0.8-2.5
Ephemerellidae	*Ephemerella*	6-12	0.01-0.97	0.5-3.8
Caenidae	*Caenis*	2-14	0.01-0.34	0.4-7.5
	Brachycerus	6-12	0.01-1.10	0.6-3.8
Ephemeridae		5-14	0.01-1.10	2.0-4.1
Plecoptera				
Pteronarcidae		5-14	0.04-0.97	0.6-2.1
Nemouridae	*Nemoura*	8-11	0.02-0.09	0.8-1.1
Capniidae		9-11	0.02-0.16	0.8-2.5
Taeniopterygidae	*Taeniopteryx*	10-11	0.01-0.05	0.8-1.1
Perlodidae	*Isoperla*	8	0.09	0.8
Perlidae		5-14	0.01-13.40	0.6-6.0
Isoperlidaea	*Isoperla*	7-11	0.01-0.16	0.8-1.0
Hemiptera				
Corixidae		5-14	0.01-2.5	0.2-6.0
Notonectidae	*Notonecta*	3-10	0.01-0.64	0.4-2.4
Pleidae		2-5	0.02-0.15	2.0-4.8
Nepidae		2-14	0.01-2.50	0.6-6.0
Nacoridae		2-10	0.01-0.15	1.8-4.8
Gerridae	*Gerris*	4-12	0.01-13.40	0.6-4.4
Veliidae		3-10	0.08-13.40	0.4-1.8
Neuroptera				
Sisyridae		5-9	0.02-0.97	0.6-2.8
Megaloptera				

Corydalidae		3-14	0.01-1.10	0.2-5.5
Sialidae	*Sialis*	5-14	0.02-1.09	0.2-6.0
Coleoptera				
Haliplidae		2-14	0.01-0.17	0.4-4.8
Dytiscidae		3-14	0.01-13.40	0.2-4.1
Noteridae		5-6	0.01	
Gyrinidae		2-14	0.01-13.40	0.3-6.0
Hydrophilidae		2-14	0.01-13.40	0.2-5.5
Dryopidae		5-14	0.01-5.80	0.5-6.0
Psephenidae		5-14	0.01-5.80	0.5-6.0
Elmidae		3-14	0.01-5.00	0.3-6.0
Chrysomelidae		7-8	0.09-0.97	0.8
Curculoionidae		9	0.01	1.8
Trichoptera				
Glossosmatidae	*Agapetus*	8	0.09	0.8
Philopotamidae		6-14	0.01-5.00	0.6-6.0
Psychomyiidae		3-14	0.01-5.00	0.3-3.5
Hydroptilidae		5-12	0.01-0.15	0.7-2.8
Phryganeidae		8-10	0.08-1.18	0.4-1.8
Limnephilidae		8-14	0.01-1.09	0.3-1.6
Molannidae	*Molana*	8-11	0.03-0.21	0.7-1.6
Hydropsychidae	*Hydropsyche*	6-14	0.01-5.80	0.2-6.0
Odontoceridae		8-11	0.09-0.17	0.8-1.6
Leptoceridae		5-14	0.01-5.80	0.6-4.8
Lepidostomatidae	*Lepidostoma*	8-10	0.01-0.09	0.6-1.1
Brachycentridae	*Brachycentrus*	4-15	0.01-0.64	0.6-0.9
Diptera				
Tipulidae		8-11	0.02-0.35	0.2-4.4
Psychodidae	*Psychoda*	4	0.1	2.2
Chaobridae	*Chaoborus*	5-8	0.10-0.85	2.5-2.8
Tanypodinae		3-14	0.01-1.10	0.5-5.3
Diamesinae		7-9	0.05-0.16	0.8-4.0
Orthocladiinae		3-14	0.01-13.4	0.6-4.1
Chironomiinae		2-14	0.01-6.13	0.3-15.4
Ceratopogonidae		2-14	0.01-1.10	0.4-4.8
Stratiomyidae		8-10	0.10-0.21	1.1-1.8
Rhagionidae		8-9	0.01-5.00	0.6-2.8
Tabanidae		5-11	0.01-0.17	0.8-2.8
Syrphidae	*Tubifera*	<1-9	0.05-6.13	1.1-15.4

Comparison of Evidence for Invertebrates

Ammonia

Field based evidence from simulated pollution events appears to indicate that invertebrates are able to persist at ammonia concentration far in excess of those defined by laboratory derived LC_{50} tests. The simulated pollution events of Turner (1992) increased unionised ammonia concentrations to 3.25 times the 96hr LC_{50} for *G.pulex* and 7 times that for *P. tenuis* without inducing mortality of caged individuals or increasing drift. The induced ammonia concentrations far exceeded the LC_{50} and minimum effect concentrations for many taxa without causing any effects: There were only two taxa, Elimdae and Chironomidae, where drift and mortality of caged individuals would not have been predicted from the LC_{50}.

In marked contrast the results of Walley & Hawkes (1996) appear to indicate far higher ammonia "toxicities" in the field (not true toxicities but concentrations above which taxa were not found) than the laboratory. Compared to LC_{50}, the conditions under which taxa were found to persist were considerably lower, suggesting field "toxicities" of 0.11 of the unionised ammonia LC_{50} for Baetidae, 0.1 for Gammaridae, 0.06 for Coenagiidae and Astacidae, 0.04 for Hydropsychidae, and 0.02 for Elmidae and Planaridae. Whilst the lowest observed effect (mortality) concentrations derived in laboratory trials were of the same order of magnitude to field based estimated tolerance, there appeared to be little discrimination in these values between low and high ranked taxa. However, the results of Walley & Hawkes (1996) are based on correlation and cannot be used to indicate ammonia toxicity *per se*. There are many reasons why taxa may not be found at a site. In particular, the combined abiotic effects of organic pollution (increased ammonia toxicity, reduced oxygen levels, physical smothering, and enrichment) can generate an apparent heightened sensitivity to any of one of these effects when viewed in isolation.

Oxygen

Field based simulated pollution events involving oxygen depletion, on the other hand produced an effect on mortality similar to that which would have been predicted from the laboratory experiments of Surber and Bessy (1974), with1mg $O_2\ l^{-1}$ causing mortality of *Dinocras cephalotes, Ephemera danica,* and *Rhyacophila dorsalis*, but not *Asellus aquaticus* or *Gammarus pulex.*

As would be expected, behavioural responses of invertebrates occurred under less extreme conditions of oxygen than would be expected from laboratory trials based on mortality: increased drift observed by Turner (1992) occurred at dissolved oxygen concentrations that were on average 1.9 times higher in July and 2.2 times higher in November (total range 0.6-8) than the minimum oxygen concentration survived for 12 hours in laboratory trials (Surber & Bessy 1974).

The field based tolerance to dissolved oxygen does not appear to follow what would be predicted from the physiological ability to survive low oxygen concentrations (Surber & Bessy, 1974). Higher ranking families (e.g. Perlidae, Ephemeridae) appear to not be able to persist at concentration that the laboratory trials would predict. In contrast, low ranking taxa (e.g. Baetidae, Asellidae) appear to be able to persist under conditions that are predicted to induce mortality in the laboratory.

Macrophytes and Algae

Organic pollution can cause death of macrophytes and attached algae, through the toxic effects of prolonged oxygen depletion under low light/dark conditions. The increased load of suspended solids reduces light availability thus accentuating the problem under conditions of gross pollution. The substrate can also be affected, becoming loose and anoxic, and thus difficult for macrophytes to root. Benthic algae can become smothered by settling particulates also.

Macrophytes have not been the subject of ecotoxicological tests to assess LC_{50} values. Few data are available on the negative effects of organic pollution on freshwater plants (see Table 14). Typically, only the positive effects on the growth of macrophytes and algae of determinands associated with organic pollution have been assessed, such as increased nutrient availability (Bowes *et al.*, 2007).

Table 14. Impact of elevated total ammonia on aquatic macrophytes (Ramachandran, 1960; Glanzer, 1974).

Species	Effect	Time	mg l^{-1} NH_3
Potamogeton coloratus	Observed stress		19
Hydrilla verticillata	Mortality	4 h	110
Hydrilla verticillata	Disruption of Photosynthesis	18 h	9.4
Ranunculus fluitans	Observed stress		19

Macrophytes and attached algae tend to show an increase in total abundance in experimental manipulations with organic pollution, due to fertilization effects and because the experiments are rarely undertaken with organic pollution additions of a concentration that would cause negative effects. However, some experiments indicate that changes in community composition may arise as a result in changes in the competitive balance between macrophyte species (Daldorph & Thomas, 1991), and between macrophytes and attached algae. In sluggish systems the development of dense surface layers of floating plants in response to increased nutrient availability can cause loss of submerged macrophytes (Daldorph & Thomas, 1991). Competition between attached algae and macrophytes can lead to reduced densities of macrophytes and the occurrence of mats of filamentous algae. Suppression of macrophytes by attached algae under increased nutrient conditions has been shown experimentally by several authors (e.g. Jones *et al.*, 1999), but the expression of this in standing waters is dependent upon the interactions with grazing invertebrates and fish (Jones *et al.*, 2002; Jones & Sayer, 2003). In standing waters dense growth of phytoplankton develop under elevated nutrient conditions; however, phytoplankton blooms only occur in large, slow-flowing rivers (Hilton *et al.*, 2006).

The impacts of eutrophication on river macrophyte and algal communities has been dealt with in depth by Mainstone *et al.* (2000) and Hilton *et al.* (2006).

3 Analysis of Macroinvertebrate Data

This section describes data analyses undertaken in this project to characterise the biological response to the organic pollution gradient in rivers. It was concluded that the best data available for such an investigation were those on macroinvertebrates, using the extensive national database of macroinvertebrate and water quality data available to CEH.

3.1 Method

The approach was to develop a ranking of taxa based on their tolerance to organic pollution, as measured by a combination of BOD, oxygen and ammonium concentration based on partial ordination. The analysis involved a two step process. Using data from sites which were not considered to be affected by any other stresses other than organic inputs, the relationship between macroinvertebrate taxa and a number of candidate environmental variables characterising river condition and type was first established. This initial step established which environmental variables had a significant influence on the variation in macroinvertebrate data and how much variation could be described by the variables used. The environmental variables offered to the analysis included distance from source, altitude, slope, wetted width, depth, and the log(x+1) transformation of each of these. Also included were substrate phi score, zero-centred easting (x), northing (y) and their quadratic and cubic terms ($x^2, xy, y^2, x^2y, xy^2, x^3\ y^3$), and a number of variables associated with organic pollution, mean, $90^{th}/10^{th}$ percentile, and standard deviation of BOD, dissolved oxygen saturation and total ammonia. The water quality parameters included were selected on the basis of sufficient data and to describe the extent and variation of organic pollution. Variables were selected from this suite sequentially for inclusion in the model after testing the significance of their influence using Monte Carlo simulation tests.

The next step in the analysis was to remove the influence of the environmental variables describing river type, leaving only the relationship between the selected organic pollution determinands and the macroinvertebrate taxa. This was done by including those variables describing river type which had a significant influence, as covariables. The variation in macroinvertebrate taxa remaining is that which is explained by the organic pollution determinands selected.

In simple terms this analytical process is equivalent to establishing: “When all other things are equal, what is the response of macroinvertebrates to organic pollution?” The output of the analysis is a single ranking of sensitivity of taxa to organic pollution irrespective of river type. From this the response of different river types has been derived using the probability of occurrence of the taxa in that type of river. This approach was chosen, rather than analysing the response of the community for each river type, to ensure maximum data (and hence maximum confidence in the results) and based on the RIVPACS assumption that rivers represent a continuum rather than discrete types.

The analysis was undertaken with both (BMWP) family level data and species level data where available. It was decided to adopt both approaches as family level data are more extensive but may mask the response of sensitive species within families which contain more tolerant species, whereas species level data are capable of resolving the response of all taxa but the data are more sparse and any results more uncertain as a consequence.

The invertebrate data included were selected on the availability of matched chemical data, from sites not considered to be affected by any other stresses other than organic inputs, and to provide an even distribution of sites across a wide gradient of organic pollution. An uneven distribution of sites across the pollution gradient causes bias in the results: If unpolluted sites are over-represented there is an increased probability of taxa being described as having a resticted distribution simply because by chance they are more likely to occur at this end of the gradient. Although this screening procedure reduced the total amount of data used in the anlayses, it increased the likelihood of a statistically significant (and real) result being found. Inclusion of data that failed to pass the criteria would introduce confounding variables, reduce the likelihood of a statistically significant result and increases the probability of committing a type I error (accepting a difference that is not real).

The family level analysis was based upon the Environment Agency 1995 General Quality Assessment (GQA) data. A subset of 699 sites were chosen from the 1995 EA GQA matched chemistry and biology data that had 2 seasons of biological data, >29 chemistry measurements from a site <0.9km away (as the crow flies), and were not considered to be affected by any other stresses other than organic inputs.

The species level analysis was based on data from CEH holdings matched with sufficient associated chemistry from three sources, Countryside Survey 2000, 1985-86 Polluted Streams Project and the RIVPACS reference dataset (including sites that had been removed during a screening process as suffering from some organic pollution stress).

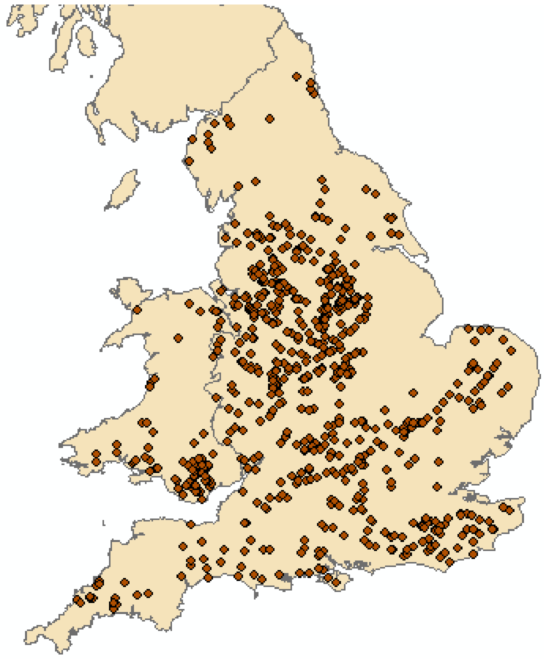
3.2 Family Level Analysis

A total of 699 sites were selected from across England and Wales to be included in the analysis (Figure 2). The data were resolved to BMWP family-level, with families included where they had more than 20 occurrences across the 699 sites; leaving 61 of the original 79 taxa in the analysis. 18 of 21 aquatic macroinvertebrate families with UK BAP Priority Species were included in the analysis. Astacidae, Potamanthidae and Aeshnidae were the only families excluded with Priority Species. Each of these three families had less than 15 occurrences across the 699 sites in the dataset. All families that had less than 15 occurrences were included in the analysis passively to indicate their tolerance relative to other taxa without influencing the analysis.

The degree of taxa turnover across the data set was assessed by Detrended Correspondence Anlysis (DCA) with rare taxa down-weighted. The length of the first gradient (axis) was 2.250; therefore a unimodal response model was used. Over shorten gradients of compositional change a linear response model is more appropriate.

Canonical Correspondence Analysis (and partial CCA) was used, with strict rules for inclusion of variables in the model: A variable had to have a $P<0.001$ after 999 permutations, to be included in the model. Additionally, in an attempt to make a simpler model, variables were not considered if a variable of the same type was already in the model, e.g. log alkalinity was excluded in alkalinity was included, x^2 if x was already included, mean BOD if 90%ile BOD was already included, etc.

Figure 2. Geographical spread of sites in England and Wales selected for partial ordination analysis.



The resulting model could account for 21.8% of the variation in macroinvertebrate community composition (see Table 15 for summary statistics), with 10th percentile dissolved oxygen saturation, log slope, log alkalinity, substrate and mean BOD accounting for 75% of the explanatory power (Figure 3). Mean BOD and 10th percentile dissolved oxygen saturation were selected as the organic pollution determinands best at describing the variation in the macroinvertebrate community (Figure 4). This does not imply that these are the drivers of change in the community, simply that they are the best statistically at describing the observed variation in the community (shown in Figure 5).

Table 15. Summary statistics for CCA relating macroinvertebrate families to selected physical, geographical and chemical environmental variables.

Axes	1	2	3	4	Total inertia
Eigenvalues :	0.120	0.056	0.022	0.019	1.153
Species-environment correlations :	0.840	0.746	0.663	0.621	
Cumulative percentage variance					
of species data :	10.4	15.3	17.2	18.8	
of species-environment relation:	47.8	70.2	78.8	86.5	
Sum of all eigenvalues					1.153
Sum of all canonical eigenvalues					0.251

Figure 3. Cumulative percantage of the species-environment relationship explained by the environmental variables in an unconstrained CCA.

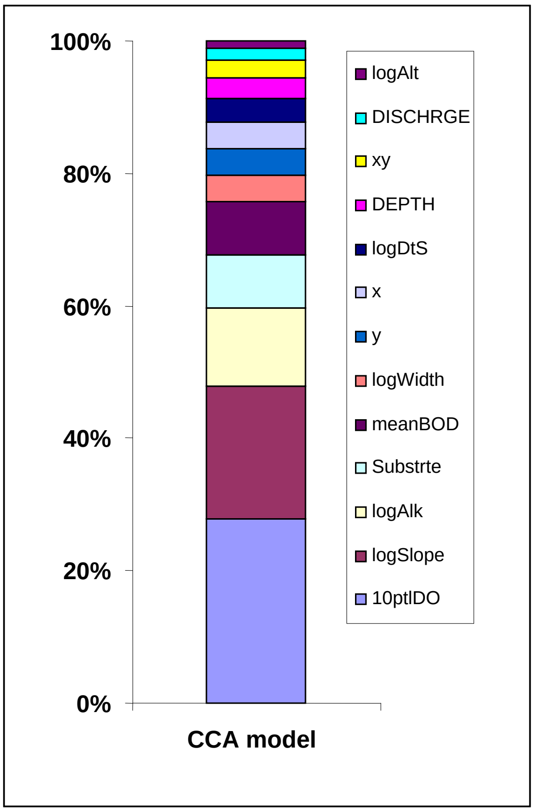


Figure 4. Ordination plot from unconstrained CCA showing relationships amongst the environmental variables used in the family level analysis.

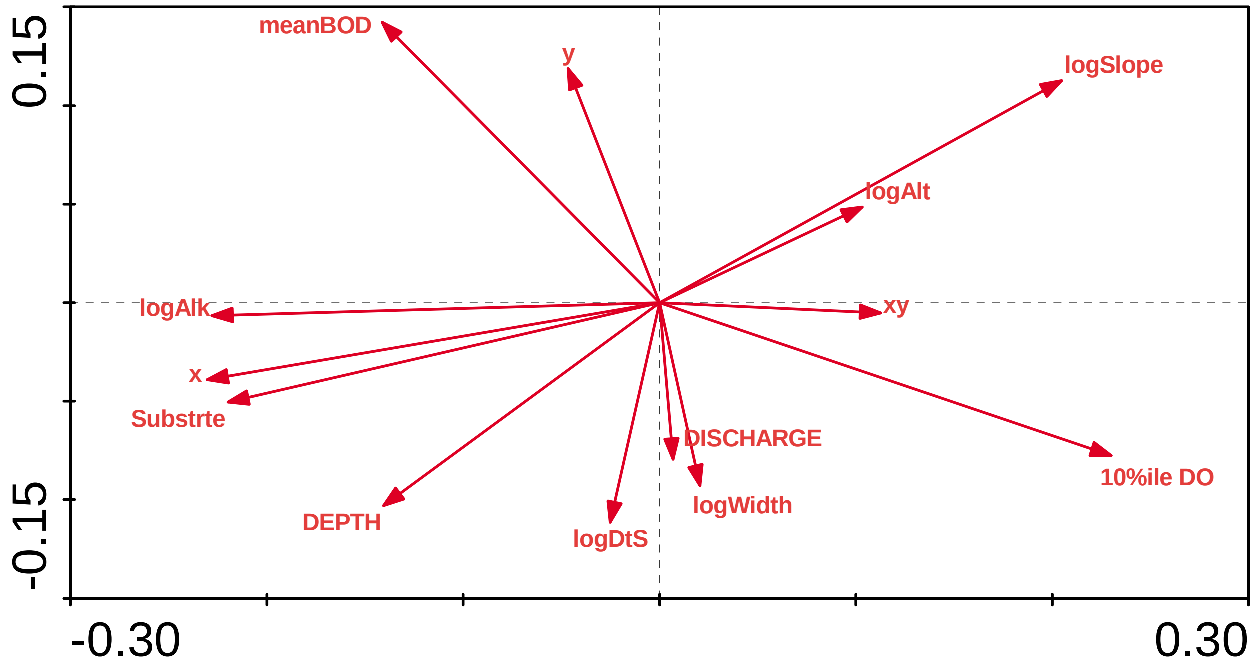
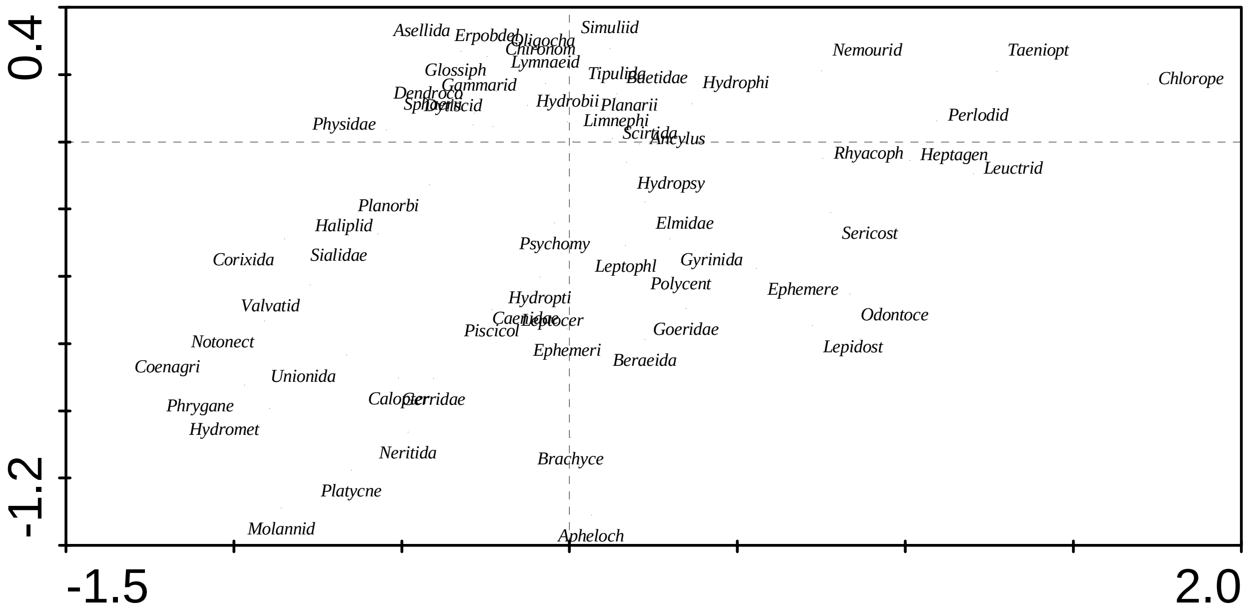


Figure 5. Ordination plot from unconstrained CCA showing distribution of macroinvertebrate invertebrate families.



The next step in the analysis was to partial out the variation in the biological data associated with the model variables that are not related to the organic pollution gradient, leaving just the variables that are of interest (i.e. 10%ileDO & mean BOD).

Table 16. Summary statistics for pCCA relating macroinvertebrate families to selected organic pollution determinands.

Axes	1	2	3	4	Total inertia
Eigenvalues :	0.036	0.003	0.071	0.053	1.153
Species-environment correlations :	0.626	0.288	0.000	0.000	
Cumulative percentage variance					
of species data :	3.9	4.2	11.8	17.4	
of species-environment relation:	91.5	100.0	0.0	0.0	
Sum of all eigenvalues					0.942
Sum of all canonical eigenvalues					0.040

The co-variables accounted for 0.211 (18.3%) of the variation in the biological data. Once this was factored out, the remaining two organic pollution variables could account for 4.25% of the residual biotic variation (see Table 16 for summary statistics), making it possible to rank taxa along the 1st-axis of the pCCA. Importantly the 1st axis was 12 times as strong and the 2nd axis and accounted for 91.5% of the explainable variation in the macroinvertebrate community. Both the 1st axis and the whole model were significant. The 1st axis was strongly correlated with both 10th percentile dissolved oxygen saturation and mean BOD (Figure 6). The 1st axis of the pCCA is a combined axis of organic pollution; the contour gradients of organic pollution determinands 10th percentile dissolved oxygen saturation and mean BOD (Figure 7) should be read in parallel, i.e for any level of mean BOD there is an overlying gradient of 10th percentile dissolved oxygen indicating increasing severity of effect towards the right, and vice versa. This combined axis is a consequence of differences in the response of rivers to organic pollution: For the same mean BOD a fast flowing, turbulent shallow river will not suffer from such severe oxygen depletion, and thus will have a higher 10th percentile dissolved oxygen saturation, as a deep slow flowing river, and vice versa. The second axis essentially contains any variation in these two parameters due to river type. The contour gradients of mean BOD and 10th percentile percentile dissolved oxygen saturation relate to the distribution of the macroinvertebrate families (Figures 8 and 9) in the same way (but note the scale difference).

The vectors of mean BOD and 10th percentile dissolved oxygen are shown on Figures 8 and 9 to aid interpretation of the relative positions of the taxa relative to variation in these two determinands. These arrows represent an increasing gradient along the arrow (including a line in the opposite direction from the intercept, which represents the average condition in the data set). The taxa can be projected onto these two vectors from their position (drawn at right angles to the vector, or a line drawn in the opposite direction from the intercept) with the proximity of the taxa to the vector indicative of how strong the relationship is with that determinand.

As neither mean BOD (summarising the extent of organic pollution) nor 10th percentile dissolved oxygen saturation (summarising the consequences of organic pollution) are deemed to be the more important, it is appropriate to use the 1st axis of the pCCA as a combined measure of organic pollution stress.

Figure 6. Relationship between 10th %ile DO and mean BOD, and the ordination axes of the partial CCA.

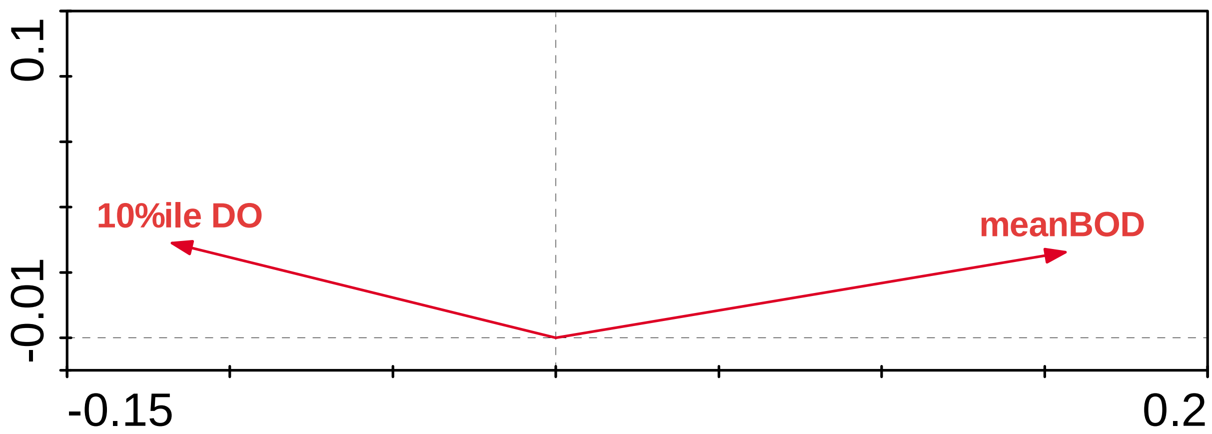


Figure 7. 10th percentile dissolved oxygen and mean BOD contour gradients through pCCA ordination space.

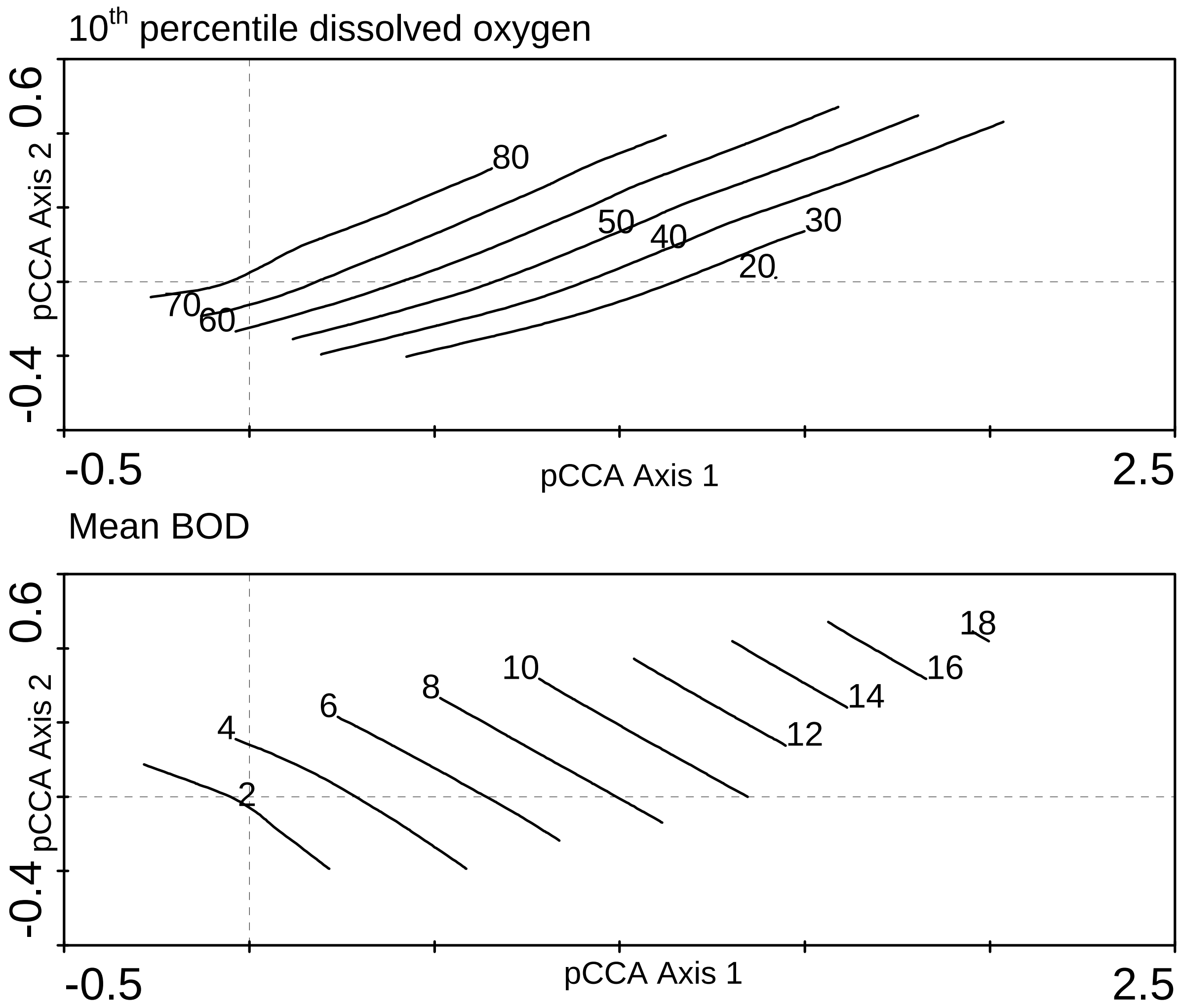


Figure 8. Ordination biplot showing the distribution of macroinvertebrate taxa in relation to the two environmental variables used in the partial CCA, 10th percentile DO and mean BOD.

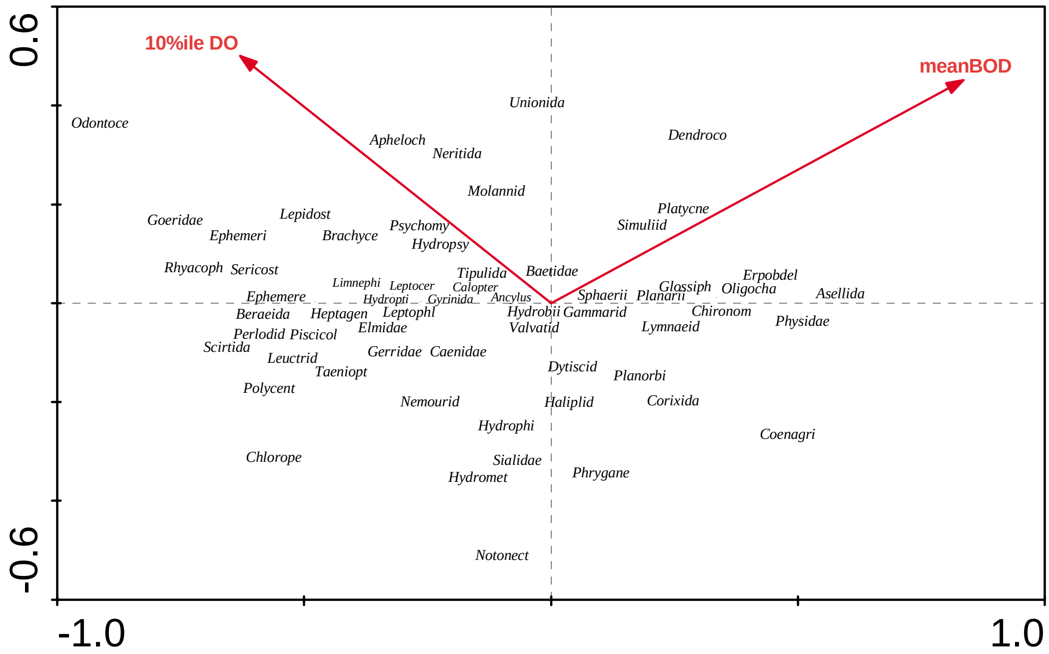


Figure 9. Ordination biplot showing the distribution of infrequent macroinvertebrate taxa passively fitted to the partial CCA using 10th percentile DO and mean BOD.

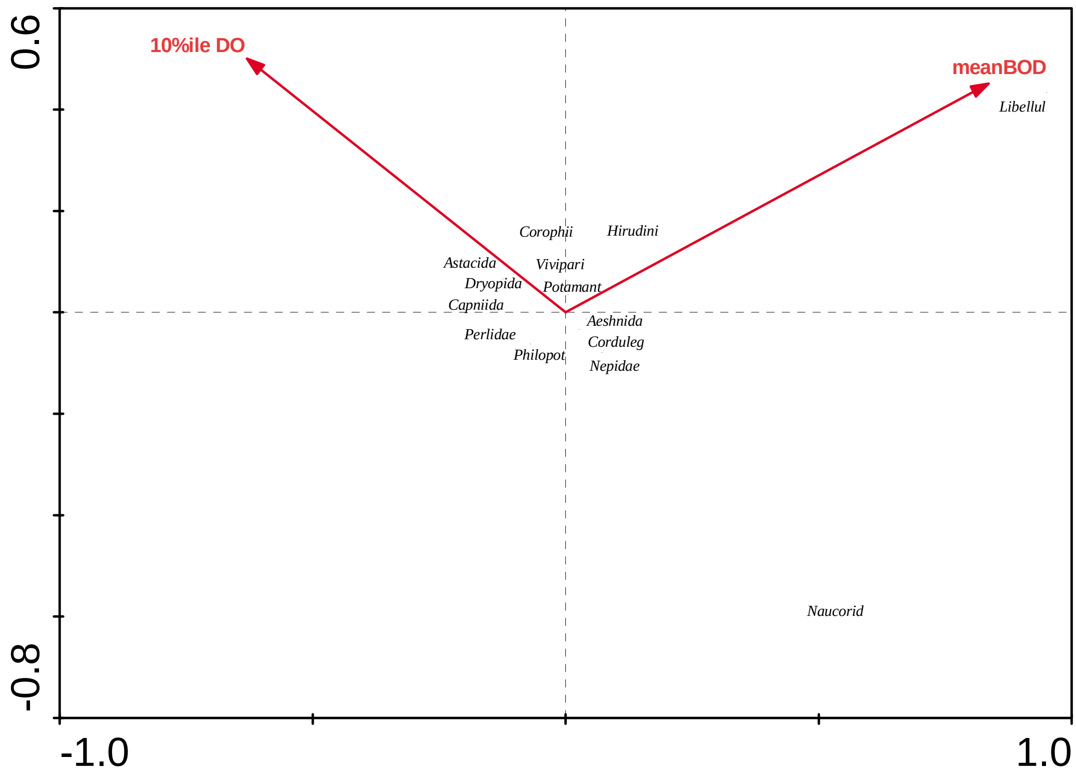
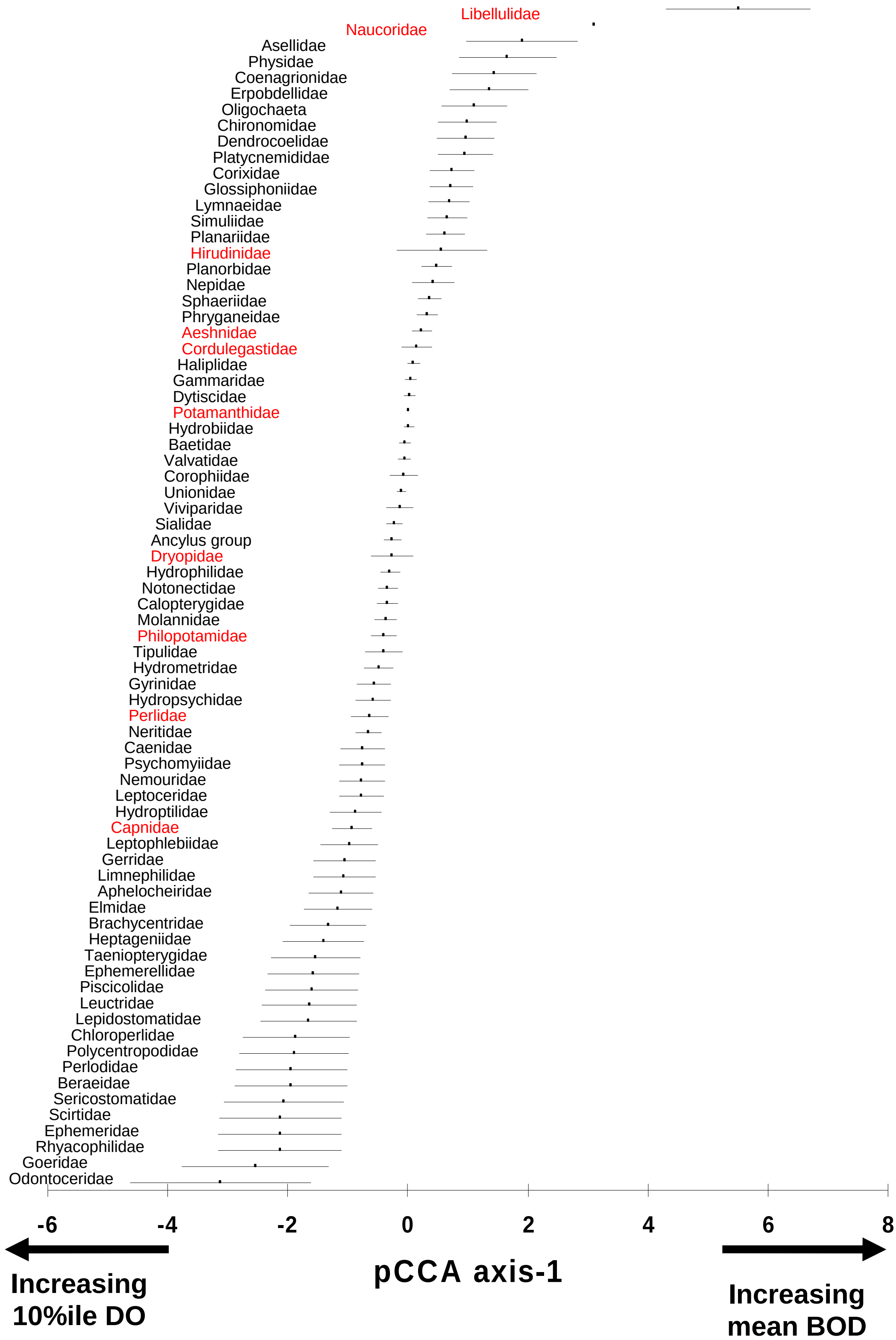


Figure 10. Optimum (point) and amplitude (line) of macroinvertebrate taxa along the first canonical axis, a summary axis of organic pollution characterised by increasing mean BOD and decreasing 10th percentile dissolved oxygen. Taxa are ranked from least sensitive to most sensitive to organic pollution (top to bottom). Infrequent taxa (fitted passively) are shown in red as there is less confidence in the description of their response.



The distribution of both the active families (i.e. the taxa that were sufficiently frequent in the data set to be used to construct the ordination; see Figure 8) and the passive families (i.e. those taxa that were infrequent in the data set, < 5% of the sites used, and whose relative position was determined without influencing the ordination; see Figure 9), for which there is less confidence in an accurate description, were described in relation to mean BOD and 10^{th} percentile dissolved oxygen saturation. The distribution of the taxa along the 1^{st} axis, a combined measure of organic pollution stress, was used to rank the taxa from most to least sensitive to organic pollution (Figure 10).

The ranking of taxa along axis 1 of the partial CCA (a combined axis of increasing severity of organic pollution) indicated that Asellidae was the macroinvertebrate taxon generally most tolerant of organic pollution (Figure 10). Physidae, Coenagrionidae, Erpobdellidae, Oligochaeta and Chironomidae were also markedly tolerant of high BOD and low oxygen conditions. At the opposite end of the gradient caddis flies (Odontoceridae, Goeridae, and Rhyacophilidae/Glossosomatidae), mayflies (Ephemeridae, Ephemerellidae), beetles (Scirtidae) and stoneflies (Perlodidae, Chloroperlidae) dominated.

It should be noted that taxa towards either extreme of the pollution gradient had increasing tolerance widths (Figure 10). This suggests that those taxa most tolerant of organic pollution are generalists, more than capable of surviving in less polluted conditions, whilst those taxa at the un-polluted end of the gradient are capable of tolerating a range of DO and BOD conditions as long as they do not exceed a certain threshold level of pollution.

By passively fitting the taxa for which there was little data (occurring in < 5% of the sites used) to the partial ordination, it was possible to tentatively determine their relative response to organic pollution, without influencing the results (Figures 9 &10). As none of these infrequent taxa appeared to be more sensitive to organic pollution than other taxa in which there was more confidence in the assessment, it can be assumed that any thresholds based on the more frequent taxa will be adequate to protect these rarer taxa.

The response (probability of occurrence) of the four taxa most tolerant of polluted conditions (Asellidae, Physidae, Coenagrionidae, Erpobdellidae; Figures 11-14) and four taxa least tolerant of polluted conditions (Odontoceridae, Goeridae, Rhyacophilidae including Glossosomatidae, Ephemeridae; Figures 15-18) to the first ordination axis, 10^{th} percentile dissolved oxygen saturation, mean BOD and 90^{th} percentile total ammonia were explored using General Additive Models (GAM).

It was noted also that there was a marked influence of organic pollution on taxon richness, with increasing pollution (corresponding to an increase in axis 1 score) resulting in a decline in taxon richness (Figures 13 and 14).

Figure 11. Probability of occurrence of Asellidae, the taxon most tolerant of organic pollution, in relation to a) axis 1 of the pCCA, a combined axis of organic pollution determinands (dotted line = 0), b) 10th percentile dissolved oxygen, c) mean BOD and d) 90th percentile total ammonium, explored using GAM.

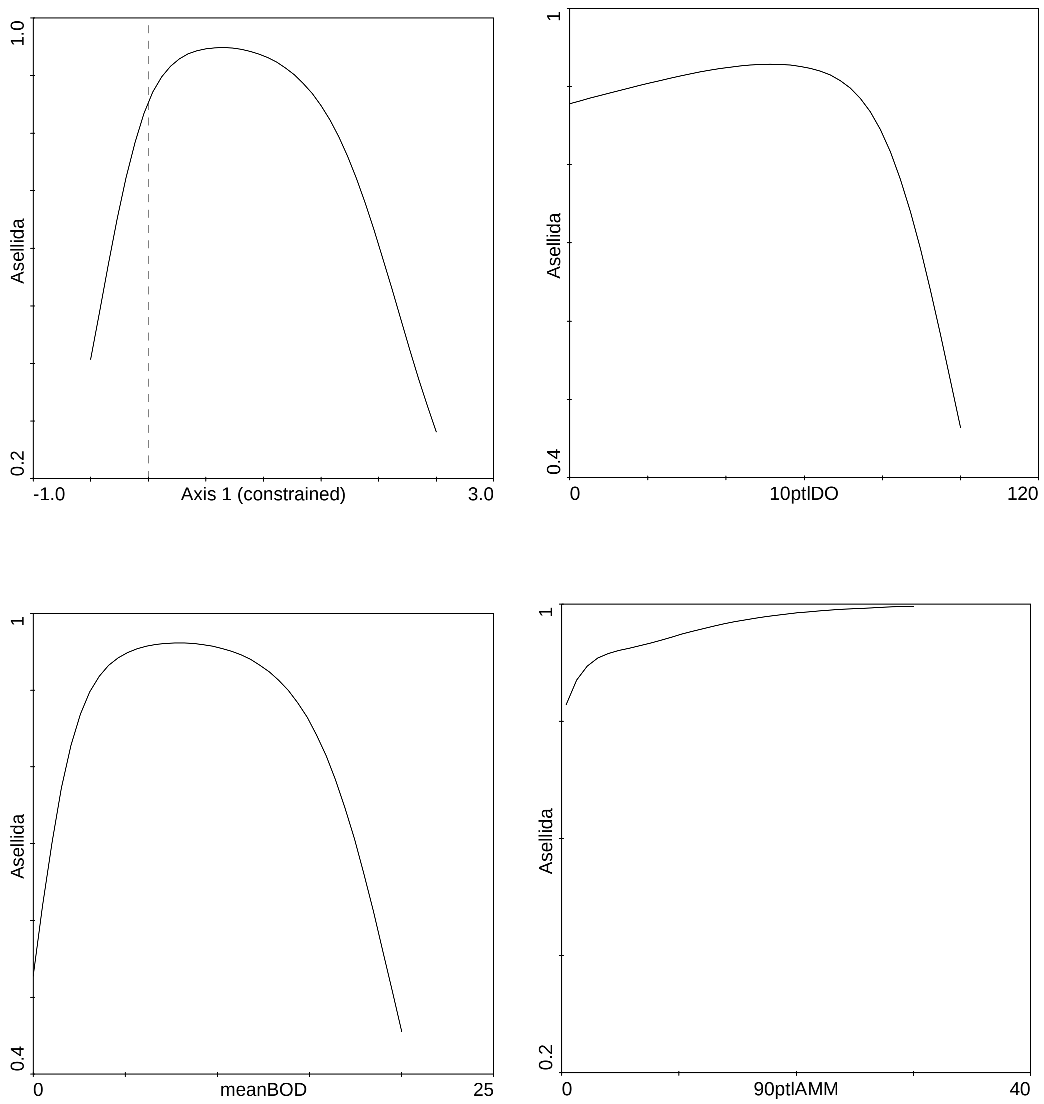


Figure 12. Probability of occurrence of Physidae, the taxon second most tolerant of organic pollution, in relation to a) axis 1 of the pCCA, a combined axis of organic pollution determinands (dotted line = 0), b) 10th percentile dissolved oxygen, c) mean BOD and d) 90th percentile total ammonium, explored using GAM.

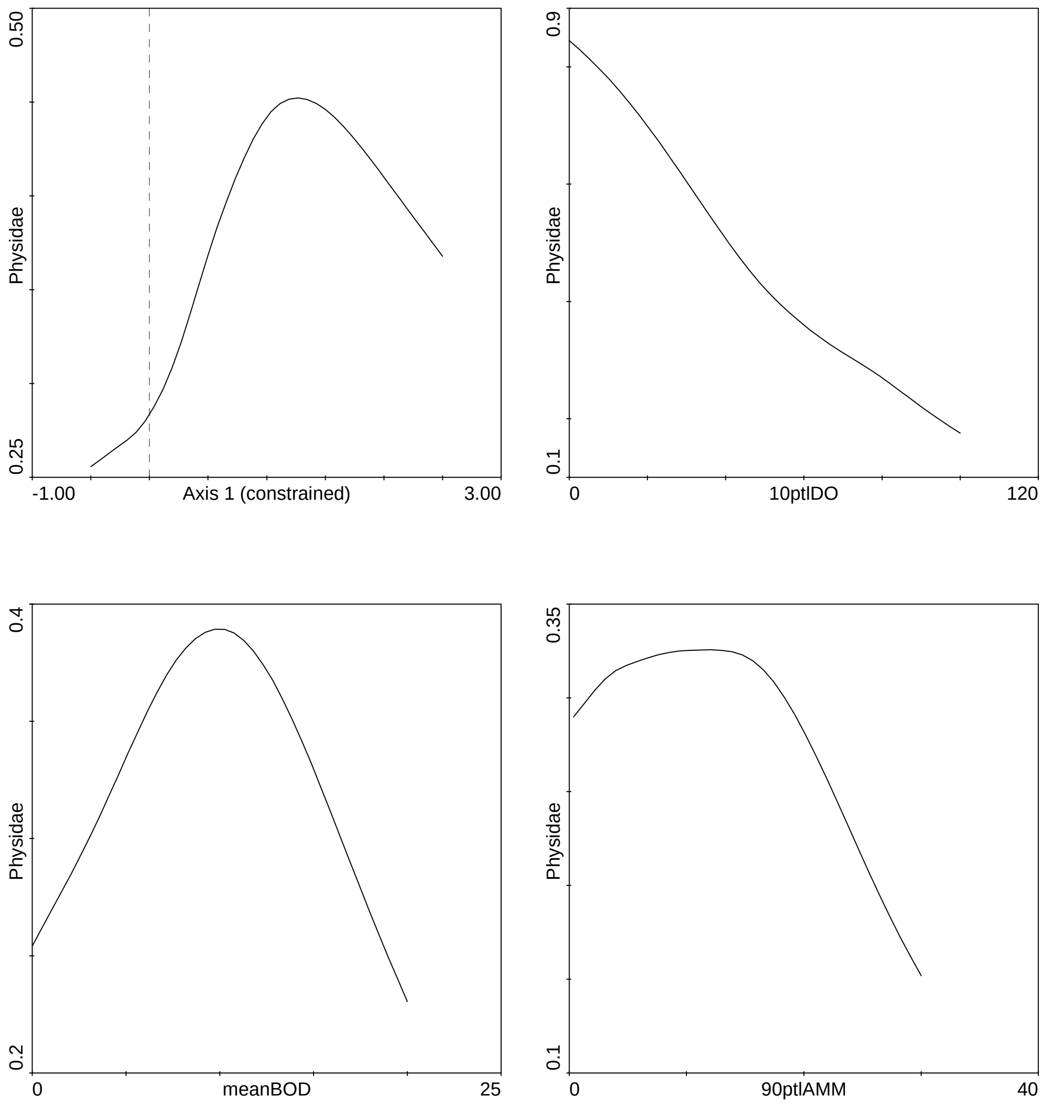


Figure 13. Probability of occurrence of Coenagrionidae, the taxon third most tolerant of organic pollution, in relation to a) axis 1 of the pCCA, a combined axis of organic pollution determinands (dotted line = 0), b) 10th percentile dissolved oxygen, c) mean BOD and d) 90th percentile total ammonium, explored using GAM.

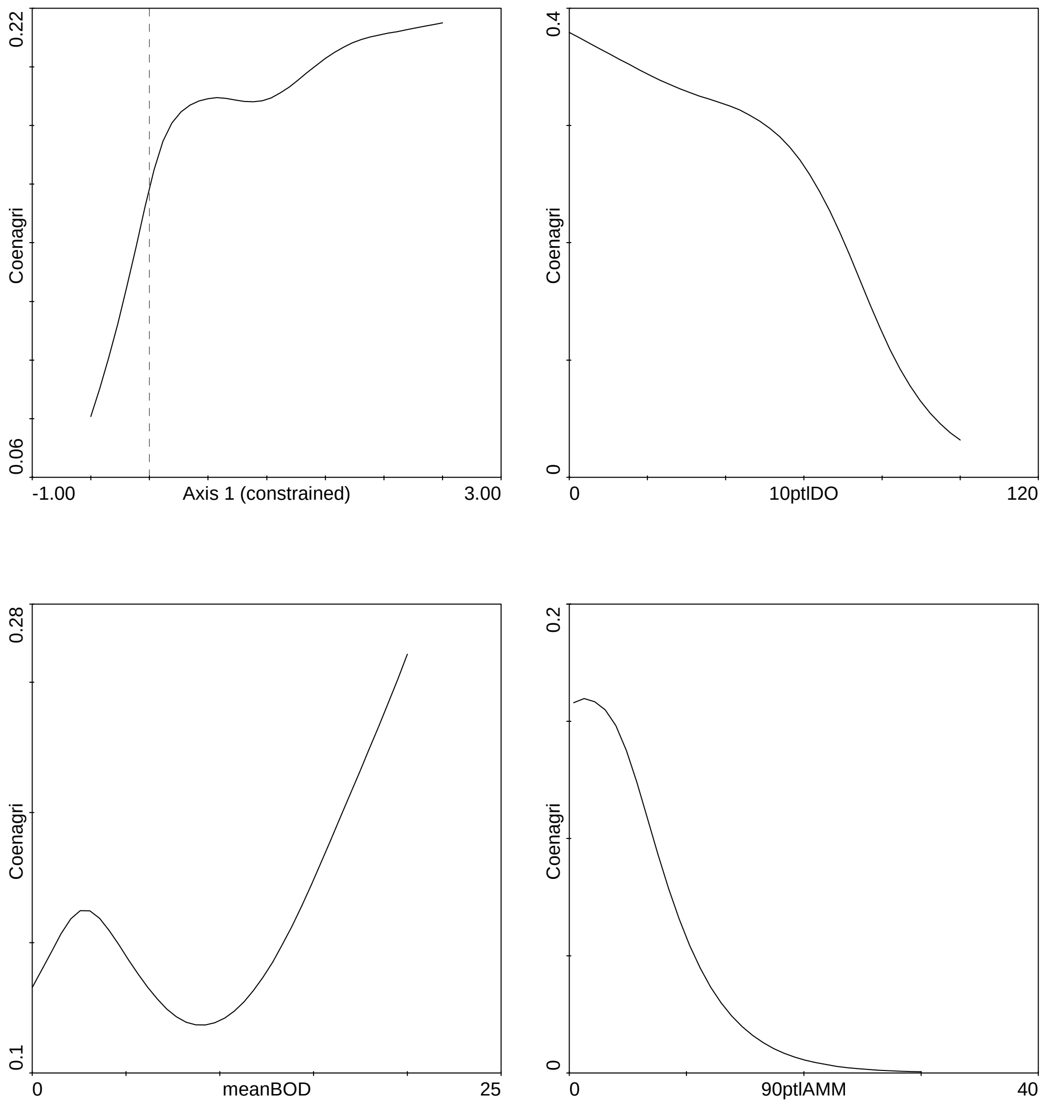


Figure 14. Probability of occurence of Erpobdellidae, the taxon fourth most tolerant of organic pollution, in relation to a) axis 1 of the pCCA, a combined axis of organic pollution determinands (dotted line = 0), b) 10th percentile dissolved oxygen, c) mean BOD and d) 90th percentile total ammonium, explored using GAM.

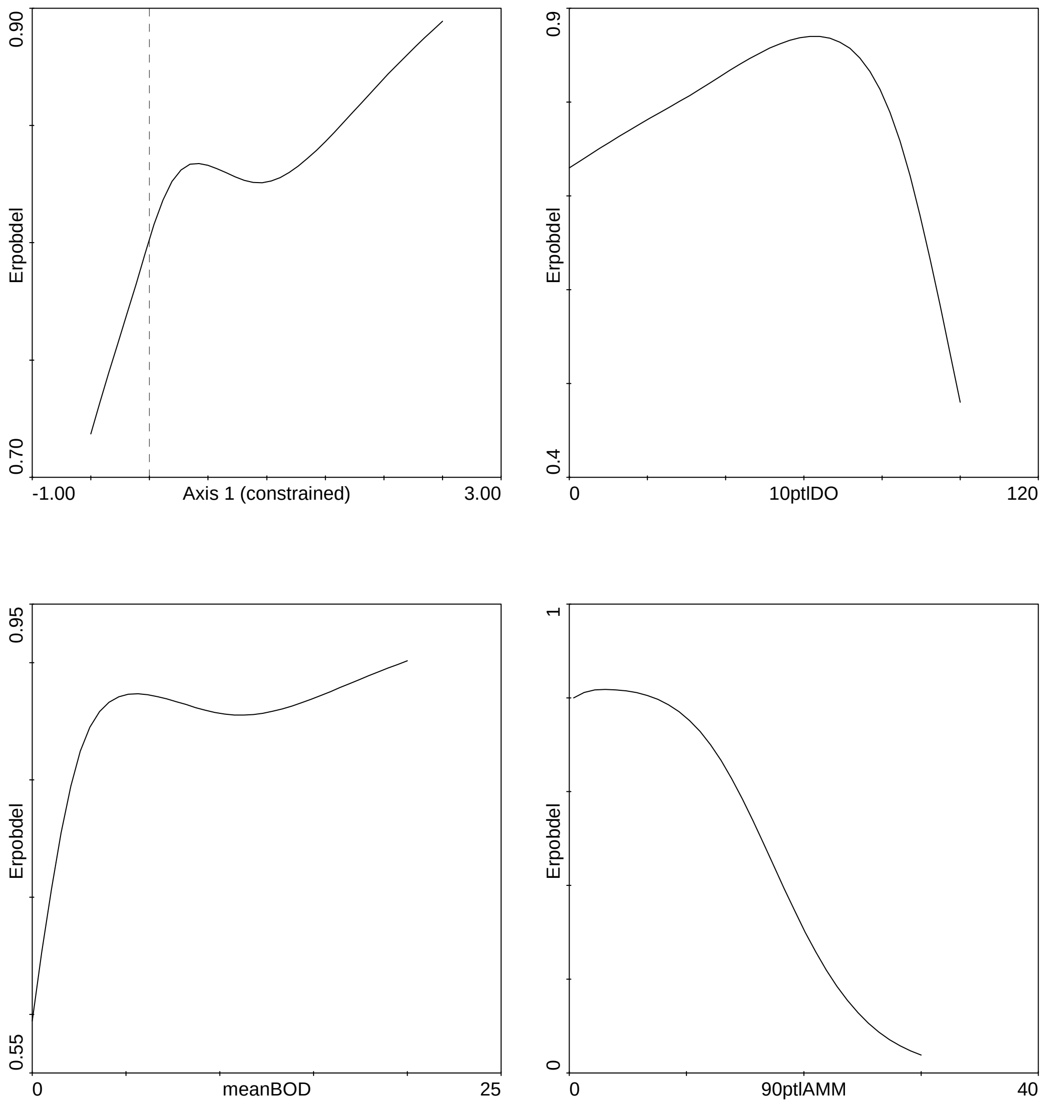


Figure 15. Probability of occurence of Odontoceridae, the taxon most sensitive to organic pollution, in relation to a) axis 1 of the pCCA, a combined axis of organic pollution determinands (dotted line = 0), b) 10th percentile dissolved oxygen, c) mean BOD and d) 90th percentile total ammonium, explored using GAM.

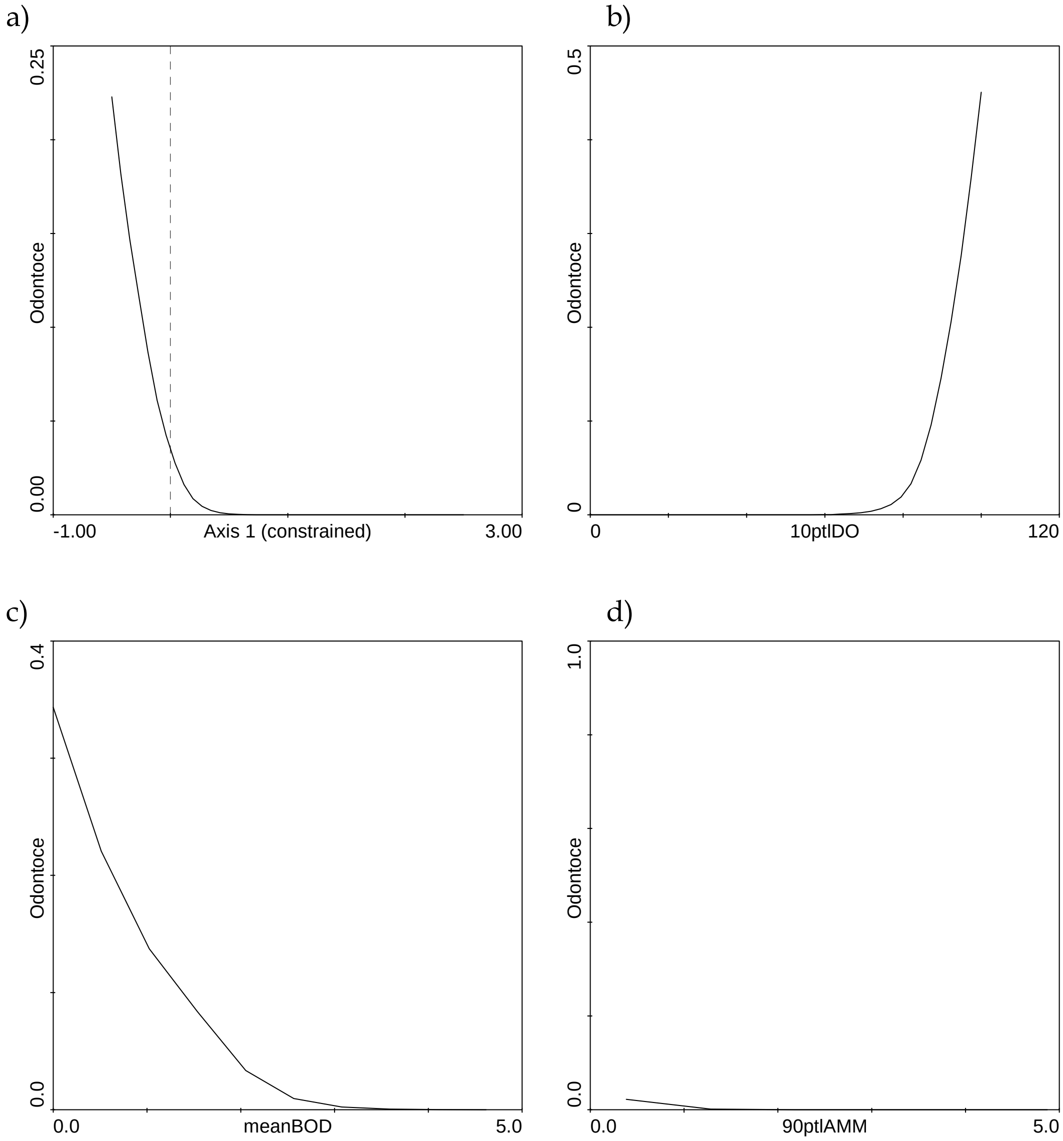


Figure 16. Probability of occurence of Goeridae, the taxon second most sensitive to organic pollution, in relation to a) axis 1 of the pCCA, a combined axis of organic pollution determinands (dotted line = 0), b) 10th percentile dissolved oxygen, c) mean BOD and d) 90th percentile total ammonium, explored using GAM.

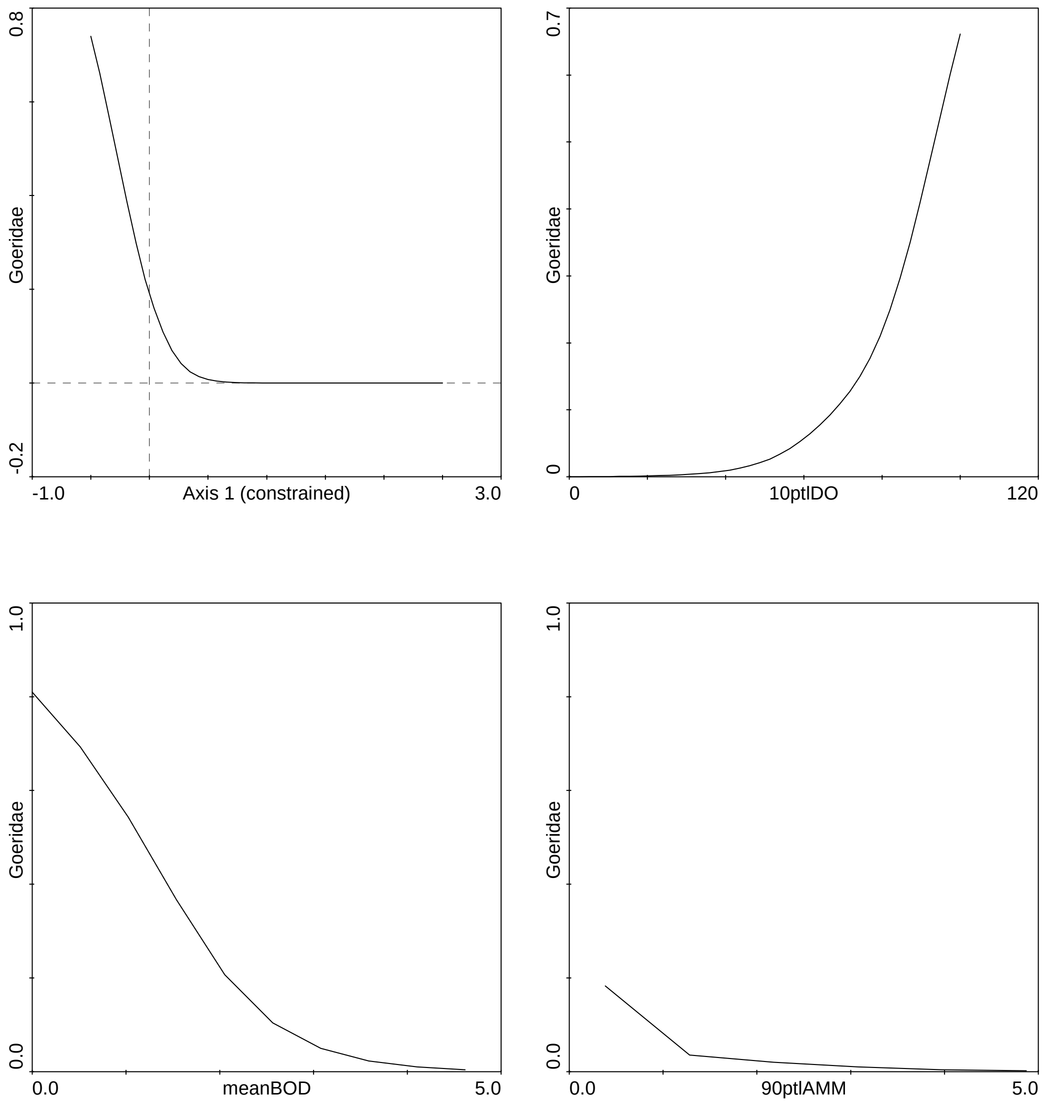


Figure 17. Probability of occurence of Rhyacophilidae (including Glossosomatidae), the taxon third most sensitive to organic pollution, in relation to a) axis 1 of the pCCA, a combined axis of organic pollution determinands (dotted line = 0), b) 10th percentile dissolved oxygen, c) mean BOD and d) 90th percentile total ammonium, explored using GAM.

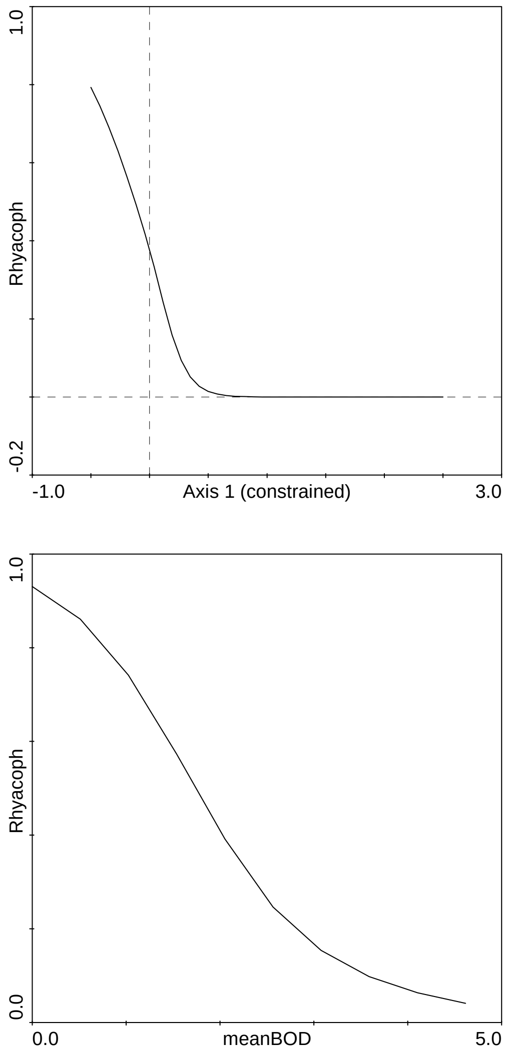


Figure 18. Probability of occurrence of Ephemeridae, the taxon fourth most sensitive to organic pollution, in realtion to a) axis 1 of the pCCA, a combined axis of organic pollution determinands (dotted line = 0), b) 10th percentile dissolved oxygen, c) mean BOD and d) 90th percentile total ammonium, explored using GAM.

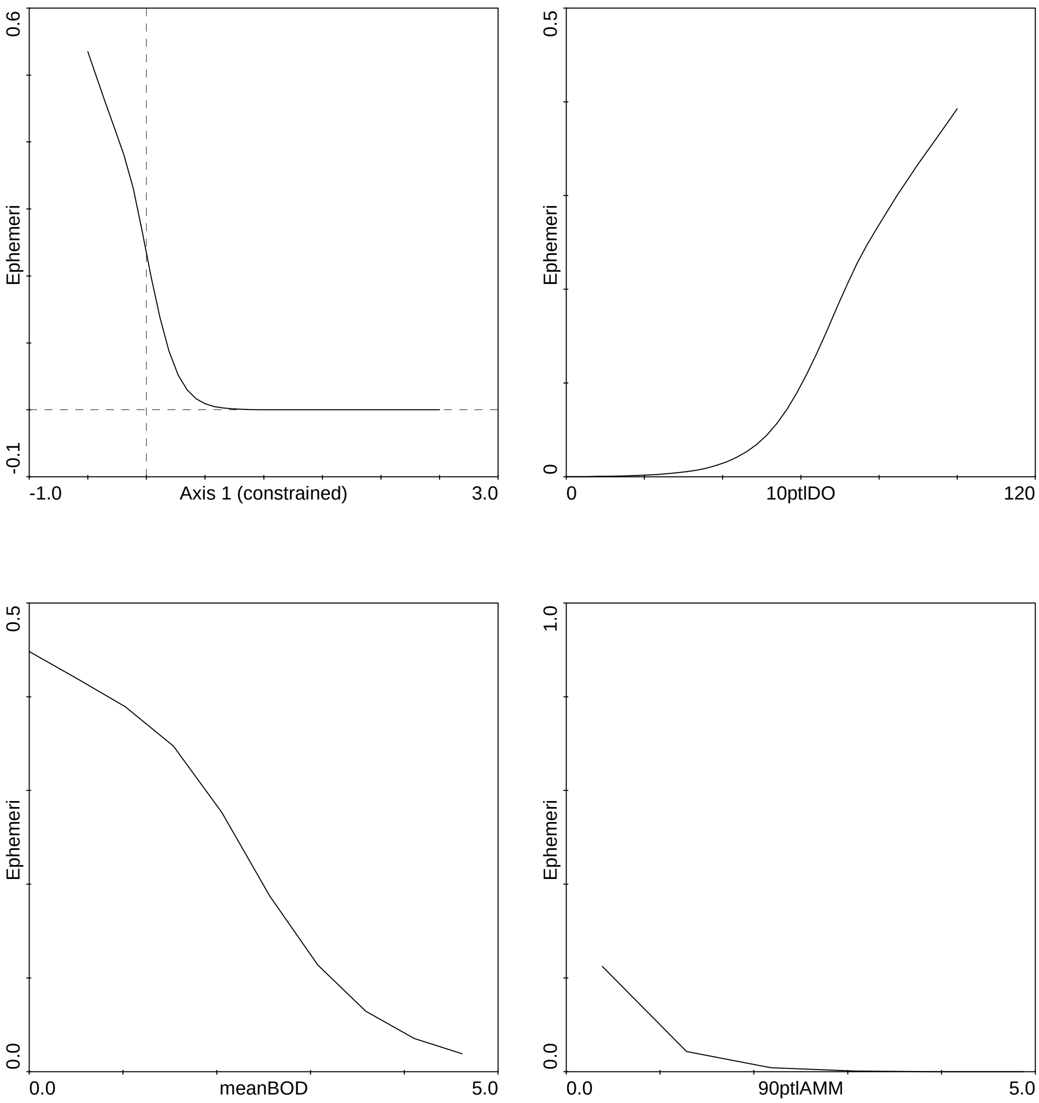


Figure 19. Relationship between taxon richness and axis 1 score of the partial CCA. Axis 1 is a summary axis of organic pollution characterised by increasing mean BOD and decreasing 10th percentile dissolved oxygen (see Figures 6 & 7). Increasing axis values indicate increased organic pollution.

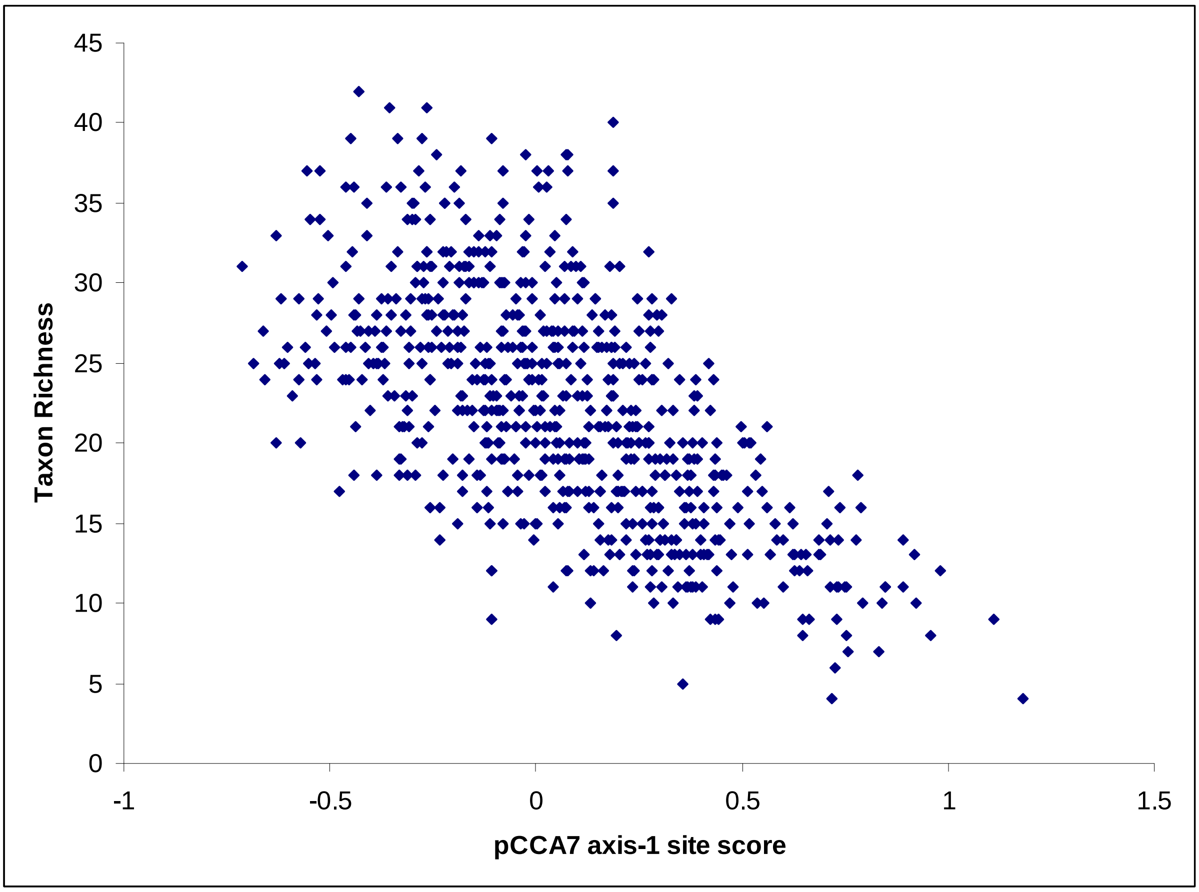
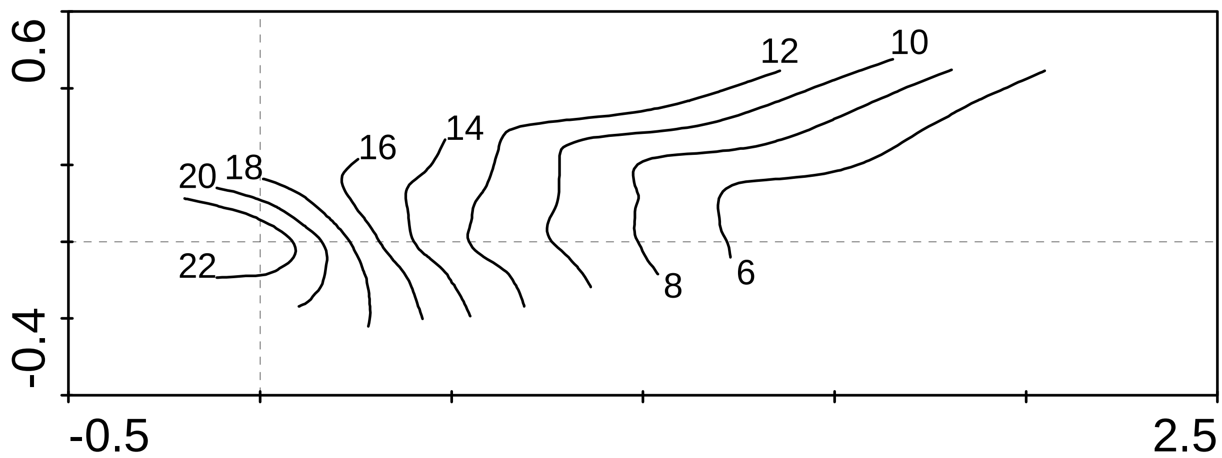


Figure 20. The taxon richness contour gradient through the pCCA ordination space. Axis 1 is a summary axis of organic pollution characterised by increasing mean BOD and decreasing 10th percentile dissolved oxygen (see Figures 6 & 7). Increasing axis values indicate increased organic pollution.



3.3 Species Level Analysis

Data analysis was based on species-level data matched with sufficient associated chemistry from three sources:

- Countryside Survey 2000 (31 sites)
- 1985-86 Polluted Streams Project (16 sites)
- RIVPACS reference dataset (26 sites)

The number of sites included in the analysis had to be restricted to ensure an even distribution across the gradient of organic pollution. The vast majority of the data were from unpolluted sites and their inclusion in the analysis would have biased the results by increasing the probability of occurrence of species at this end of the pollution gradient simply by chance, with failure to address this issue resulting in an over-estimation of the sensitivity of taxa to organic pollution.

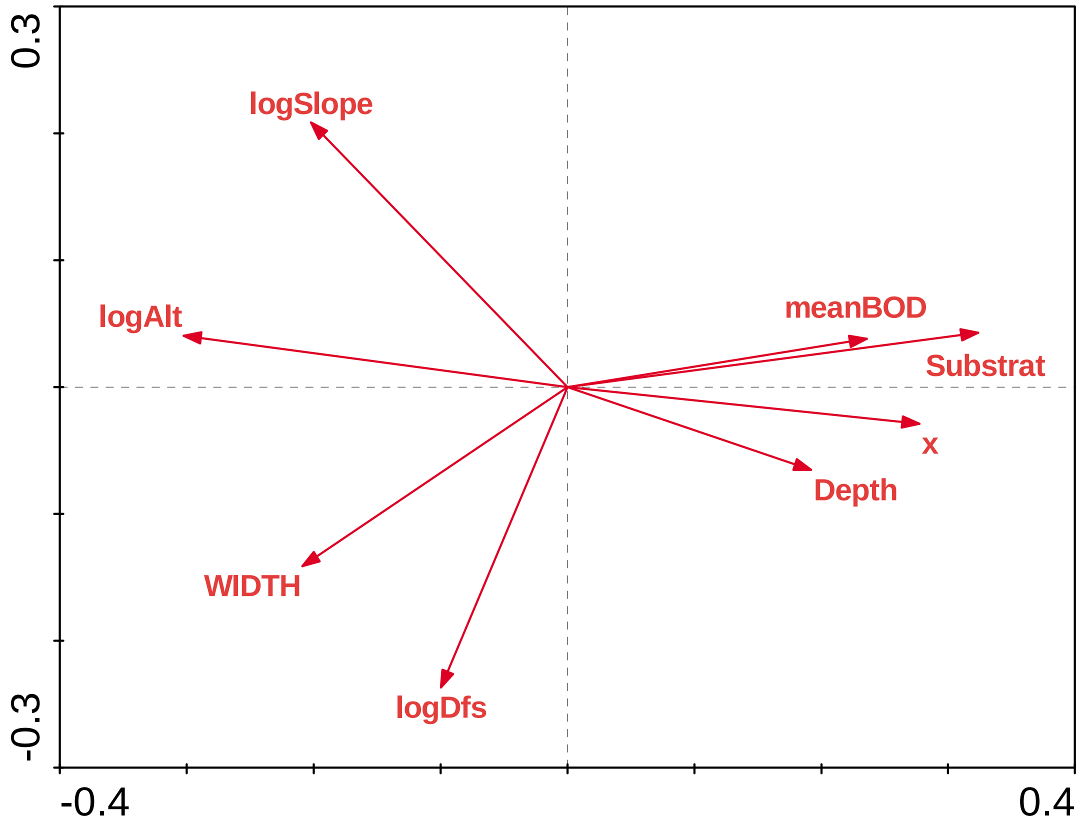
A total of 249 taxa occurred in the dataset but rare taxa (<9 occurrences) were excluded from the analysis to remove any undue influence on the results (as determined by preliminary analyses). Taxa with between 8 and 4 occurences were retained but included passively, in order to provide at least a low-confidence characterisation of the response of rare species, since they are likely to be of high conservation priority in their own right. No BAP species were included in the analysis, but 4 genera containing BAP species were represented (either as more common species or as indeterminate species) together with a further 2 families containing BAP species. An initial DCA confirmed that there was sufficient turnover of taxa across the 73 sites (length of Axis 1 = 2.809) to justify assuming a uni-modal response between the biological and environmental data.

CCA was used to generate the most parsimonious model to explain the variation in the macroinvertebrate community across the 73 sites. Variables were included in the model at a lower statistical significance, $P<0.05$, than in the family level analysis to reflect lower number of sites used in the analysis. The most parsimonious model could account for 27% of the biological variation (63 taxa, 73 sites), and contained 8 environmental variables (Figure 21; for summary statistics see Table 17). Of the variables included mean BOD was the only determinand associated with organic pollution that was selected for inclusion.

Table 17. Summary statistics for CCA relating macroinvertebrate species to selected physical, geographical and chemical environmental variables.

Axes	1	2	3	4	Total inertia
Eigenvalues	0.237	0.084	0.068	0.037	1.994
Species-environment correlations :	0.873	0.811	0.813	0.779	
Cumulative percentage variance					
of species data :	11.9	16.1	19.5	21.4	
of species-environment relation:	44.7	60.4	73.3	80.2	
Sum of all eigenvalues					1.994
Sum of all canonical eigenvalues					0.532

Figure 21. Ordination plot from unconstrained CCA showing relationships amongst the environmental variables used in the species level analysis.



Next, that portion of the biological variation that could be accounted for by the variables other than mean BOD was partialled out, as this was the only determinand associated with organic pollution that had a statistically significant influence on the species variation. The remaining variation was correlated with mean BOD to derive the ranking of species according to their tolerance to organic pollution.

Mean BOD could only account for 3.4% of the residual biological variation after factoring out that which could be accounted for by the other 7 environmental variables. The organic pollution gradient was relatively weak within the dataset: Species level data were not available from sites suffering from high levels of organic pollution.

The cumulative fit per species as a fraction of the overall variance of each species indicated that the pCCA model was accounting for at most 10% of the variance of any species in the dataset. A subset of species where > 2% of the variance was explained by the constrained gradient was included in the final analysis (for summary statistics see Table 18), as for these species we can make the most reliable predictions regarding their relative tolerances to organic pollution (Table 19).

In the final partial ordination the variation in species occurrence was associated with mean BOD alone with any vertical scatter due to noise (Figure 22). Although the gradient was short due to the range of data available, as it was the only variable included, mean BOD was aligned with the 1st axis (Figure 23). Using this approach *Limnophora* sp. (family Muscidae) was identified as the most tolerant macroinvertebrate in our dataset and that the leech P. *geometra* the most sensitive (Table 19; Figure 24). The niche widths along the mean BOD pollution gradient were quite wide, probably reflecting the large proportion of unexplained variance in the model (Figure 24). Although a restricted set of species was included in this analysis, it should be noted that the most sensitive taxa identified using this approach (*Piscicola geometra)* tolerated > 3 mg l^{-1} BOD, higher than any of the taxa identified as sensitive in the family level analysis. It should be noted that the taxa are ranked according to their optima, and that the ecological amplitude of the taxa increases towards the upper and lower extreme. This is a consequence of a reduced ability to accurately predict the range of conditions where these taxa occur, as they are less frequent in the data set. With a larger number of total samples (as in the family level analysis) this effect is eliminated.

Table 18. Summary statistics for pCCA relating macroinvertebrate species to mean BOD, with other physical and geographical characteristics entered as covariables.

Axes	1	2	3	4	Total inertia
Eigenvalues :	0.051	0.131	0.101	0.088	1.994
Species-environment correlations :	0.695	0.000	0.000	0.000	
Cumulative percentage variance					
of species data :	3.4	12.0	18.7	24.5	
of species-environment relation:	100.0	0.0	0.0	0.0	
Sum of all eigenvalues					1.513
Sum of all canonical eigenvalues					0.051

In conclusion we recommend that a more robust training dataset would be required to more reliably rank macroinvertebrate species according to their tolerance to organic pollution. The findings presented here were constrained by the lack of data from more organically polluted sites. As a consequence both the length of the organic pollution gradient (influencing the explanatory power of the 1st axis) and the number of sites, and hence species, included were affected. CEH hold an extensive dataset from unpolluted sites (>700 sites with matched chemistry). With increased matching of species level data with chemistry from organically polluted sites a more powerful analysis could be undertaken.

Nevertheless, the results of the current study do provide a suggestion of those commonly occurring taxa likely to be good indicators of condition of river reaches. Furthermore, no taxa have been identified as being more sensitive to BOD than those identified in the family level analysis, although it should be stressed that the results presented here are based on a limited set of species.

Figure 22. Ordination plot from pCCA showing the distribution of the top 34 taxa (based on >2% of variance explained by the constrained, BOD, gradient).

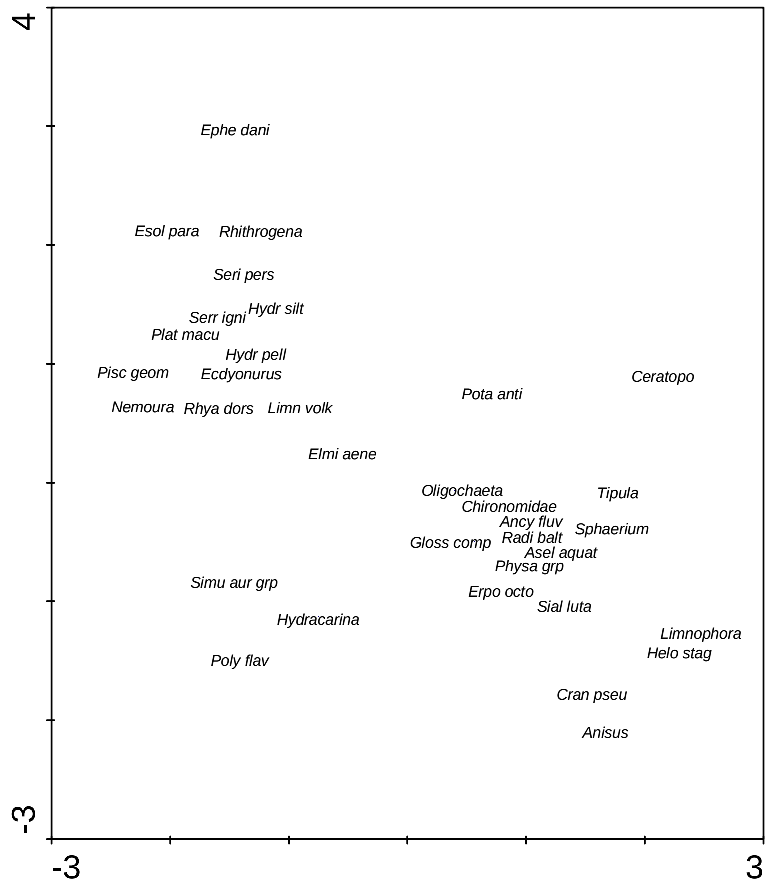


Figure 23. Contour plot showing the mean BOD gradient (in mgl^{-1}) through the pCCA ordination space.

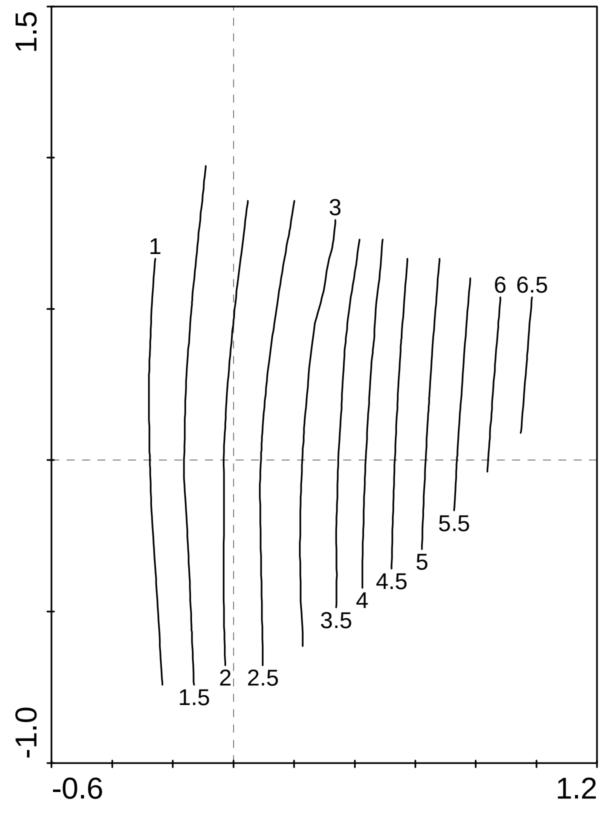
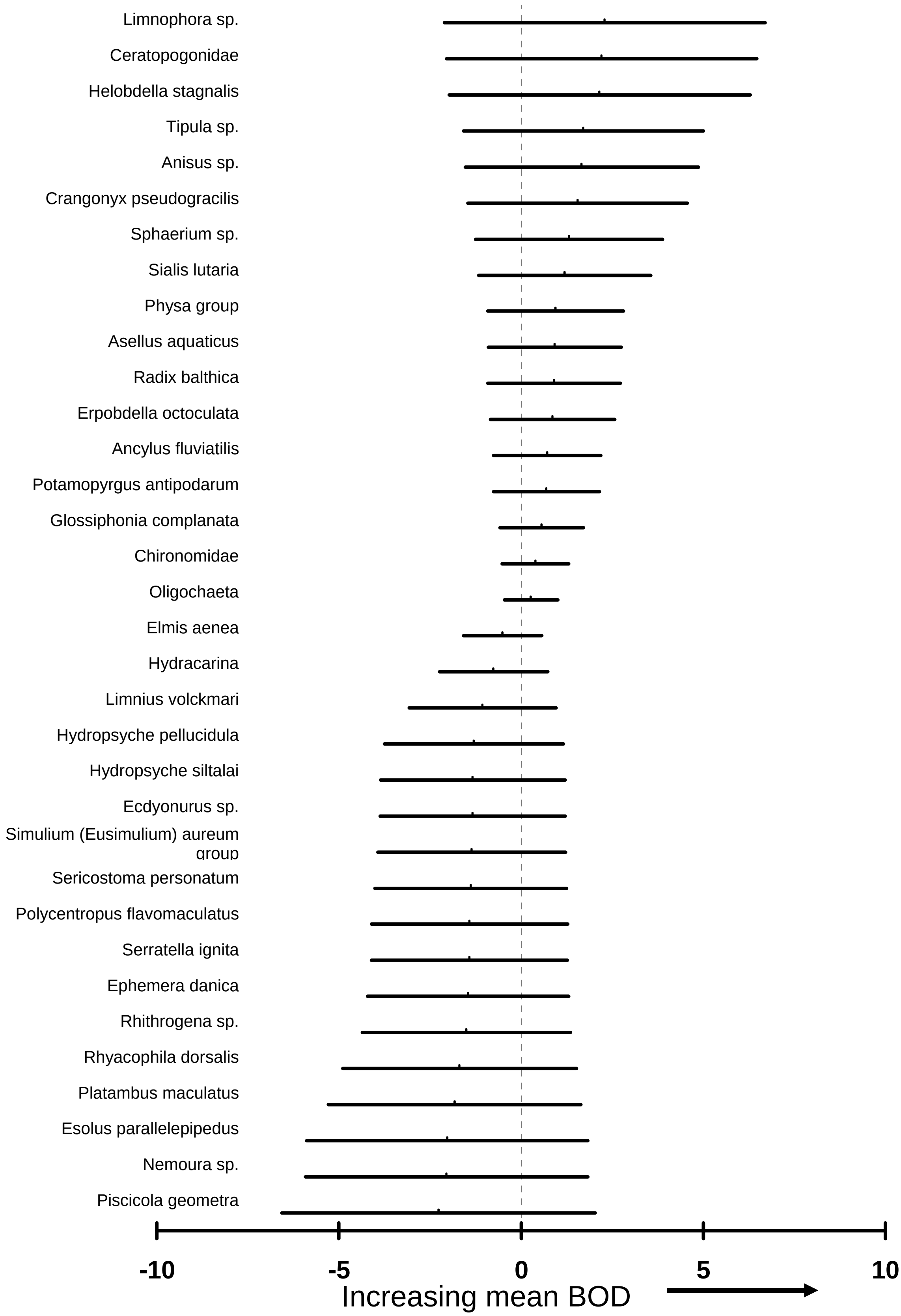


Table 19. Axis score and upper and lower tolerance limits of macroinvertebrate species together with the proportion of variance of each species that can be explained by axis 1 of the pCCA.

	pCCA axis 1 score	**lower 2SD limit**	**upper 2SD limit**	**% of species variance explained by pCCA axis 1**
Piscicola geometra	-2.265	-6.5666	2.0366	5.21
Nemoura sp.	-2.042	-5.9206	1.8366	2.96
Esolus parallelepipedus	-2.0273	-5.8861	1.8315	3.13
Platambus maculatus	-1.8245	-5.2945	1.6455	5.14
Rhyacophila dorsalis	-1.6853	-4.8929	1.5223	7.81
Rhithrogena sp.	-1.502	-4.3608	1.3568	2.48
Ephemera danica	-1.4517	-4.2103	1.3069	3.66
Serratella ignita	-1.4159	-4.1073	1.2755	3.75
Polycentropus flavomaculatus	-1.4157	-4.1141	1.2827	2.81
Sericostoma personatum	-1.3818	-4.011	1.2474	4.41
Simulium aureum group	-1.3539	-3.9321	1.2243	3.72
Ecdyonurus sp.	-1.3318	-3.8702	1.2066	4.28
Hydropsyche siltalai	-1.3282	-3.8614	1.205	5.04
Hydropsyche pellucidula	-1.2885	-3.7455	1.1685	5.16
Limnius volckmari	-1.0566	-3.0766	0.9634	5.25
Hydracarina	-0.7531	-2.2355	0.7293	2.04
Elmis aenea	-0.5082	-1.5834	0.567	2.04
Oligochaeta	0.2717	-0.4609	1.0043	2.13
Chironomidae	0.3936	-0.5176	1.3048	3.66
Glossiphonia complanata	0.5643	-0.5795	1.7081	2.19
Potamopyrgus antipodarum	0.7019	-0.7525	2.1563	3.45
Ancylus fluviatilis	0.7174	-0.758	2.1928	2.89
Erpobdella octoculata	0.8605	-0.8459	2.5669	4.77
Radix balthica	0.9072	-0.9094	2.7238	5.62
Asellus aquaticus	0.9229	-0.9029	2.7487	3.28
Physa group	0.9481	-0.9079	2.8041	2.09
Sialis lutaria	1.2008	-1.1638	3.5654	2.23
Sphaerium sp.	1.3206	-1.2428	3.884	5.01
Crangonyx pseudogracilis	1.554	-1.4552	4.5632	2.07
Anisus sp.	1.6693	-1.5365	4.8751	2.03
Tipula sp.	1.7119	-1.5839	5.0077	7.02
Helobdella stagnalis	2.1556	-1.9762	6.2874	9.92
Ceratopogonidae	2.2159	-2.0435	6.4753	10.89
Limnophora sp.	2.2966	-2.1042	6.6974	8.38

Figure 24. Relationship between macroinvertebrate species and the first canonical axis of the partial CCA, characterised by increasing mean BOD. Optimum (point) and ecological amplitude (bar) plotted for taxa ranked from least sensitive to most sensitive to organic pollution (top to bottom).



3.4 Representation of Data by River Type

As certain river types will be more prone to the impacts of organic pollution than others, it is necessary to characterise the biological response separately for the different river types. This is not a simple issue, since the river typology employed to characterise macroinvertebrate communities is based on RIVPACS end groups, whereas the typology used currently to set organic pollution targets within SSSI conservation objectives is a simple physical typology based on catchment geology and river size (Table 20). The RIVPACS calssification is biologically derived and so explains natural variations in invertebrate communities very well, and in practice RIVPACS uses the physicochemical characteristics of the river to predict the invertebrate community present, whereas the typology used to define organic pollution targets has no objective biological basis, although seeks to reflect environmental variation in river types in a way that is ecologically relevant. An additional typology that is relevant is the macrophyte-based classification used to designate SSSI river as representatives of the different river habitat types found in the UK (Table 21).

To provide a representation of the invertebrate community in terms of the two typologies of relevance to Natural England, it is necessary to cross-match types with the RIVPACS river types. This has been achieved using sites on rivers that are designated SSSI and are also included within the RIVPACS reference dataset, identifying and correlating the NE river type class with the RIVPACS 9 and 4 endgroup class (i.e. at a hierarchical level in the TWINSPAN classification that produces 9 and 4 endgroups). There were a total of 96 SSSI units that contain a RIVPACS reference site for which the unit had been allocated a class (some provisionally) according to the NE typology (See Appendix 1). Some NE river types appeared to match RIVPACS 9 endgroup classes well (e.g. NE Type A3 corresponds to endgroup 6; Table 23), whereas other NE river types contained macroinvertebrate communities that corresponded to disparate RIVPACS 9 endgroup classes (e.g. NE Type C1 corresponds to endgroups 2, 7, 8 & 9; Table 23). For three NE types there were no sites where matches could be made to RIVPACS reference dataset samples (C3, D3, E1; Table 23).

In part this variability in matching is due to the different approaches used. The NE typology has been defined using dominant catchment geology and river size; the RIVPACS classification is derived from cluster analysis of field samples of macroinvertebrate communities, with the class definitions derived from the physical characteristics of the sites used to derive these clusters. There may also be a mismatch in the types of sites sampled; the RIVPACS reference dataset appears to include a higher proportion of small headwater sites than the portfolio of SSSIs (or matching may not be as good in small headwaters). In some circumstances the most frequent class of matched sites corresponded to the definition/description of that type/endgroup from the two systems. In other circumstances there were no sites where matches could be made, matches were made with several different highly disparate RIVPACS end groups, or the matches that were made corresponded to very different definitions/descriptions in the two systems. In these latter cases more weight was given to direct matching of typology/classification.

Using best judgement of the characterisations used to define and describe the typologies and classifications and the matched sites (See Appendix 1) we propose that the NE and JNCC typologies match with the RIVPACS 9 endgroup classification as outlined in Tables 24 and 25.

Table 20. Natural England River Typology, based on dominant catchment geology and river size.

Type	Dominant Catchment Geology	Size	
A	Hard upland geologies (all land over 330m) – impermeable poor geologies	1	Head water
		2	River
		3	Large River
B	Other Cambrian-Devonian geologies – hard mudstones and sandstones	1	Head water
		2	River
		3	Large River
C	Jurassic and Cretaceous limestones – soft limestone and chalk	1	Head water
		2	River
		3	Large River
D	Triassic sandstones and mudstones – soft sandstones and mudstones in lowland areas	1	Head water
		2	River
		3	Large River
E	Mesozoic clay vales and Tertiary clays – impermeable rich geologies	1	Head water
		2	River
		3	Large River

Table 21. JNCC River Typology, based on macrophytes, and catchment and river characteristics (Holmes *et al*. 1999).

Type	Description
I	Lowland, low gradient rivers
II	Lowland, clay-dominated rivers
III	Chalk rivers and other base-rich, baseflow dominated rivers
V	Sandstone, mudstone and hard limestone rivers of England and Wales
VI	Sandstone, mudstone and hard limestone rivers of Scotland and Northern England
VII	Mesotrophic rivers dominated by gravels, pebbles and cobbles
VIII	Oligo-mesotrophic rivers
IX	Oligotrophic low altitude rivers
X	Ultra-oligotrophic rivers

Table 22. Physical characteristics of RIVPACS 9 and 4 endgroup classifications. Classification based on cluster analysis of macroinvertebrate communities; definitions based on physical/chemical characteristics of sites from which the samples were collected.

9 Endgroup Classification	4 Endgroup Classification	Description (NB classification is on invertebrate community composition)
1	1	Small rivers and headwaters with low alkalinity, typically on hard upland geologies in Scotland, Wales, and the north and southwest of England
2	1	Small rivers and headwaters with moderate alkalinity, typically lowland on sedimentary geologies, mainly England
3	2	Medium to large rivers of low alkalinity, typically on hard upland geologies in Scotland, Wales, and the north of England
4	2	Medium to large rivers of low alkalinity, typically on hard geologies in Scotland, Wales, and the north and southwest of England
5	3	Medium rivers of moderate alkalinity, typically on sedimentary geologies
6	3	Large rivers of moderate alkalinity, typically on sedimentary geologies
7	4	Medium to large rivers of high alkalinity, typically on lowland calcareous geologies in southern England
8	4	Medium rivers of high alkalinity, typically on lowland calcareous geologies in southern England
9	4	Large rivers of high alkalinity, typically on lowland sedimentary geologies in southern England

Table 23. Summary of match of NE river classification to RIVPACS 9 endgroup classification by common sites. Shaded cells represent matches, numbers represent the total number of sites matched (total including possibles in brackets). Hatched cells represent best judgement match of site definitions of NE typology (Table 20) and descriptions of sites by RIVPACS classification (Table 21).

		RIVPACS 9 endgroup								
		1	2	3	4	5	6	7	8	9
A	1	(2)			1(4)		(3)			
	2	1(2)		2	1(2)		3(6)			
	3						4			
B	1	(1)			(3)	1(2)				
	2				3(4)	4(5)	6	4	1	
	3							2		
C	1		3					1	5(7)	(1)
	2					1		11	3(5)	3(1)
	3									
D	1	1							1	
	2						5	1		1
	3									
E	1									
	2							6		5
	3							3		

Table 24. Proposed matching of NE river physical typology based on dominant catchment geology and river size, and the RIVPACS 9 endgroup biological classification based on cluster analysis of macroinvertebrate communities.

		RIVPACS 9 endgroup								
		1	2	3	4	5	6	7	8	9
A	1	■								
	2			■						
	3						■			
B	1	■								
	2				■					
	3							■		
C	1		■							
	2							■		
	3								■	
D	1		■							
	2					■				
	3						■			
E	1		■							
	2							■		
	3									■

Table 25. Proposed matching of JNCC river physical typology based on catchment and river characteristics, and the RIVPACS 9 endgroup biological classification based on cluster analysis of macroinvertebrate communities.

	RIVPACS 9 endgroup								
	1	2	3	4	5	6	7	8	9
I							■		
II									■
III							■		
V								■	
VI						■			
VII			■						
VIII				■					
IX			■						
X	■								

3.5 Generating Tentative Thresholds for River Types

Using the frequency of occurrence of taxa within the RIVPACS 9-endgroup river types (i.e. at a hierarchical level in the TWINSPAN classification that produces 9 end groups) and their mean abundance in such rivers, it is possible to predict the taxa likely to be present by NE river type. The tolerance of the most sensitive taxa typically present can then be used to establish the thresholds by river type. The probability of occurrence across all sites of the four most sensitive taxa to the determinands characteristic of organic pollution has been modelled using GAM (Figures 15 – 18). However, it is necessary to establish the likelihood of occurrence of sensitive taxa by river type in order to set thresholds that protect the most sensitive taxa present in a river, but are not over-prescriptive in situations where the community is more tolerant.

From the frequency of occurrence of taxa in the RIVPACS 9-endgroup level classification (Table 26) it can be seen that Odontoceridae, the taxa most sensitive to organic pollution as determined by the partial CCA analysis, are not found in rivers of types 6 and 9, and are infrequent (<10% of rivers) in rivers of types 3, 7 and 8. When Odontoceridae do occur in rivers of type 3 and 7 they are found at low abundance (mean 1-9 individuals per sample), but where they are found in rivers of type 8 they are found at slightly higher abundances (Table 27).

Goeridae, the taxa second most sensitive to organic pollution, are found at low frequency (7%) and low abundance (mean 1-9 individuals per sample) in rivers of type 3, and Rhyacophilidae (incl. Glossosomatidae) the taxa third most sensitive at low frequency (2%) and low abundance (mean 1-9 individuals per sample) in rivers of type 9.

Hence, we suggest that the tolerance of Odontoceridae is used to define organic pollution thresholds for rivers of types 1, 2, 4 and 5, the tolerance of Goeridae is used to define organic pollution thresholds for rivers of types 6, 7, 8 and 9, and the tolerance of Rhyacophilidae (incl. Glossosomatidae) is used to define organic pollution thresholds for rivers of types 3.

We suggest that a value corresponding to 80% of the occurrences of the most sensitive taxon present likely to be found in that river type is used to set the thresholds for the different determinands associated with organic pollution. In other words the thresholds are set at a level where 80% of the populations of the most sensitive taxa occur in less polluted conditions. Whilst 20% of populations persist in more polluted conditions, the environmental conditions that enable the sensitive taxa to persist at these more polluted sites are not known. By setting the thresholds at 80%, not a higher percentile, we increase the confidence that the thresholds provide adequate protection under a range of environmental conditions. If a higher percentage of occurrences were to be selected to define the cut off, we would reach the tail of the distribution where a slight increase in percentage would correspond to a large increase in concentration or, in other words, a large difference in concentration results in a slight difference in the probability that the taxa can persist under thoses conditions. By selecting 80%, a slight reduction in the concentration below the cut off results in large increase in the probability that the sensitive taxa can persist under those conditions.

The models constructed with GAM (Figures 15-18) provide some information regarding the response of the sensitive taxa to the determinands of interest; however these models use the probability of occurrence across all sites as a response variable. To establish more exactly the concentration corresponding to 80% of the occurrences of the taxa, the cumulative proportion of occurrences (or 1- the cumulative proportion of occurrences to aid interpretation) of the three most sensitive taxa were calculated (Figures 25 – 27). These figures can be used to determine the concentrations of the various determinands which correspond to 80% of the occurrences of that taxon. Using mean BOD for Odonotoceridae (Figure 25a) as an example, 100% of the observations occurred at a mean BOD less than 2.6 mg l^{-1}, and 80% of the observations occurred at a mean BOD of 1.8 mg l^{-1} or less. For 10th percentile dissolved oxygen concentration the cumulative proportion of occurrences is shown, as a lower concentration indicates more stressful condition: for example, 80% of occurrences of Odontoceridae have a 10th percentile dissolved oxygen saturation of 85% or more (Figure 25b).

An indication of the response of the whole community by river type to increasing organic pollution is illustrated in Figures 27 to 36. Here the taxa typically present are ranked according to their response to the 1st axis of the partial CCA. As organic pollution stress increases, the community is predicted to move towards the right, as sensitive taxa are lost.

Thus the putative thresholds for the determinands of interest corresponding to the 80% of the occurrences of three most sensitive taxa have been established (Table 28), and these can be applied according to river type, by the likely occurrence (>10% sites) of the taxa by river type (Table 29). As there is only one river type where both Odontoceridae and Goeridae occur in <10% sites (i.e. RIVPACS end group 3), and the sensitivity of Goeridae and Rhyacophilidae (incl. Glossosomatidae) appeared to vary across the different determinands indicative of organic pollution, we suggest that thresholds are set at two levels according to Odontoceridae and the more sensitive of Goeridae and Rhyacophilidae (incl. Glossosomatidae), namely:

I: 10th %ile Dissolved Oxygen saturation = 85%
Mean BOD = 1.8 mg l^{-1}
90th %ile Total Ammonia (NH_3 -N) = 0.23 mg l^{-1}

II: 10th %ile Dissolved Oxygen saturation = 79%
Mean BOD = 2.0 mg l^{-1}
90th %ile Total Ammonia (NH_3 -N) = 0.29 mg l^{-1}

These thresholds should be applied to the NE river types according to the likelihood of occurrence of the sensitive taxa. Thus, thresholds should be applied according to Table 30, summarised here:

Dominant Catchment Geology		Threshold		
		1. Head water	2. River	3. Large River
A	Hard upland geologies	I	II	II
B	Other Cambrian-Devonian geologies	I	I	II
C	Jurassic and Cretaceous limestones	I	II	II
D	Triassic sandstones and mudstones	I	I	II
E	Mesozoic clay vales and Tertiary clays	I	II	II

The time period over which the chemical determinands are to be sampled to determine mean and 10th and 90th percentiles should be the same as that used to derive these thresholds, i.e. over at least the preceeding 3 years and including at least 30 samples.

Whilst this approach may be pragmatic in that the thresholds of organic pollution are set at a level that protects the most sensitive taxa with a reasonably high probability of being present in rivers of that type, the level II threshold does not afford protection to the low number of sites of that river type where the more sensitive taxa do occur (albeit at a low probability for that river type). Nor does the level II threshold protect sites where, atypical for that river type, the more sensitive taxa occur. To guarantee the protection of all taxa at all sites, the thresholds of organic pollution would have to be set at level I for all rivers, and it is recommended that this higher target is the prefereable position for all rivers designated for conservation, of all river types, wherever practically possible, and wherever Odontoceridae are known to occur.

It should be noted also that the analyses presented here are based on relatively recent data and do not account for historic losses of taxa, that may have been more sensitive to organic pollution, but have been lost from the British fauna (or severely restricted in their distribution) due to widespread changes/impacts to the river types that they used to habituate.

It should be stressed that neither of the determinands used in the partial CCA, mean BOD and 10th percentile dissolved oxygen, are assumed to be drivers of the change in macroinvertebrate community, merely that they are the best descriptors of the impact of organic pollution on the macroinvertebrate community. It is likely that other determinands characteristic of organic pollution are correlated with the two selected and it may be these that are driving the change. The selection of mean BOD and 10th percentile dissolved oxygen as summary variables for organic pollution will be influenced by the variability, detection limit and range of these parameters relative to others, more than any biological effect. Nevertheless, these determinands do provide an adequate measure of organic pollution and appear to be the best, statistically, at explaining the variation in the invertebrate community with respect to organic pollution. As such, the determinands selected should provide robust measures of the impact of organic pollution on the biological community.

Table 26. Frequencies of occurrence of taxa by RIVPACS 9- endgroup level classification, ranked by sensitivity to organic pollution determinands from results of pCCA analysis. Shaded taxa not included in analysis.

Taxon Name	Taxon Code	F1	F2	F3	F4	F5	F6	F7	F8	F9
Asellidae	36110000	4	31	6	6	51	60	91	89	98
Physidae	16210000	1	4	1	1	10	24	63	53	74
Coenagriidae	42120000	4	4	1		8	2	9	8	62
Erpobdellidae	22310000	13	31	20	45	78	85	99	96	91
Oligochaeta	20000000	99	100	99	100	100	100	100	100	100
Chironomidae	50400000	100	100	100	100	100	100	100	100	100
Dendrocoelidae	05130000		4		1	4	22	43	25	40
Platycnemididae	42110000									7
Corixidae	43610000	3	12	6	4	24	10	43	40	90
Glossiphoniidae	22120000	11	66	20	37	84	79	96	100	98
Lymnaeidae	16220000	28	36	52	58	69	68	84	75	90
Simuliidae	50360000	89	91	87	92	98	95	97	92	36
Planariidae (incl. Dugesiidae)	051Z0000	51	59	33	61	43	61	68	60	76
Planorbidae	16230000		15	8	7	18	40	96	70	90
Sphaeriidae	17130000	46	92	28	51	92	92	100	100	100
Phryganeidae	48310000							6	4	22
Haliplidae	45110000	6	24	5	11	43	37	71	74	86
Gammaridae (incl. Crangonyctidae & Niphargidae)	371Z0000	48	100	29	86	98	97	100	96	100
Dytiscidae (incl. Noteridae)	451Z0000	54	69	51	52	76	45	71	70	88
Hydrobiidae (incl. Bithyniidae)	161Z0000	18	74	13	69	90	84	96	91	98
Baetidae	40120000	94	95	100	100	100	99	100	98	95
Valvatidae	16130000	3		1	3	12	13	69	40	78
Unionidae	17120000					2	1	9	4	36
Sialidae	46110000	23	32	5	8	57	9	44	62	69
Ancylidae (incl. Acroloxidae)	162Z0000	45	72	53	86	84	86	85	66	57
Hydrophilidae (incl. Hydraenidae)	453Z0000	56	54	41	61	61	43	12	25	24
Notonectidae	43510000	1	1						2	29
Calopterygidae	42140000	6	11	1	7	37	9	37	17	40
Molannidae	48390000		1					16	4	36
Tipulidae	50100000	92	99	88	93	98	89	79	89	38
Hydrometridae	43210000		3			2				2
Gyrinidae	45150000	11	26	18	63	73	68	71	19	34
Hydropsychidae	48250000	82	74	94	100	98	99	99	85	40
Neritidae	16110000		1		1	2	13	51		31
Caenidae	40510000	20	16	75	77	90	97	87	45	90
Psychomyiidae (incl. Ecnomidae)	482Z0000	6	34	11	25	27	34	43	28	43
Nemouridae	41120000	100	86	96	93	84	68	10	47	5
Leptoceridae	48410000	14	16	37	61	80	74	96	45	83
Hydroptilidae	48130000	38	22	57	37	65	66	78	62	45
Leptophlebiidae	40210000	61	64	42	39	76	33	41	51	21
Gerridae	43230000	3	5		3	2		1	2	5
Limnephilidae	48340000	90	96	71	70	100	55	81	92	74
Aphelocheiridae	43420000					10	20	26		12
Elmidae	45630000	97	96	98	100	100	100	100	96	95
Brachycentridae	48320000	6		31	15	27	23	35	8	5
Heptageniidae	40130000	90	57	100	100	94	93	50	30	5
Taeniopterygidae	41110000	56	27	37	49	55	60	24	8	3
Ephemerellidae	40410000	17	39	28	61	84	64	69	64	29
Piscicolidae	22110000	1	22		11	22	9	47	58	43
Leuctridae	41130000	100	54	95	83	88	59	16	9	
Lepidostomatidae	48330000	14	28	70	70	69	67	38	21	3
Chloroperlidae	41230000	93	20	84	70	41	21	3		
Polycentropodidae	48240000	86	57	73	72	80	76	78	36	64
Perlodidae	41210000	94	76	95	94	84	85	19	9	2
Beraeidae	48360000	6	18			8			6	2
Sericostomatidae	48370000	56	62	46	76	88	54	43	43	9
Scirtidae	45510000	52	57	8	10	6		1	17	5
Ephemeridae	40320000	17	55	1	37	78	37	66	49	28
Rhyacophilidae (incl. Glossosomatidae)	481Z0000	93	86	95	97	90	90	63	68	2
Goeridae	48350000	27	50	7	41	47	22	51	49	17
Odontoceridae	48380000	18	12	7	14	20		6	9	
Aeshnidae	42230000									9
Astacidae	34310000	3	3	1	4	14	3	7		
Capniidae	41140000	14	8	2	3	2	2			
Cordulegasteridae	42220000	11	16	6	6	6	1		4	
Corophiidae	37110000									14
Dryopidae	45620000	6	3	1		6	1	1	2	5
Gomphidae	42210000							1		7
Hirudinidae	22210000		1		1				2	2
Libellulidae	42250000									2
Naucoridae	43410000									2
Nepidae	43310000		1					1	4	3
Perlidae	41220000	37	5	78	59	10	23			
Philopotamidae	48210000	23	11	6	7		2			
Potamanthidae	40310000						1	1		
Siphlonuridae	40110000	27		18		4				
Viviparidae	16120000							3		22

Table 27. Mean log abundance categories of taxa by RIVPACS 9-endgroup level classification, ranked by sensitivity to organic pollution determinands from results of pCCA analysis. Shaded taxa not included in analysis. (log abundance category 1 = 1-9; 2 = 10-99; 3 = 100-999; 4 = 1000-9999).

Taxon Name	Taxon Code	F1	F2	F3	F4	F5	F6	F7	F8	F9
Asellidae	36110000	1.00	1.61	1.20	1.00	1.72	1.69	2.11	2.02	2.49
Physidae	16210000	2.00	1.00	1.00	1.00	1.40	1.57	1.56	1.54	1.79
Coenagriidae	42120000	1.33	1.00	1.00		1.25	1.00	1.17	1.00	1.56
Erpobdellidae	22310000	1.00	1.39	1.18	1.19	1.53	1.58	1.60	1.61	1.79
Oligochaeta	20000000	1.86	2.35	1.78	2.35	2.80	2.61	2.88	3.08	3.12
Chironomidae	50400000	2.07	2.50	2.13	2.51	2.90	2.87	2.94	2.98	2.91
Dendrocoelidae	05130000		1.00		1.00	1.50	1.05	1.17	1.08	1.26
Platycnemididae	42110000									1.25
Corixidae	43610000	2.00	1.00	1.60	1.00	1.50	1.11	1.41	1.24	1.77
Glossiphoniidae	22120000	1.00	1.47	1.12	1.04	1.49	1.39	1.66	1.92	1.81
Lymnaeidae	16220000	1.35	1.41	1.40	1.24	1.56	1.42	1.51	1.55	1.50
Simuliidae	50360000	1.73	2.03	1.68	2.08	2.46	2.43	2.48	2.33	1.76
Planariidae (incl. Dugesiidae)	051Z0000	1.39	1.77	1.22	1.51	1.52	1.42	1.70	1.72	1.80
Planorbidae	16230000		1.27	1.14	1.00	1.22	1.43	1.57	1.78	2.17
Sphaeriidae	17130000	1.18	1.79	1.43	1.19	1.96	1.70	2.49	2.68	2.86
Phryganeidae	48310000							1.25	1.00	1.00
Haliplidae	45110000	1.25	1.22	1.25	1.00	1.33	1.16	1.42	1.33	1.56
Gammaridae (incl. Crangonyctidae & Niphargidae)	371Z0000	2.12	3.00	1.42	1.90	2.71	2.30	2.78	2.98	2.41
Dytiscidae (incl. Noteridae)	451Z0000	1.21	1.63	1.10	1.14	1.38	1.21	1.25	1.41	1.47
Hydrobiidae (incl. Bithyniidae)	161Z0000	2.00	2.71	1.36	1.69	2.73	2.15	2.51	2.54	2.79
Baetidae	40120000	2.34	2.36	2.34	2.76	2.88	2.85	2.60	2.69	2.16
Valvatidae	16130000	1.00		1.00	1.00	1.17	1.36	1.53	1.57	2.11
Unionidae	17120000					1.00	1.00	1.67	1.00	1.19
Sialidae	46110000	1.00	1.08	1.00	1.17	1.18	1.13	1.30	1.36	1.48
Ancylidae (incl. Acroloxidae)	162Z0000	1.31	1.58	1.18	1.46	1.73	1.80	1.76	1.69	1.64
Hydrophilidae (incl. Hydraenidae)	453Z0000	1.30	1.23	1.09	1.44	1.27	1.24	1.25	1.15	1.14
Notonectidae	43510000	1.00	1.00						1.00	1.18
Calopterygidae	42140000	1.00	1.38	1.00	1.00	1.11	1.00	1.20	1.22	1.13
Molannidae	48390000		1.00					1.18	1.50	1.29
Tipulidae	50100000	1.52	1.67	1.40	1.48	1.85	1.58	1.39	1.49	1.09
Hydrometridae	43210000		1.00			1.00				1.00
Gyrinidae	45150000	1.25	1.21	1.07	1.24	1.28	1.32	1.29	1.60	1.20
Hydropsychidae	48250000	1.83	1.95	1.76	2.37	2.27	2.51	2.15	1.98	1.39
Neritidae	16110000		1.00		1.00	1.00	1.45	1.66		1.61
Caenidae	40510000	1.57	1.58	1.63	1.89	2.25	2.32	2.27	1.75	2.38
Psychomyiidae (incl. Ecnomidae)	482Z0000	1.00	1.08	1.11	1.11	1.23	1.30	1.31	1.27	1.32
Nemouridae	41120000	2.17	1.77	1.85	1.95	1.54	1.37	1.14	1.36	1.00
Leptoceridae	48410000	1.10	1.50	1.23	1.37	1.64	1.69	1.82	1.67	1.67
Hydroptilidae	48130000	1.48	1.56	1.36	1.54	1.69	1.81	1.87	1.88	1.54
Leptophlebiidae	40210000	1.26	1.77	1.26	1.32	1.68	1.21	1.36	1.70	1.50
Gerridae	43230000	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Limnephilidae	48340000	1.64	1.99	1.41	1.64	1.71	1.27	1.56	1.86	1.53
Aphelocheiridae	43420000					1.60	1.82	1.61		1.14
Elmidae	45630000	2.09	2.18	2.07	2.52	2.76	2.78	2.69	2.63	1.91
Brachycentridae	48320000	1.00		1.27	1.64	1.38	1.75	1.42	1.00	1.67
Heptageniidae	40130000	2.41	1.90	2.47	2.62	2.41	2.33	1.59	1.38	1.00
Taeniopterygidae	41110000	1.40	1.65	1.19	1.43	1.48	1.37	1.44	1.50	1.00
Ephemerellidae	40410000	1.83	1.66	1.57	1.77	2.07	1.93	1.79	1.94	1.41
Piscicolidae	22110000	2.00	1.19		1.00	1.00	1.00	1.28	1.29	1.28
Leuctridae	41130000	2.11	1.65	1.86	1.85	1.70	1.57	1.36	1.20	
Lepidostomatidae	48330000	1.30	1.38	1.50	1.86	2.00	1.81	1.62	1.45	1.00
Chloroperlidae	41230000	1.45	1.33	1.44	1.40	1.50	1.33	1.00		
Polycentropodidae	48240000	1.28	1.26	1.34	1.37	1.54	1.56	1.70	1.68	1.78
Perlodidae	41210000	1.61	1.52	1.49	1.63	1.63	1.57	1.38	1.40	1.00
Beraeidae	48360000	1.00	1.23			1.25			1.67	1.00
Sericostomatidae	48370000	1.35	1.46	1.11	1.48	1.70	1.28	1.45	1.70	1.20
Scirtidae	45510000	1.05	1.48	1.14	1.00	1.00		1.00	1.33	1.00
Ephemeridae	40320000	1.33	1.66	1.00	1.27	1.53	1.25	1.60	1.62	1.31
Rhyacophilidae (incl. Glossosomatidae)	481Z0000	1.56	1.75	1.72	2.19	2.20	2.01	1.72	1.50	1.00
Goeridae	48350000	1.05	1.35	1.00	1.41	1.52	1.21	1.40	1.35	1.60
Odontoceridae	48380000	1.15	1.44	1.00	1.30	1.00		1.00	1.80	
(shaded)										
Aeshnidae	42230000									1.00
Astacidae	34310000	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Capniidae	41140000	1.20	1.50	1.00	1.00	1.00	2.00			
Cordulegasteridae	42220000	1.00	1.08	1.00	1.00	1.00	1.00		1.00	
Corophiidae	37110000									2.38
Dryopidae	45620000	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.33
Gomphidae	42210000							1.00		1.25
Hirudinidae	22210000		1.00		1.00				1.00	1.00
Libellulidae	42250000									1.00
Naucoridae	43410000									1.00
Nepidae	43310000		1.00					1.00	1.00	1.00
Perlidae	41220000	1.35	1.00	1.32	1.29	1.00	1.15			
Philopotamidae	48210000	1.25	1.25	1.00	1.20		1.00			
Potamanthidae	40310000						2.00	1.00		
Siphlonuridae	40110000	1.16		1.13		1.50				
Viviparidae	16120000							1.50		1.85

Figure 25. Relationship between a) mean BOD (mg l^{-1}), b) 10^{th} percentile of dissolved oxgyen saturation, c) 90^{th} percentile of BOD (mg l^{-1}) and d) 90^{th} percentile of total ammonia (mg l^{-1}) and 1 – the cumulative proportion of occurrences (or cumulative proportion of occurrences for b) dissolved oxygen) of Odontoceridae. The intersection of the dashed line and the response surface corresponds to a concentration below (or above for b) dissolved oxygen) which 80% of sites containing this taxon occurs.

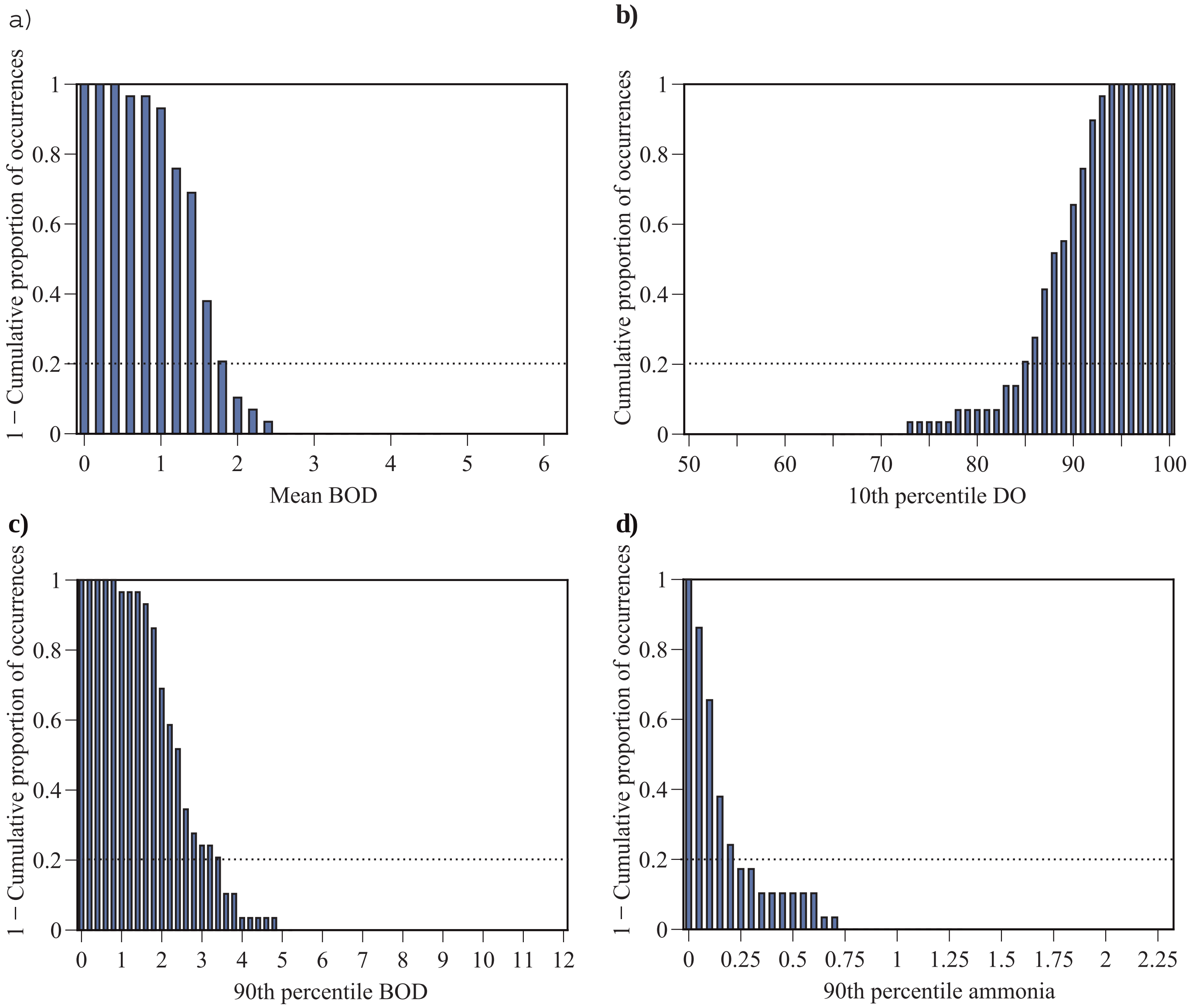


Figure 26. Relationship between a) mean BOD (mg l^{-1}), b) 10th percentile of dissolved oxgyen saturation, c) 90th percentile of BOD (mg l^{-1}) and d) 90th percentile of total ammonia (mg l^{-1}) and 1 – the cumulative proportion of occurrences (or cumulative proportion of occurrences for b) dissolved oxygen) of Goeridae. The intersection of the dashed line and the response surface corresponds to a concentration below (or above for b) dissolved oxygen) which 80% of sites containing this taxon occurs.

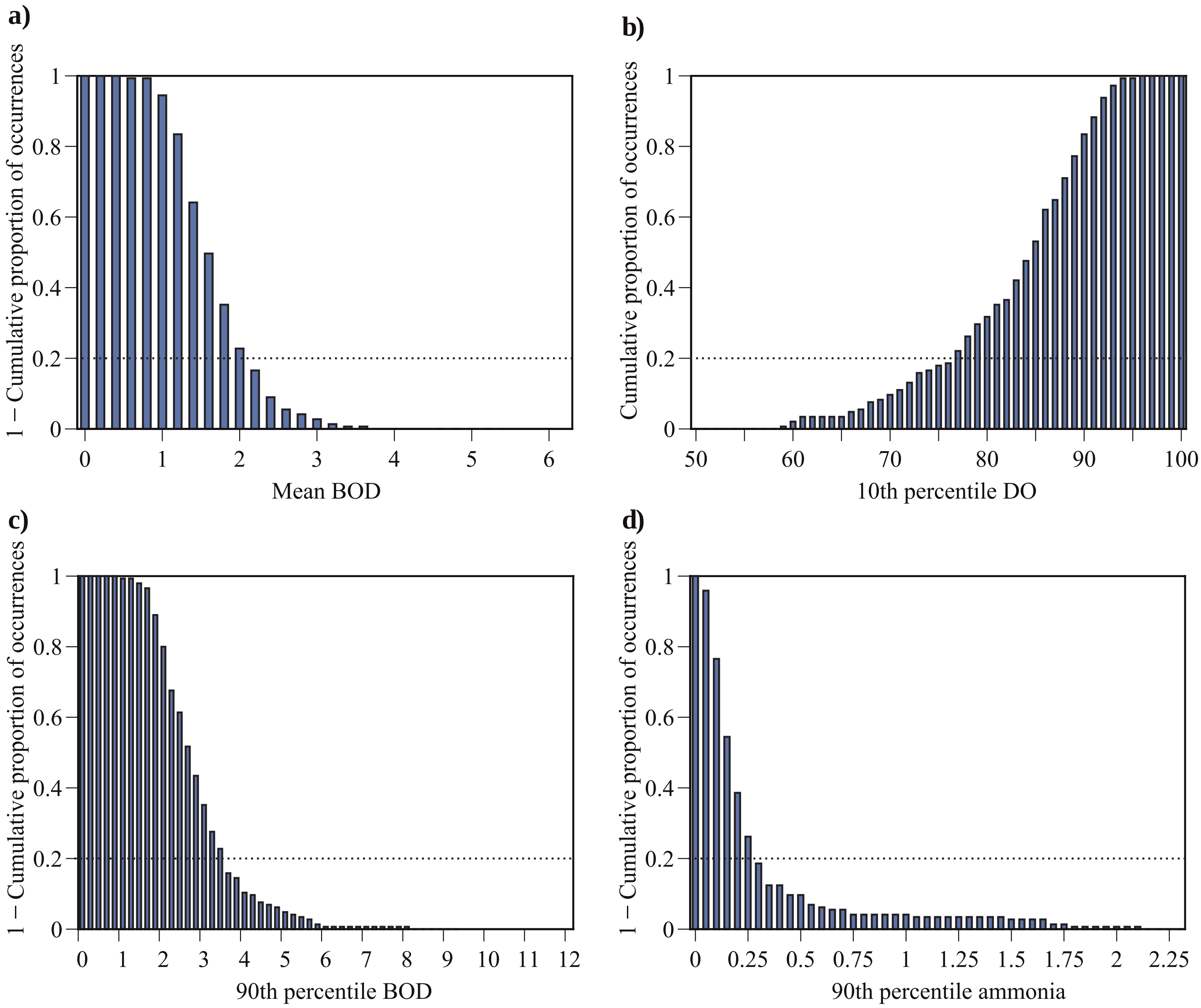


Figure 27. Relationship between a) mean BOD (mg l^{-1}), b) 10th percentile of dissolved oxgyen saturation, c) 90th percentile of BOD (mg l^{-1}) and d) 90th percentile of total ammonia (mg l^{-1}) and 1 – the cumulative proportion of occurrences (or cumulative proportion of occurrences for b) dissolved oxygen) of Rhyacophilidae (incl. Glossosomatidae). The intersection of the dashed line and the response surface corresponds to a concentration below (or above for b) dissolved oxygen) which 80% of sites containing this taxon occurs.

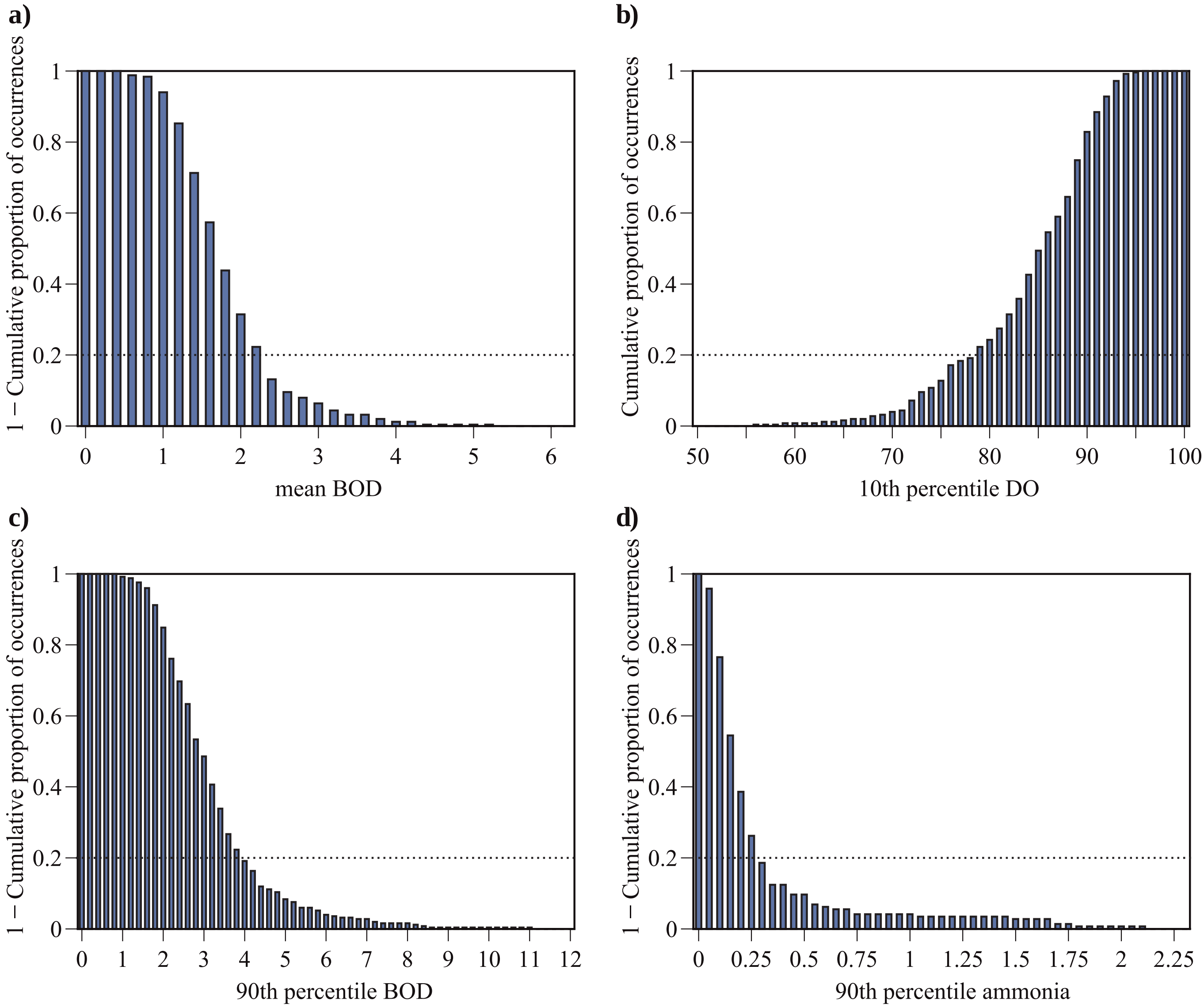


Table 28. Thresholds of sensitive taxa as defined by 80% of occurrences.

	% O_2	BOD		Total NH_3
	10^{th} percentile % saturation	Mean mg l^{-1}	90^{th} percentile mg l^{-1}	90^{th} percentile mg l^{-1} (as N)
Odontoceridae	85	1.8	3.4	0.23
Goeridae	77	2.0	3.4	0.29
Rhyacophilidae (incl. Glossosomatidae)	79	2.2	3.9	0.35

Table 29. Likley occurrence (> 10% of sites) of ranked sensitive taxa within RIVPACS endgroups.

	Likely occurrence in RIVPACS Endgroups								
	1	2	3	4	5	6	7	8	9
Odontoceridae	■	■		■	■				
Goeridae						■	■	■	■
Rhyacophilidae (incl. Glossosomatidae)			■						

Table 30. Putative organic pollution targets by class for the Natural England river typology.

a) 10th percentile Dissolved Oxygen saturation (%)

Dominant Catchment Geology		Threshold		
		1. Head water	2. River	3. Large River
A	Hard upland geologies (	85	79	79
B	Other Cambrian-Devonian geologies	85	85	79
C	Jurassic and Cretaceous limestones	85	79	79
D	Triassic sandstones and mudstones	85	85	79
E	Mesozoic clay vales and Tertiary clays	85	79	79

b) mean BOD (mg l^{-1})

Dominant Catchment Geology		Threshold		
		1. Head water	2. River	3. Large River
A	Hard upland geologies (	1.8	2.0	2.0
B	Other Cambrian-Devonian geologies	1.8	1.8	2.0
C	Jurassic and Cretaceous limestones	1.8	2.0	2.0
D	Triassic sandstones and mudstones	1.8	1.8	2.0
E	Mesozoic clay vales and Tertiary clays	1.8	2.0	2.0

c) 90th percentile total Ammonia as N (mg l^{-1})

Dominant Catchment Geology		Threshold		
		1. Head water	2. River	3. Large River
A	Hard upland geologies (	0.23	0.29	0.29
B	Other Cambrian-Devonian geologies	0.23	0.23	0.29
C	Jurassic and Cretaceous limestones	0.23	0.29	0.29
D	Triassic sandstones and mudstones	0.23	0.23	0.29
E	Mesozoic clay vales and Tertiary clays	0.23	0.29	0.29

The time period over which the chemical determinands are to be sampled to determine mean and 10th and 90th percentiles should be the same as that used to derive these thresholds, i.e. over at least the preceeding 3 years and including at least 30 samples.

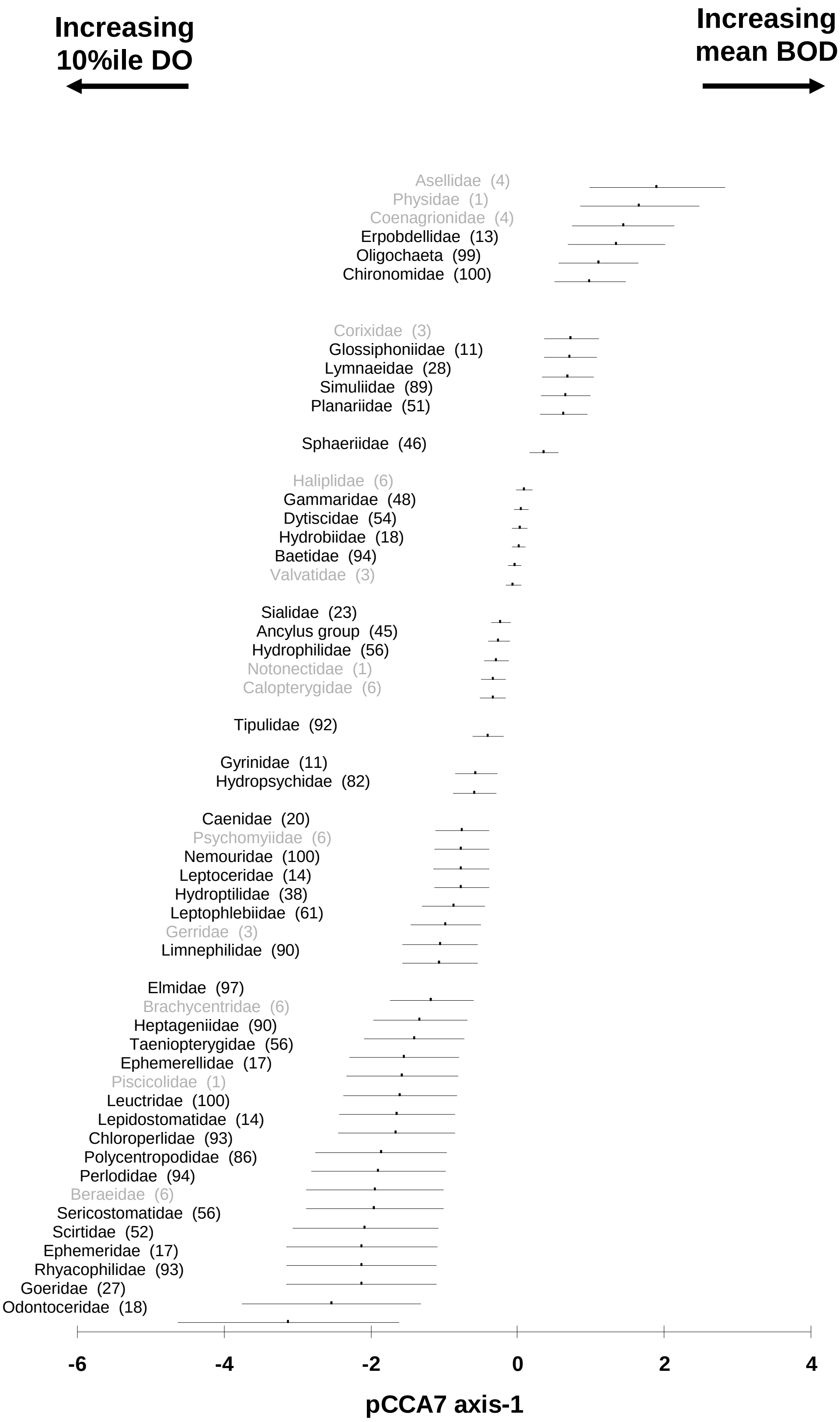


Figure 28. Relationship between macroinvertebrate taxa occurring in RIVPACS 9-endgroup Class 1 and the first canonical axis, characterised by increasing mean BOD and decreasing 10th percentile dissolved oxygen. Frequencies of occurrence of taxa in sites of RIVPACS 9- endgroup level Class 1 are shown in parenthesis. Shaded taxa are present in less than 10% of sites of Class 1.

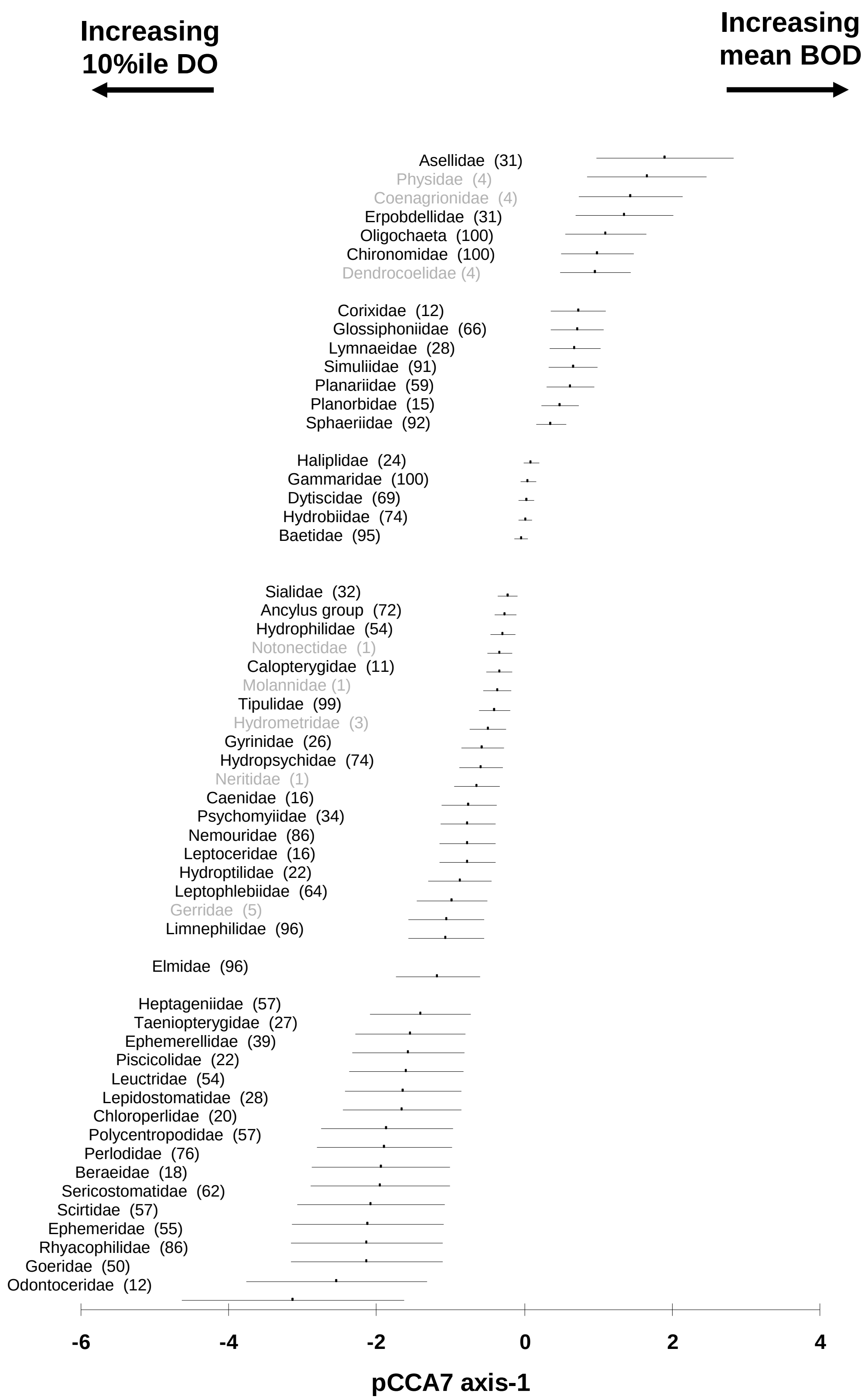


Figure 29. Relationship between macroinvertebrate taxa occurring in RIVPACS 9-endgroup Class 2 and the first canonical axis, characterised by increasing mean BOD and decreasing 10th percentile dissolved oxygen. Frequencies of occurrence of taxa in sites of RIVPACS 9- endgroup level Class 2 are shown in parenthesis. Shaded taxa are present in less than 10% of sites of Class 2.

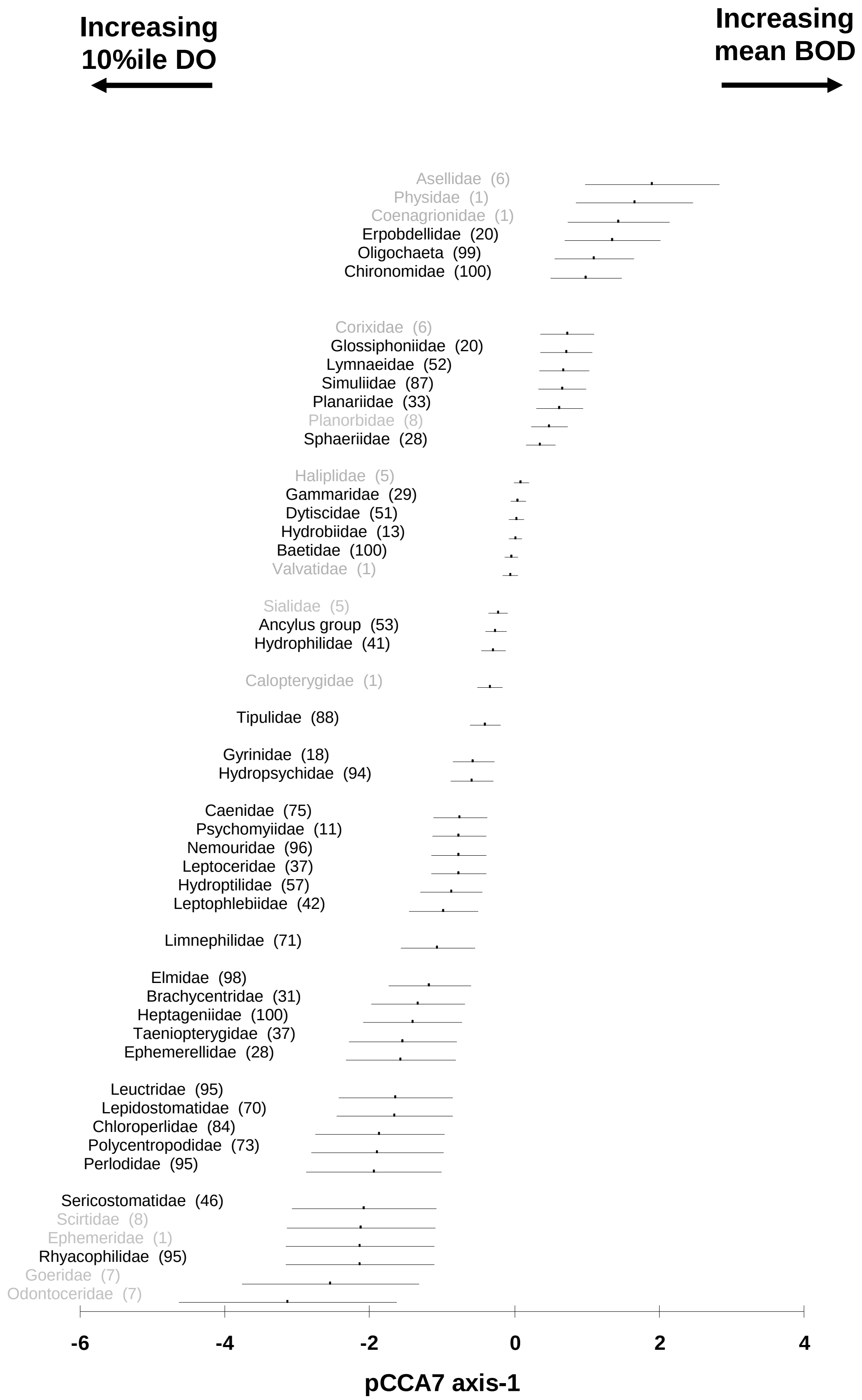


Figure 30. Relationship between macroinvertebrate taxa occurring in RIVPACS 9-endgroup Class 3 and the first canonical axis, characterised by increasing mean BOD and decreasing 10th percentile dissolved oxygen. Frequencies of occurrence of taxa in sites of RIVPACS 9- endgroup level Class 3 are shown in parenthesis. Shaded taxa are present in less than 10% of sites of Class 3.

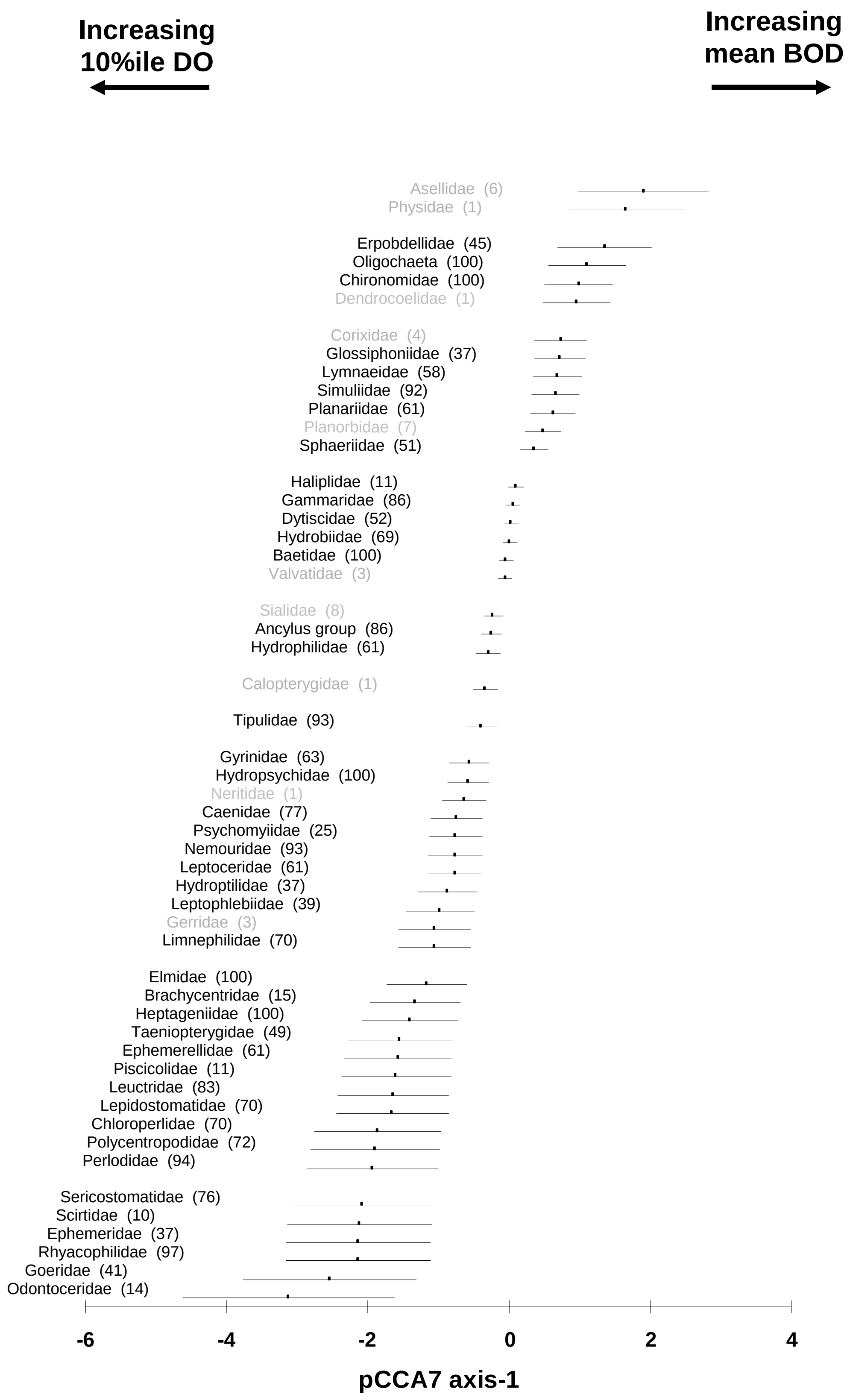


Figure 31. Relationship between macroinvertebrate taxa occurring in RIVPACS 9-endgroup Class 4 and the first canonical axis, characterised by increasing mean BOD and decreasing 10th percentile dissolved oxygen. Frequencies of occurrence of taxa in sites of RIVPACS 9- endgroup level Class 4 are shown in parenthesis. Shaded taxa are present in less than 10% of sites of Class 4.

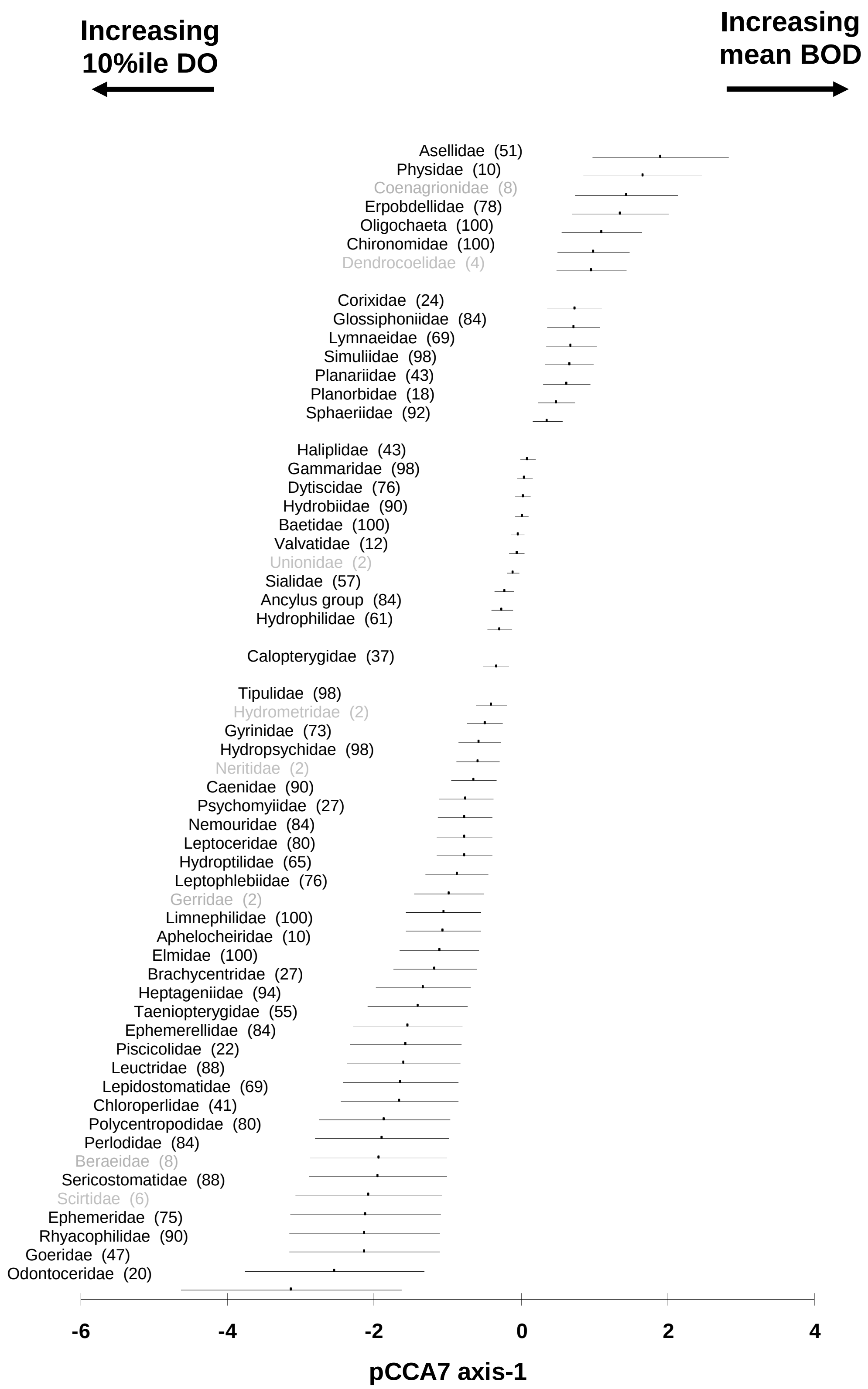


Figure 32. Relationship between macroinvertebrate taxa occurring in RIVPACS 9-endgroup Class 5 and the first canonical axis, characterised by increasing mean BOD and decreasing 10th percentile dissolved oxygen. Frequencies of occurrence of taxa in sites of RIVPACS 9- endgroup level Class 5 are shown in parenthesis. Shaded taxa are present in less than 10% of sites of Class 5.

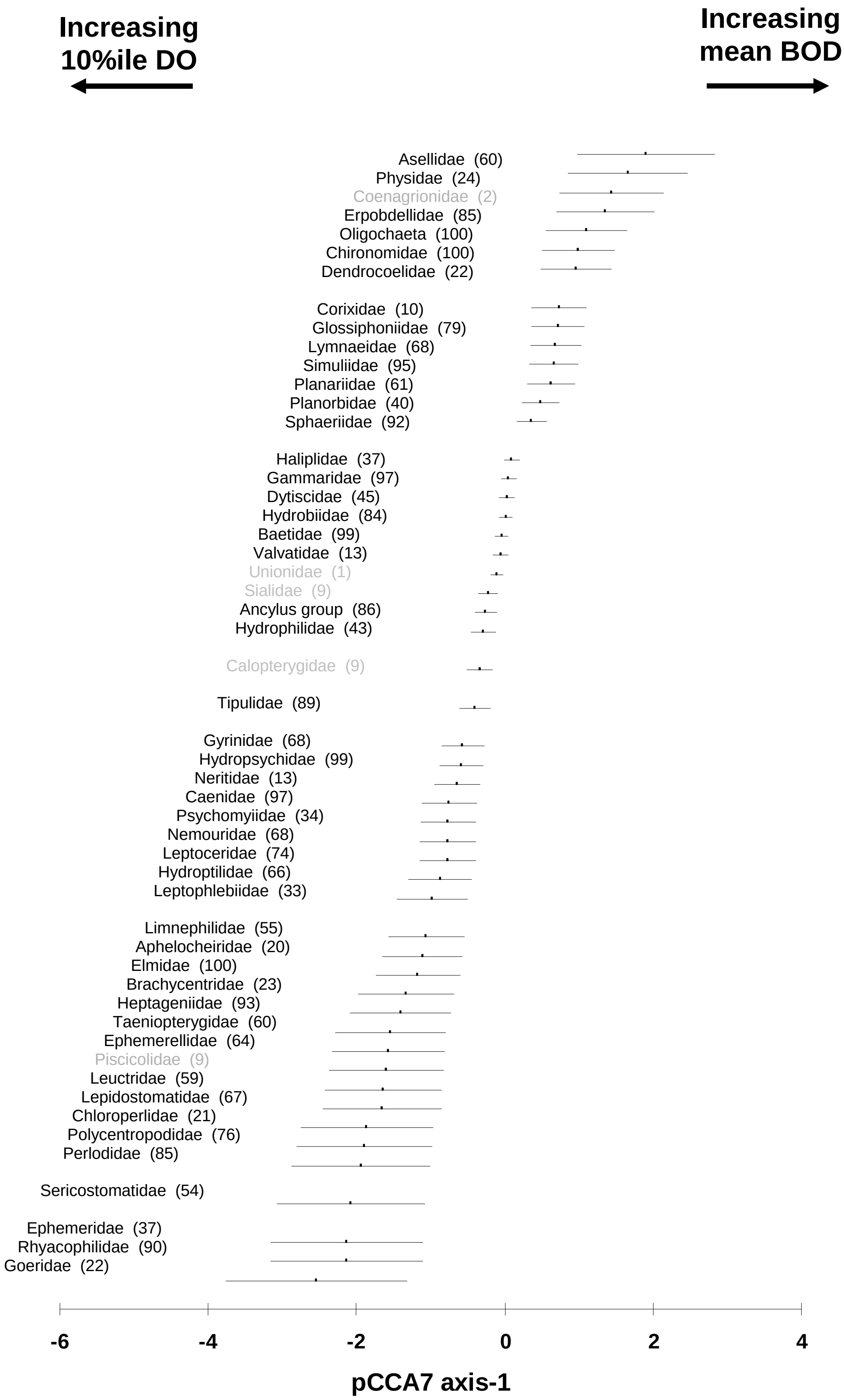


Figure 33. Relationship between macroinvertebrate taxa occurring in RIVPACS 9-endgroup Class 6 and the first canonical axis, characterised by increasing mean BOD and decreasing 10th percentile dissolved oxygen. Frequencies of occurrence of taxa in sites of RIVPACS 9- endgroup level Class 6 are shown in parenthesis. Shaded taxa are present in less than 10% of sites of Class 6.

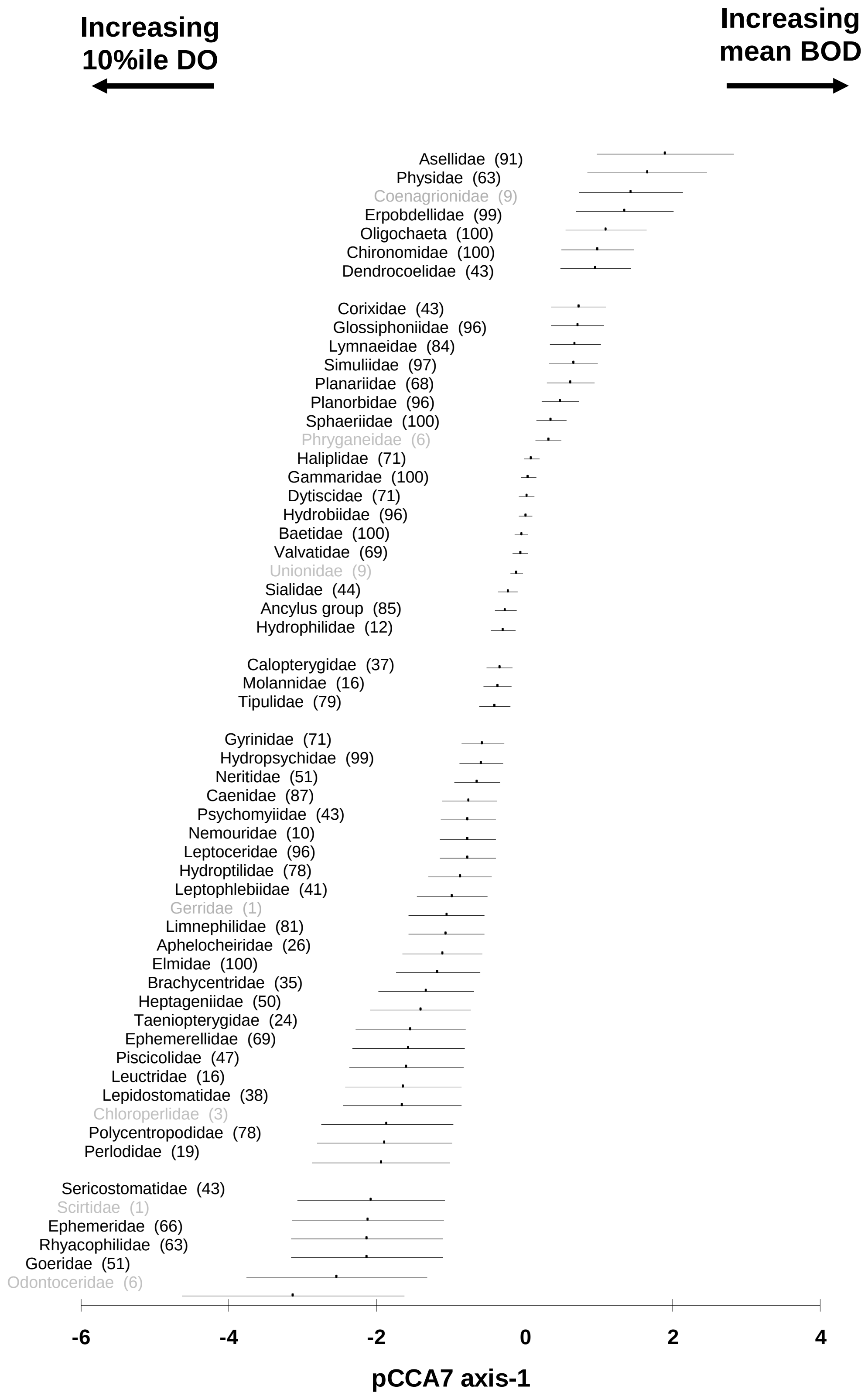


Figure 34. Relationship between macroinvertebrate taxa occurring in RIVPACS 9-endgroup Class 7 and the first canonical axis, characterised by increasing mean BOD and decreasing 10th percentile dissolved oxygen. Frequencies of occurrence of taxa in sites of RIVPACS 9- endgroup level Class 7 are shown in parenthesis. Shaded taxa are present in less than 10% of sites of Class 7.

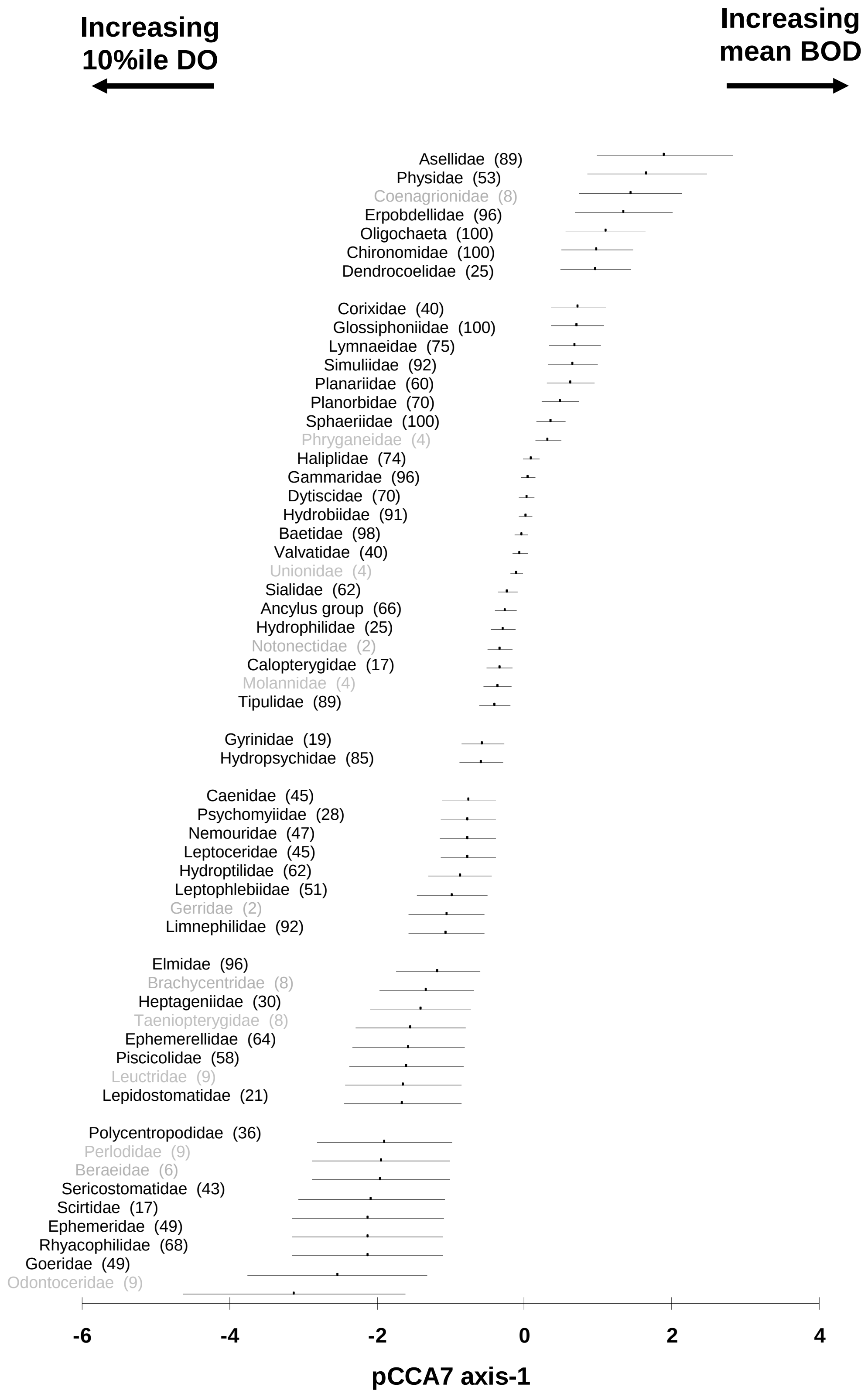


Figure 35. Relationship between macroinvertebrate taxa occurring in RIVPACS 9-endgroup Class 8 and the first canonical axis, characterised by increasing mean BOD and decreasing 10th percentile dissolved oxygen. Frequencies of occurrence of taxa in sites of RIVPACS 9- endgroup level Class 8 are shown in parenthesis. Shaded taxa are present in less than 10% of sites of Class 8.

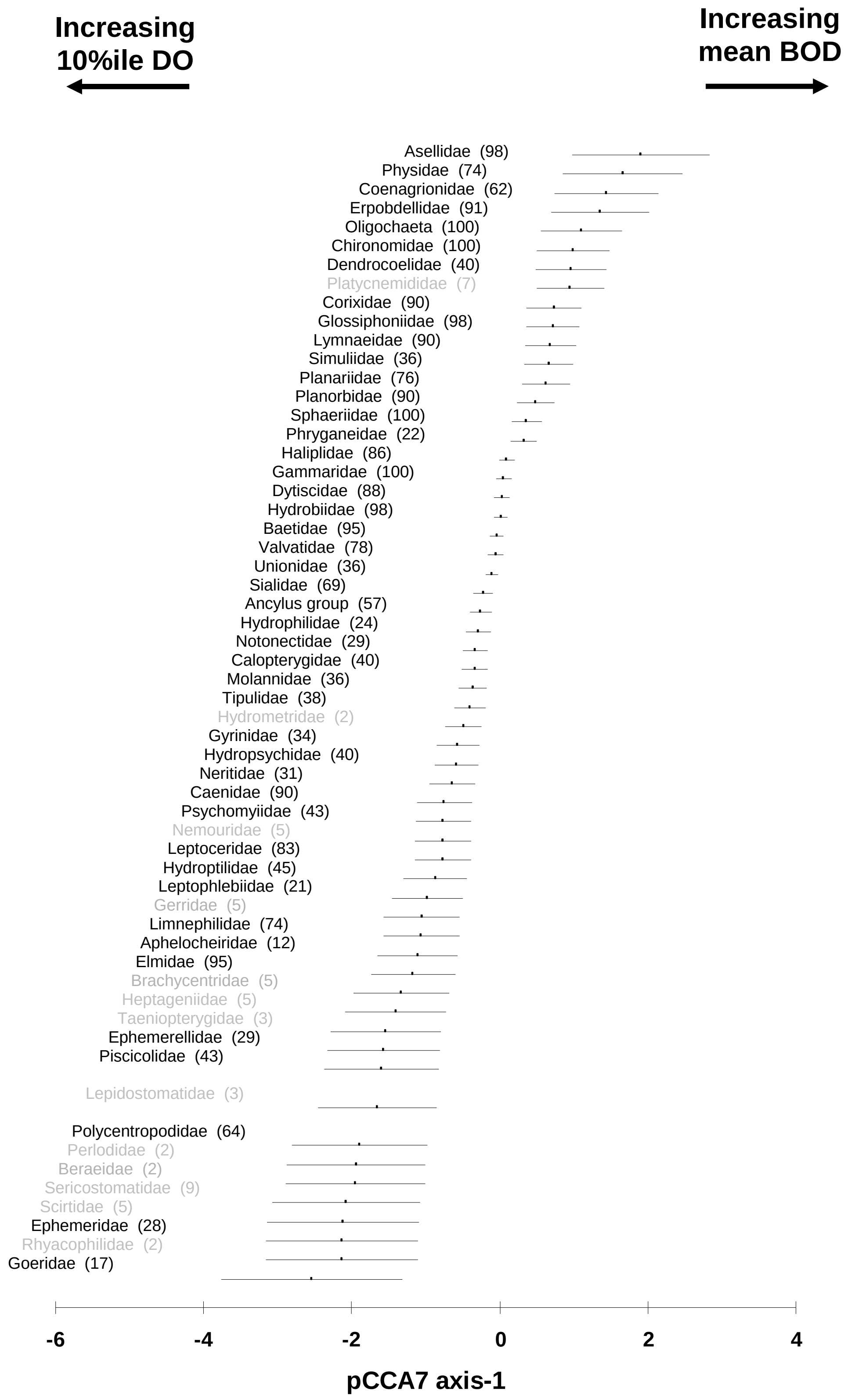


Figure 36. Relationship between macroinvertebrate taxa occurring in RIVPACS 9-endgroup Class 9 and the first canonical axis, characterised by increasing mean BOD and decreasing 10th percentile dissolved oxygen. Frequencies of occurrence of taxa in sites of RIVPACS 9- endgroup level Class 9 are shown in parenthesis. Shaded taxa are present in less than 10% of sites of Class 9.

4. Reconciling Data Analysis with Published Literature

It is recognised that the results presented here may differ from those published previously. In part this may be due to differences in the approach used or to the measures of organic pollution determinands used. BOD has been used here as it a relatively stable measure (analytically) that summarises the extent of organic pollution, not to imply that it is a driver of change in the community

The main distinction between the results presented here and those published previously relates to differences between data produced by laboratory assessments under controlled conditions and data produced by correlation of observational data produced through field survey. As discussed earlier (section 2.4), laboratory trials enable a high degree of control but lack realism, and correlation between these two approaches was not expected. Laboratory trials do not allow any behavioural avoidance of the episodic extreme conditions that occur with pollution events, which enables populations to persist under field conditions. Controlled dosing of real systems represents a good compromise beween control and realism, but lacks the population level effects that are inherent in field observations. Whilst there was good correspondence in taxon rank order of sensitivity between the controlled dosing experiments of Turner (1992) and the results presented here, the absolute concentrations required to produce an experimental response were indicative of more severe pollution stress than was seen to produce a response here in field observation data, possibly due to sub-lethal effects impacting populations that are not apparent on individuals over short time scales.

Nevertheless, the threshold proposed for ammonia (0.23 mg l^{-1}) using the most sensitive taxa identified here, Odontoceridae, was similar to the LC_{50} for the most sensitve invertebrate taxa for which data were available, *Polycelis tenuis* (0.58 mg l^{-1}; Table 4). Both thresholds proposed (Table 30) are considerably lower than the published LC_{50} for the majority of invertebrate taxa, but an order of magnitude higher than the minimum concentration of ammonia in the literature that has produced a response (Table 4).

It should be stressed that numerous factors influence the occurrence of a taxon at a site, including historic and spatial constraints. The occurrence of a taxon at any site is influenced not only by local conditions, but by the relationship with associated populations (i.e. the meta-population context). The occurrence of a taxon will differ among sites dependent upon how well connected the site is with sources of potential colonists; of specific issue here, recovery from a pollution event will be more rapid if there is an unaffected population upstream than if there is not. Recolonisation of a site will be dependent upon the distance between neighbouring populations, and the rate of movement through the landscape, as well as the growth rate of the population and the time since the last pollution event. It is also possible that a site may lack a taxon, although conditions may be appropriate, because conditions in the surrounding landscape are not suitable to support a viable meta-population. These population/landscape level factors introduce noise into analyses of field data, but do not influence estimates of toxicity derived in the laboratory.

Compared to the tolerance of the most sensitive taxa identified by correlation analyses based on the 1995 river survey data conducted by Walley & Hawkes of Staffordshire University, the thresholds defined here are similar (Table 31). It should be noted, however, none of the three most sensitive taxa defined by Walley & Hawkes were included in the analyses here as they were too infrequent, and that many of the apparently more sensitive species as identified by Staffordshire University, occur infrequently in their data set. As the full range of conditions under which infrequently occuring taxa can persist cannot be accurately described from the few sites where they occur, such taxa were excluded from the analysis here, and fitted passively (i.e. with little influence on the results, but still giving some indication of the conditions under which they were found). The discrepancy between the Walley & Hawkes rank order of sensitivity and that observed here increased with a decreasing number of observations used in the Staffordshire data (Figure 37), indicating that the inclusion of infrequently observed taxa underestimates the range of conditions under which they can persist. We suggest that the tolerance can only be confidently assessed for taxa that occurred more than 500 times in the Walley & Hawkes dataset using their approach. Of the 23 most sensitive taxa identified by Walley & Hawkes only one was observed in more than 500 sites (Chloroperlidae mean rank 20): The 24th most sensitive taxa was Goeridae, the second most sensitive taxa identified here. Odontoceridae, the most sensitive taxa identified here, was ranked 17th most sensitive using the Staffordshire approach (Table 34).

The thresholds set using the most sensitive taxa identified here are considerably lower than the limits of occurence of these taxa identified by Staffordshire University (Table 32), probably due to the approaches used but poor matching between chemistry and biology in the 1995 GQA data used by Staffordshire may have played a part also. However, there is reasonable agreement between the 75th percentile of the distribution as determined by Staffordshire University and the thresholds set here at 80% of occurrences (Table 33).

Overall the putative thresholds proposed here appear to be of the same order as previously published data, but there will always be considerable uncertainty in the absolute values dependent on the approach and data used to derive them.

Table 31. Summary statistics of tolerance to dissolved oxygen saturation, BOD and total ammonia of the three most sensitive taxa identified by Staffordshire University. NB none of these taxa were included in the analysis here due to low frequency of occurrence.

	DO % satn.		BOD		Total Ammonia	
Rank		%		mg l^{-1}		mg l^{-1}
1	Potamanthidae	93.3	Potamanthidae	2.37	Potamanthidae	0.053
2	Siphlonuridae	79.1	Dryopidae	2.70	Dryopidae	0.31
3	Philopotamidae	78.3	Siphlonuridae	3.00	Capniidae	0.4

Table 32. Summary statistics of tolerance and rank sensitivity to dissolved oxygen saturation, BOD and total ammonia as determined by Staffordshire University and from the pCCA of the three most sensitive taxa identified here.

	DO % satn.			BOD			Total Ammonia		
	Rank	Tolerance		Rank	Tolerance		Rank	Tolerance	
	Staffs		CEH	Staffs		CEH	Staffs		CEH
Odontoceridae	16	50.1	78	23	9.5	2.4	32	25.14	0.54
Goeridae	16	50.1	66	23	9.5	2.8	36	30.67	0.91
Rhyacophilidae	47	20.4	70	33	12.5	3.2	36	30.67	0.81

Table 33. Summary statistics of rank sensitivity and 75th percentile to dissolved oxygen saturation, BOD and total ammonia as determined by Staffordshire University and the 80th percentile as determined by CEH for the three most sensitive taxa identified here.

	DO % satn.			BOD			Total Ammonia		
	Staffs		CEH	Staffs		CEH	Staffs		CEH
	Rank	75%ile	80%ile	Rank	75%ile	80%ile	Rank	75%ile	80%ile
Odontoceridae	16	97	85	23	1.6	1.8	32	0.25	0.23
Goeridae	16	92	77	23	1.8	2.0	36	0.11	0.29
Rhyacophilidae	47	94	79	33	1.8	2.2	36	0.10	0.35

Table 34. Comparison of family rank order as determined in section 3.1 by partial ordination and by tolerance to BOD, ammonia and dissolved oxygen as determined using artificial intelegence by Walley & Hawkes (see table 12), together with the number of observations used by Walley & Hawkes.

	CEH Rank	Walley & Hawkes Mean Rank	Walley & Hawkes Rank Order	Walley & Hawkes N obs
Odontoceridae	1	18.8	7	392
Goeridae	2	24.2	11	1639
Ephemeridae	3	31.6	21	1472
Rhyacophilidae	4	37.4	28	2853
Scirtidae	5	34.3	24	470
Sericostomatidae	6	31.4	20	2578
Beraeidae	7	13.4	5	144
Perlodidae	8	26	13	1754
Polycentropodidae	9	43.2	35	1635
Chloroperlidae	10	20	8	893
Lepidostomatidae	11	28	16	1658
Leuctridae	12	26	12	2199
Piscicolidae	13	37.2	27	950
Ephemerellidae	14	30.4	19	1766
Taeniopterygidae	15	28.8	18	783
Heptageniidae	16	41	33	2504
Brachycentridae	17	23	10	499
Elmidae	18	47.8	39	5079
Aphelocheiridae	19	8.4	1	223
Limnephilidae	20	54.4	51	3594
Gerridae	21	26.6	14	270
Leptophlebiidae	22	43.8	36	1535
Hydroptilidae	23	35.2	25	1641
Leptoceridae	24	37.8	29	3231
Nemouridae	25	41	34	1969
Psychomyiidae	26	40.8	32	1280
Caenidae	27	36	26	2689
Neritidae	28	9.4	2	391
Hydropsychidae	29	50.2	41	4441
Gyrinidae	30	39.4	30	2090
Hydrometridae	31	28.6	17	179
Tipulidae	32	51.2	43	4238
Molannidae	33	13.2	4	250
Calopterygidae	34	33.6	23	1179
Notonectidae	35	33	22	437
Hydrophilidae	36	49.2	40	2304
Ancylusgroup	37	50.4	42	3595
Sialidae	38	52.4	47	1646
Unionidae	39	17	6	299
Valvatidae	40	51.6	44	1277
Baetidae	41	53.8	48	5610
Hydrobiidae	42	55.6	52	5406
Dytiscidae	43	56.5	56	3343
Gammaridae	44	53.8	49	5795
Haliplidae	45	45	37	1662
Phryganeidae	46	22.6	9	197
Sphaeriidae	47	55.6	53	5087
Planorbidae	48	51.8	45	2405
Planariidae	49	47.2	38	3208
Simuliidae	50	54.3	50	4064
Lymnaeidae	51	55.7	54	3684
Glossiphoniidae	52	58	57	4323
Corixidae	53	52	46	1463
Platycnemididae	54	12.4	3	132
Dendrocoelidae	55	27.4	15	452
Chironomidae	56	63.5	60	6797
Oligochaeta	57	63.3	58	6788
Erpobdellidae	58	56.4	55	4111
Coenagrionidae	59	40.2	31	1015
Physidae	60	63.3	59	1344
Asellidae	61	68.3	61	4036
Aeshnidae	Not determined	29		37
Astacidae	Not determined	8.4		79
Capniidae	Not determined	23.6		31
Cordulegasteridae	Not determined	16.4		180
Corophiidae	Not determined	6.6		77
Dryopidae	Not determined	7.8		26
Hirudididae	Not determined	18.3		20
Libellulidae	Not determined	21.8		44
Naucoridae	Not determined	12.4		52
Nepidae	Not determined	20.8		41
Perlidae	Not determined	9		302
Philopotamidae	Not determined	10.4		161
Potamanthidae	Not determined	1.3		11
Siphlonuridae	Not determined	2.5		8
Viviparidae	Not determined	11.3		99

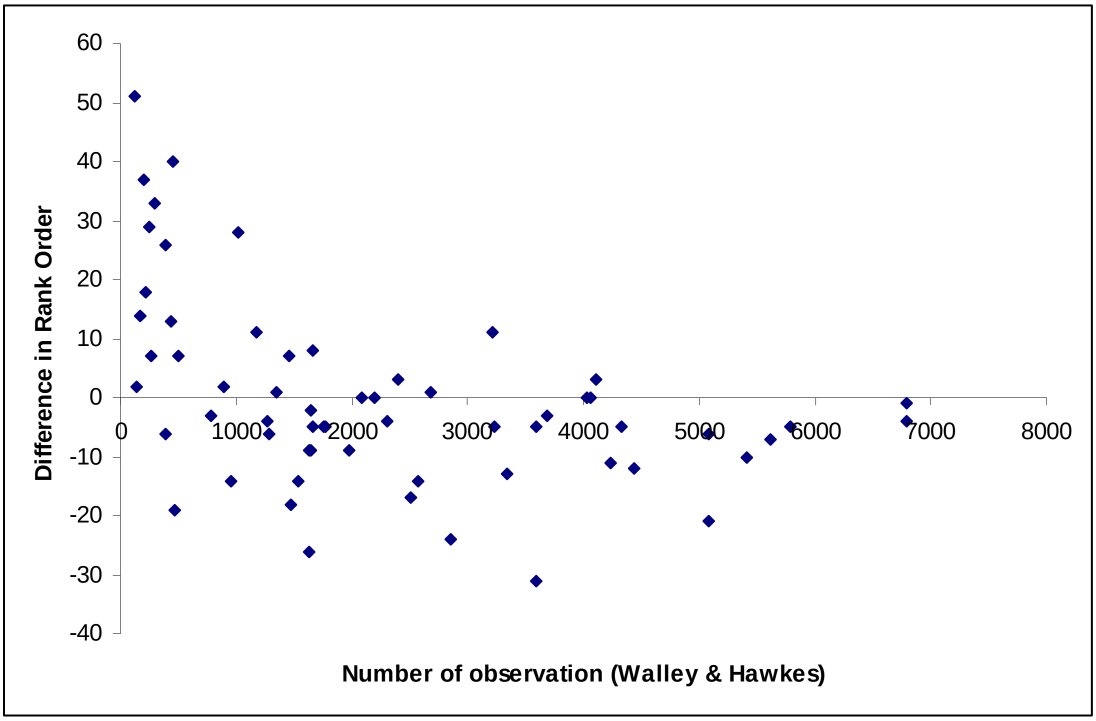


Figure 37. Relationship between differences in rank order in response of taxa to organic pollution as determined here by partial ordination and by Walley & Hawkes and the number of observations used by Walley & Hawkes. NB the number of observations for the 15 taxa for which a response was not determined here ranged from 8 – 302.

5. Finalising Proposals for Thresholds

The final proposals for thresholds for organic pollution need to be based on the soundest evidence available. Here we present both new analysis directed towards establishing such thresholds and information published previously.

It is also necessary to consider compliance with these thresholds in the context of the statistical approach to uncertainty. Failure to comply with water quality targets typically takes into account the uncertainty associated with sampling and analysing the determinand under consideration, and it is typical for the Environment Agency to adopt a requirement of 95% certainty of failure of a target before a river is considered non-compliant.. However, in terms of the thresholds presented here, the aim I to ensure that conditions are suitable for characteristic biota, including the persistence of populations of the most sensitive taxa. As such, it is necessary to err on the side of caution. Hence, we recommend that the burden on proof should be on the probability of achieving the threshold target rather than on probability of failure.

The legislation covering specially designated wildlife sites implies a high level of certainty in the protection afforded these sites. Here thresholds have been selected on the most sensitive taxa likely to be present, with the concentrations set such that 80% of all occurrences of these taxa are in less polluted conditions. By selecting 80%, the tail of the distribution of occurrences relative to pollution determinands is avoided, such that any difference in the percentage chosen as the cut-off would make little difference in the concentrations used for the thresholds. Thus, the confidence in the thresholds is increased.
In terms of biological targets, it is recommended that GQA Class A should be the target for all types of designated rivers. RIVPACS takes into account differences in the fauna of different river types with quality measured as observed/expected. Therefore, any impact on the biological community will be reflected in a deviation from class A, and correspondingly, deviation from Class A implies that part of the biological community is lacking compared to an unpolluted river of the same type. Class B is described as “a small reduction in the number of families that are sensitive to pollution, and a moderate increase in the number of individual creatures in the families that tolerate pollution (like worms and midges). This may indicate the first signs of organic pollution” (Hemsley-Flint 2000).

6. Analysis of Compliance with Proposed Thresholds at GQA Sites

The data compiled from CEH holdings were used to determine the compliance of rivers with national and international designations for wildlife, including Sites of Special Scientific Interest (SSSIs) and Special Areas of Conservation (SACs), with the proposed thresholds of organic pollution.

For each designated river, sites where sufficient data were available collected since 2000, the concentration profiles (mean, minimum, maximum, and 10th and 90th percentiles) were plotted graphically, together with the proposed thresholds for each relevant determinand (Figures 38 to 56). Both thresholds were plotted, with the relevant one dependent upon river type. The length of the x axis is scaled to the total length of the designated portion of the river and sites arranged along the x axis in their relative spatial positions, upstream to downstream, labelled with GQA site codes; site names are given in Table 35. Calculated unionised ammonia concentration profiles were plotted together with the Environment Agency threshold of 21 $\mu g\ l^{-1}$. Where data were available the total inorganic nitrogen concentration profile and orthophosphate concentration profile were plotted also.

These figures can be used to infer compliance at each monitoring site. If the relevant measure (mean for BOD, i.e dark bar, and 90th/10th percentile for Total Ammonia and Dissolved Oxygen, i.e. upper and lower limit of box) exceeds the relevant threshold that site is likely to have failed.

6.1 Data Collation and Analysis

Data from CEH holdings were compiled from GQA sites within SSSI sites where more than 2 samples had been analysed, and the mean, standard deviation, minimum, maximimum, and 5th, 10th, 90th and 95th percentiles calculated for various determinands indicative of organic and associated pollution (See Appendix 2). The number of samples analysed per site varied amongst the different determinands, with infrequent samples analysed for heavy metals in particular: the determinands indicative of organic pollution were analysed most frequently. The number of samples used is given in each case (see Appendix 2). Site names corresponding to codes are given in Table 35.

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6.2 Summary of Compliance

Table 35. Codes and names of sites used to compile summary statistics for determinands associated with organic pollution.

Site Code	Site Name
70220119	River Axe U/S Colyton Stw
70220140	River Axe D/S Whitford Abstraction
70230103	River Axe at Bow Bridge
50211448	Eastern Avon at Sharcott
50210705	Western Avon at Upavon
50260521	Hampshire Avon Upsrteam Of Salisbury Stw
50230245	River Wylye Steeple Langford Bridge
50250551	River Wylye U/S Warminster Stw
50260330	Hampshire Avon at Downton (Main River)
50260338	Hampshire Avon Upstream Of Downton Stw
50280572	Hampshire Avon D/S Fordingbridge Stw
50280344	Hampshire Avon at Avon Causeway
C0217000	Avon Ibsley
50280463	Mill Stream U/S Ringwood Stw
50280545	Avon Downstream Bickton Gqa
50240488	River Wylye at Bishopstrow Mill
50260464	Hampshire Avon at Alderbury
50260443	Britford Navigation Channel at Longford
50280445	Mill Stream, 25om D/S Ringwood Stw
50260409	Hampshire Avon at Footbridge U/S Barford Carrier
70581171	River Barle at Simonsbath
E0000546	D/S Smarden Stw at Hadmans Br
E0000540	D/S Headcorn Stw-Slaney Place
E0000531	Beult D/S Lesser Teise
E0000544	Beult D/S Hammer Stream
63987300	Spring Brook - Earlswood
82520705	River Ruthern at Grogley Downs Bridge
82522505	Davidstow Stream at Tregoodwell
82528026	River Camel D/S Scarletts Well Stw
82528120	River Camel at Pencarrow
82528154	River Camel at Camelford Bridge
82528159	River Camel at Slaughterbridge
82530133	De Lank River at Bradford Bridge
82540170	River Allen at Knightsmill Bridge
82528082	River Camel at Wenford
42300040	Coquet at Alwinton
42300041	Coquet at Hepple
42300064	Coquet at Felton
42300073	Alwin at Clennell
42300181	Coquet at Bygate
88010390	River Greta Ptc River Derwent
88005723	River Marron at Woodend Bridge
88005652	Whit Beck at Whit Beck Bridge
88005619	Sail Beck at NY173 170
88005567	Naddle Beck U/S R Greta at Naddle Bridge

49600134	River Derwent at Derwent Bridge
88006427	River Eden at Sheepmount
88006278	Briggle Beck at Rd Bridge D/S Board Mills
88006266	Briggle Beck at Briggle Bridge
88009739	Goldrill Beck U/S Ullswater
88006244	Haweswater Beck at Bomby Bridge
88006241	Swindale Beck at Rosgill Moor Bridge
88006238	Dacre Beck at A592
88006218	Howe Grain at Sandwick
88006187	Scale Beck at Quarry
88006185	Hilton Beck at Roman Road Coupland
88006181	Helm Beck at Little Ormside
88006196	River Belah at Belah Bridge
88006427	River Eden at Sheepmount
88006278	Briggle Beck at Rd Bridge D/S Board Mills
88006266	Briggle Beck at Briggle Bridge
88009739	Goldrill Beck U/S Ullswater
88006244	Haweswater Beck at Bomby Bridge
88006241	Swindale Beck at Rosgill Moor Bridge
88006238	Dacre Beck at A592
88006218	Howe Grain at Sandwick
88006187	Scale Beck at Quarry
88006185	Hilton Beck at Roman Road Coupland
88006181	Helm Beck at Little Ormside
88006196	River Belah at Belah Bridge
88005134	River Ehen at Ennerdale Bridge
50550130	River Frome at Bockhampton
50570188	River Frome at Pallington
50590188	River Frome at Wool Bridge
50590110	River Frome at Wareham
C0527000	Frome Greys Bridge
50590203	River Frome U/S Lytchett Confluence
C0508000	Mill Str Kings Rd Dorch.
49200071	Rainbow Springs Trout Farm Inlet No 2
RISE150B	R.Ise Barford A6003 Rd.Br.
RISE180G	R.Ise Geddington A43 Rd.Br.
G0003812	Itchen D/S Alresford Bypass
G0003793	R Itchen Bishopstoke
G0003810	R Itchen at Itchen Stoke
G0003814	Itchen:Titchbourne Sewards Br
G0003806	R Itchen Easton
G0003857	R Alre Franklyns F.F. Inlet
PKER0038	Kennet and Canal at Woolhampton
PKER0045	Kennet at Hungerford Bridge
PKER0052	Kennet at Stitchcombe Mill
PKER0058	Lambourn at A4, Newbury
PKER0059	Lambourn at Bagnor
PKER0063	Lambourn at Gauging Station, East Sheffo
PKER0066	Lambourn at Lambourn
PKER0162	Kennet at Gauging Station, Knighton
PKER0263	Kennet above Hungerford Stw
PKER0043	Kennet at Hambridge Road, Newbury
PKER0046	Kennet at Inlet to Fish Farm, Mildenhall
PKER0053	Kennet at Thatcham Railway Station
PKER0160	Kennet 200m below Hungerford Stw

88004394	River Kent Stramongate Weir Kendal
88004390	Flodder Beck at A685 Roadbridge
88004369	River Gowan Ptc River Kent
G0004188	R Lymington Balmer L
G0004207	Ober Water Boldreford
G0004186	R Lymington Whitley
58472140	River Mease - Stretton Bridge
58472580	River Mease - Measham
58473850	River Mease - Ds Snarestone Stw
58807700	Gilwiskaw Brook - Measham Fields Farm
50360477	River Crane at Potterne Bridge Verwood
50360406	River Crane at A31 Road Bridge
58M02	R.Nar B1145 Rd.Br.Mileham
58M03	R.Nar Litcham Rd.Br.
58M05	R.Nar Castle Acre Rd.Br.
58M09	R.Nar Highbridge Wormegay Blackboro End
58M04	R.Nar West Lexham Rd.Br.
G0003929	R Test East Aston Cm
G0003900	R Test Greatbridge
G0003902	R Test Kimbridge
G0003947	R Test Polhampton
G0004098	R Dever Sutton Scotn
G0003943	R Test Bridge St. Overton
G0003976	Q/Hampton R Test above Portals
G0003935	Town Mill Whitchurch R. Test
41000033	Tweed U/S confluence with R Till
41000035	Till at Doddington Bridge
41000037	Wooler Water at Coldgate Mill
41000051	Bowmont Water at Kilham, B6351 Road Br
41000102	Breamish at Brandon, U/S Ford
41000358	Wooler D/S Wooler Stw
WEN010	R.Tat Tatterford Common (R.Wensum)
WEN235	R.Wensum Taverham Bridge
50021	R Wye at Whitney Toll Bridge
50042	R Lugg at Eaton Brdg,Leominster
50044	R.Lugg at Hampton Crt.Bdg.Upper

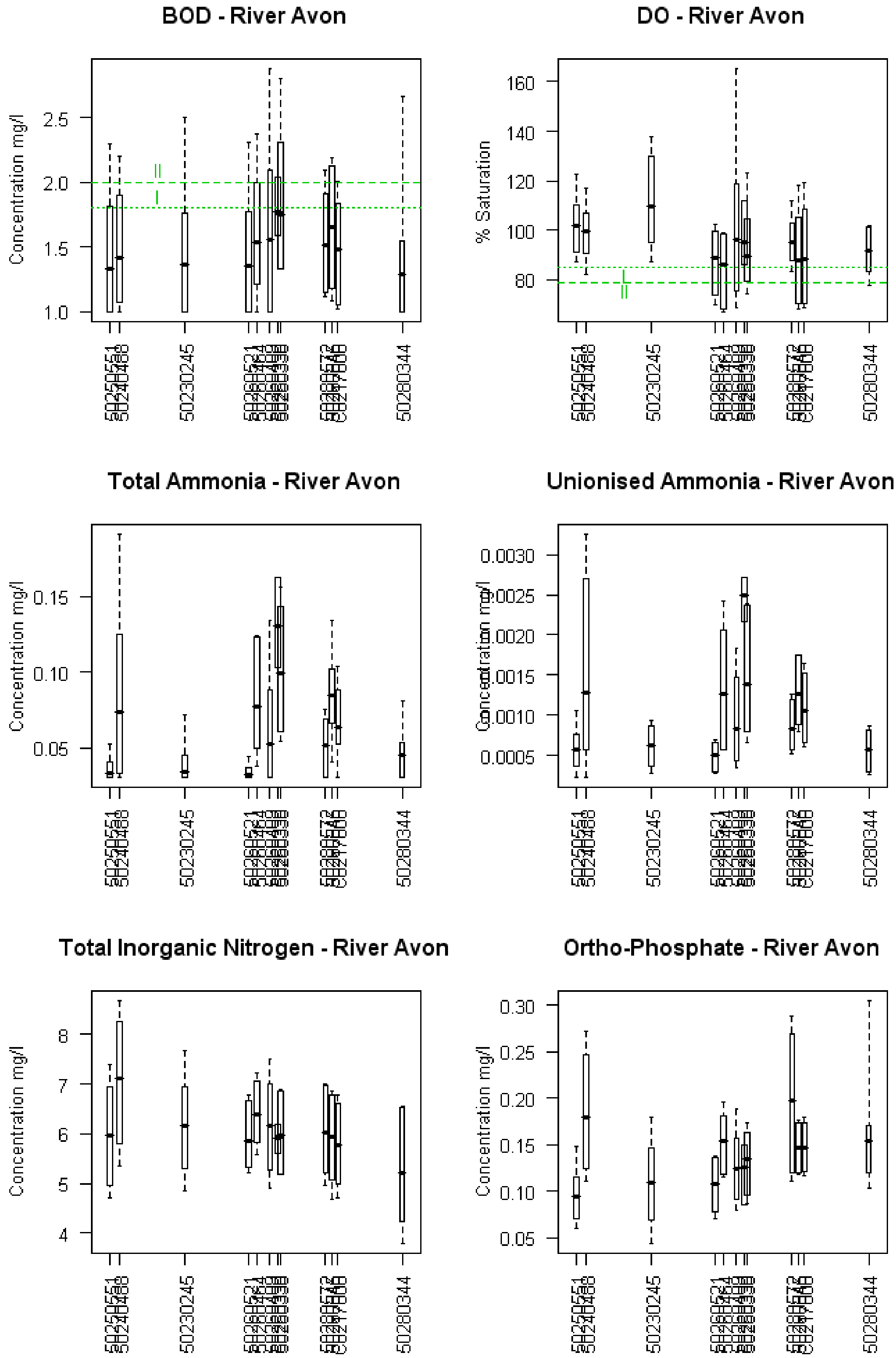

Figure 38. Box and whisker plots describing concentration profiles of organic pollution determinands in the River Avon (mean, 10th and 90th percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream) See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

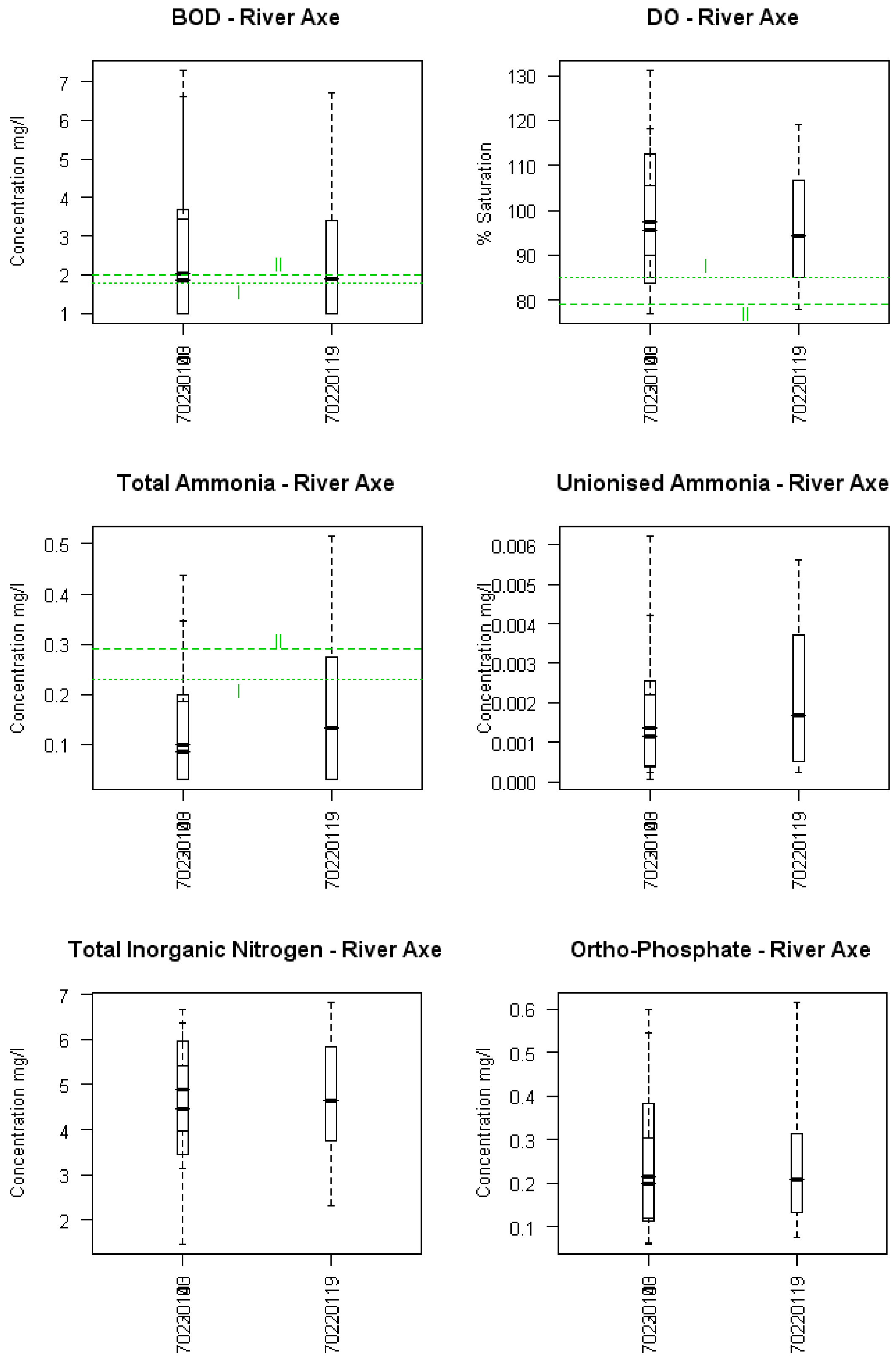

Figure 39. Box and whisker plots describing concentration profiles of organic pollution determinands in the River Axe (mean, 10th and 90th percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream). See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

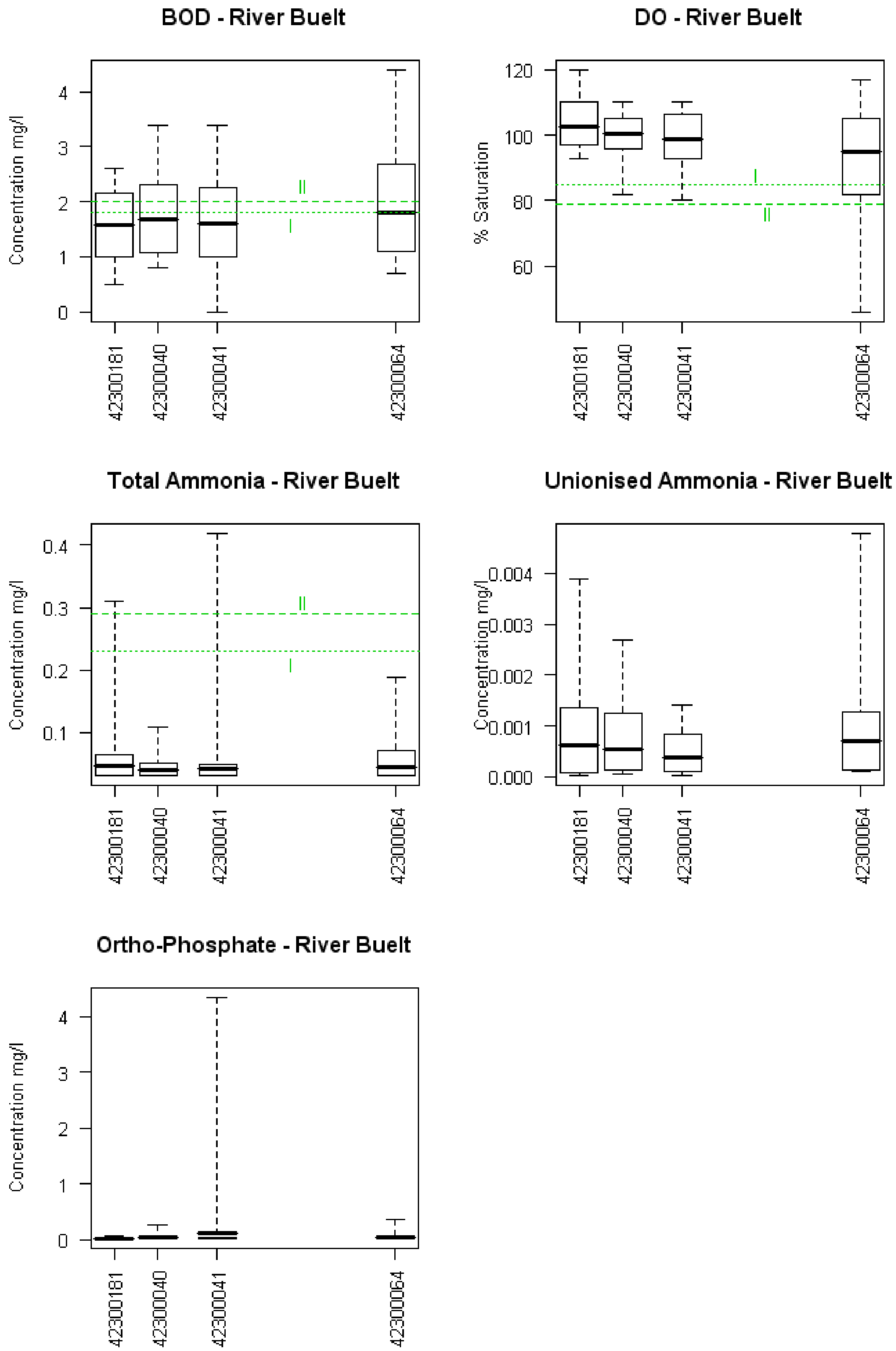

Figure 40. Box and whisker plots describing concentration profiles of organic pollution determinands in the River Buelt (mean, 10th and 90th percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream). See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

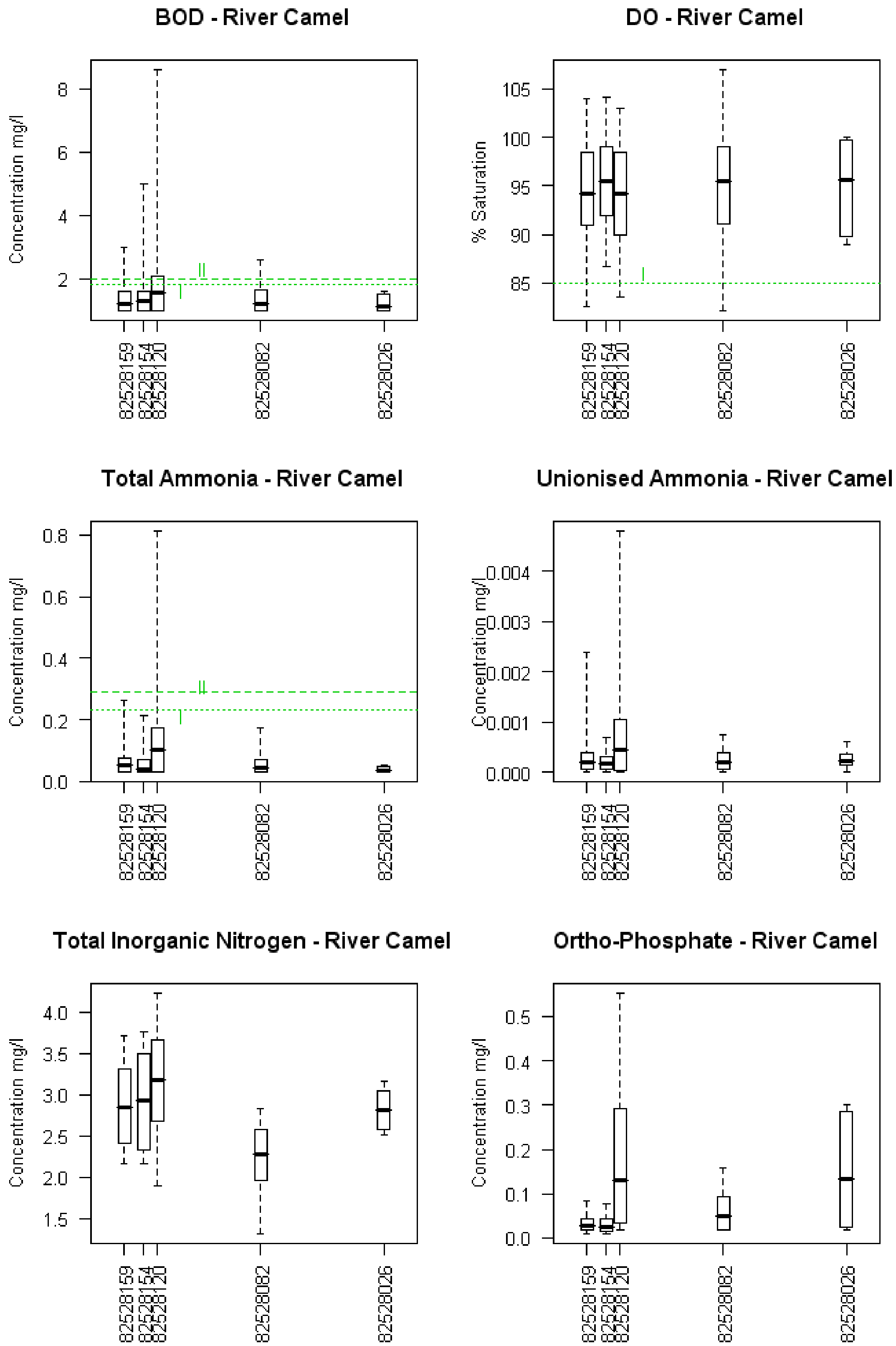

Figure 41. Box and whisker plots describing concentration profiles of organic pollution determinands in the River Camel (mean, 10th and 90th percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream). See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

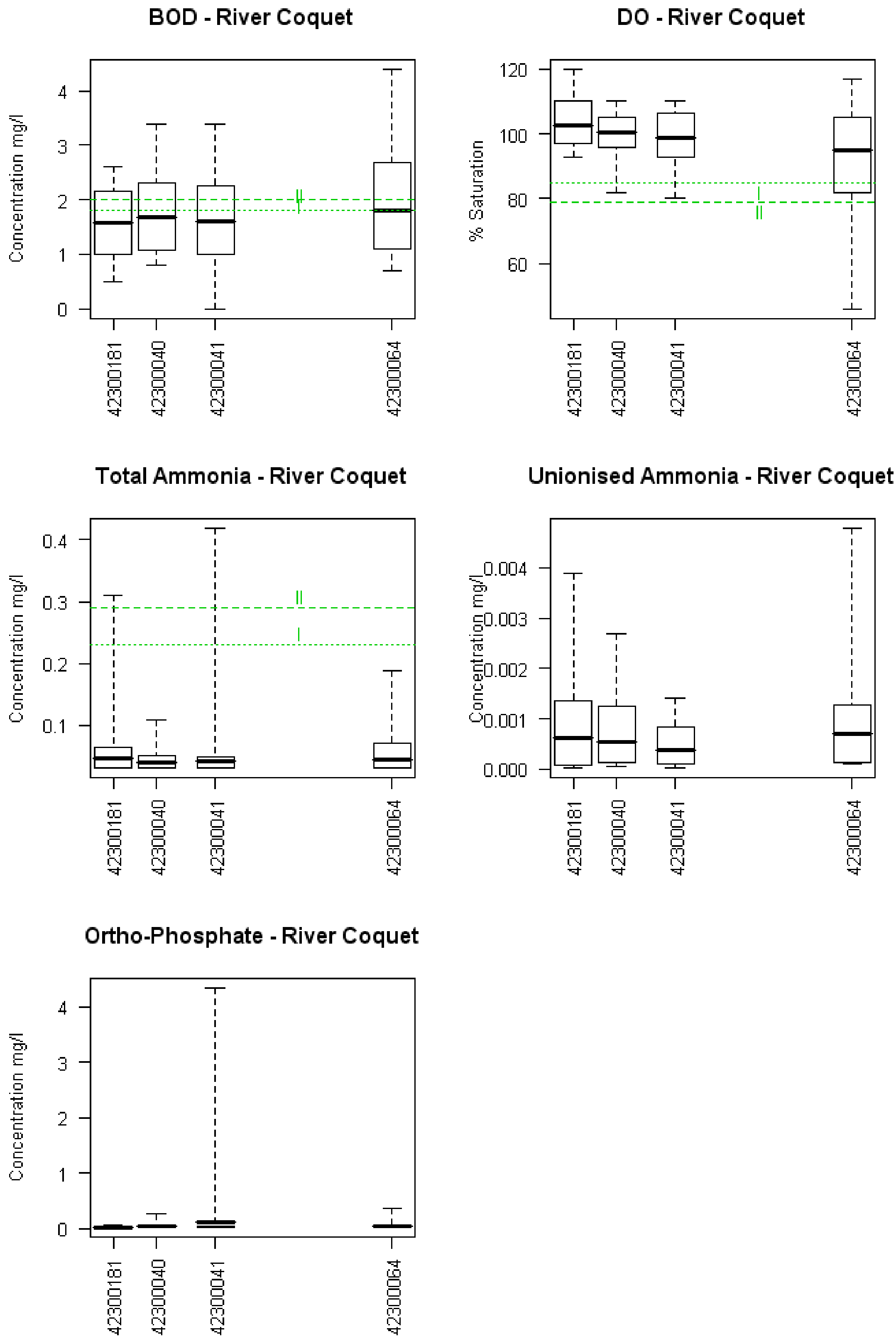

Figure 42. Box and whisker plots describing concentration profiles of organic pollution determinands in the River Coquet (mean, 10th and 90th percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream). See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

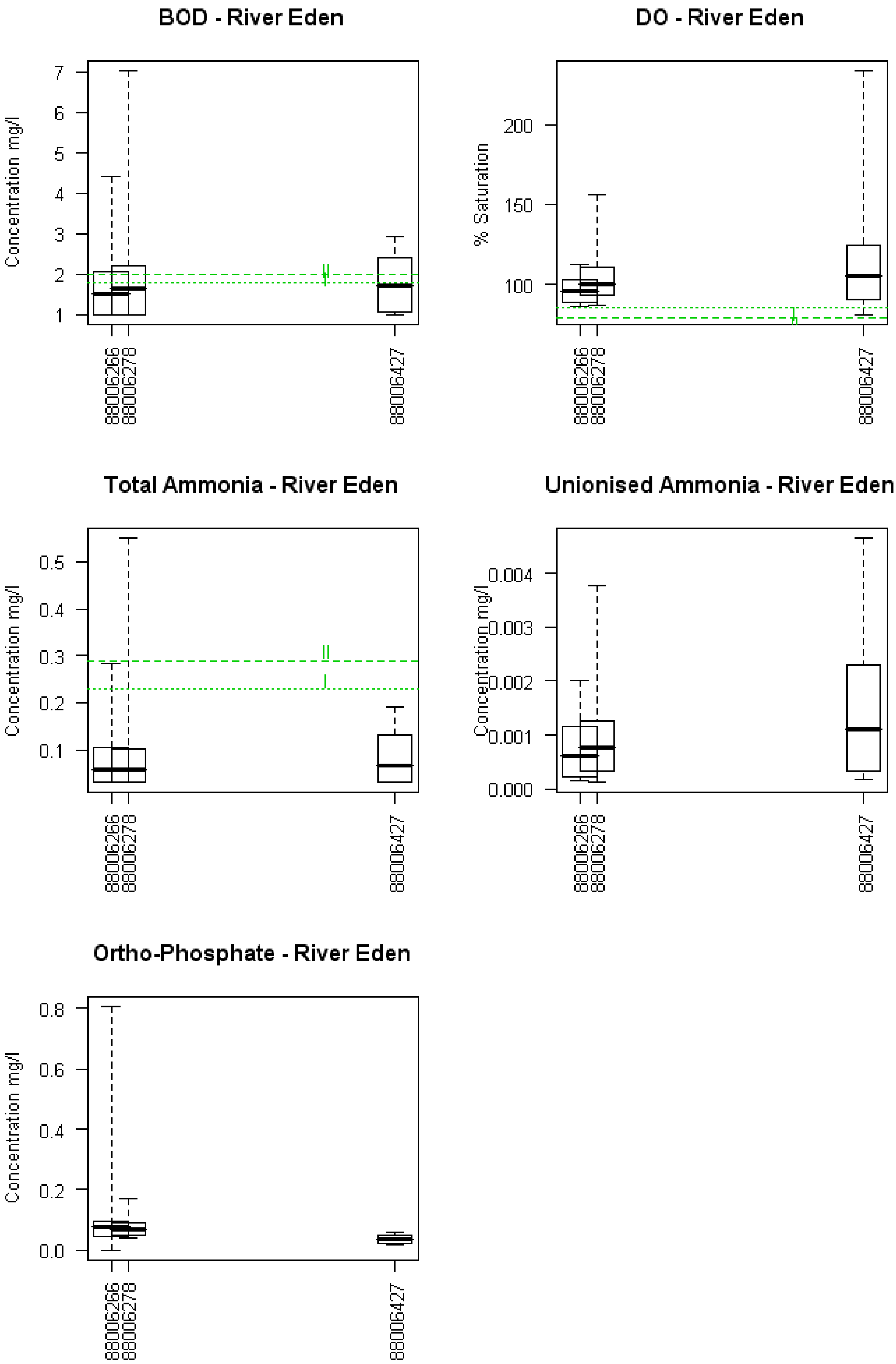

Figure 43. Box and whisker plots describing concentration profiles of organic pollution determinands in the River Eden (mean, 10th and 90th percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream). See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

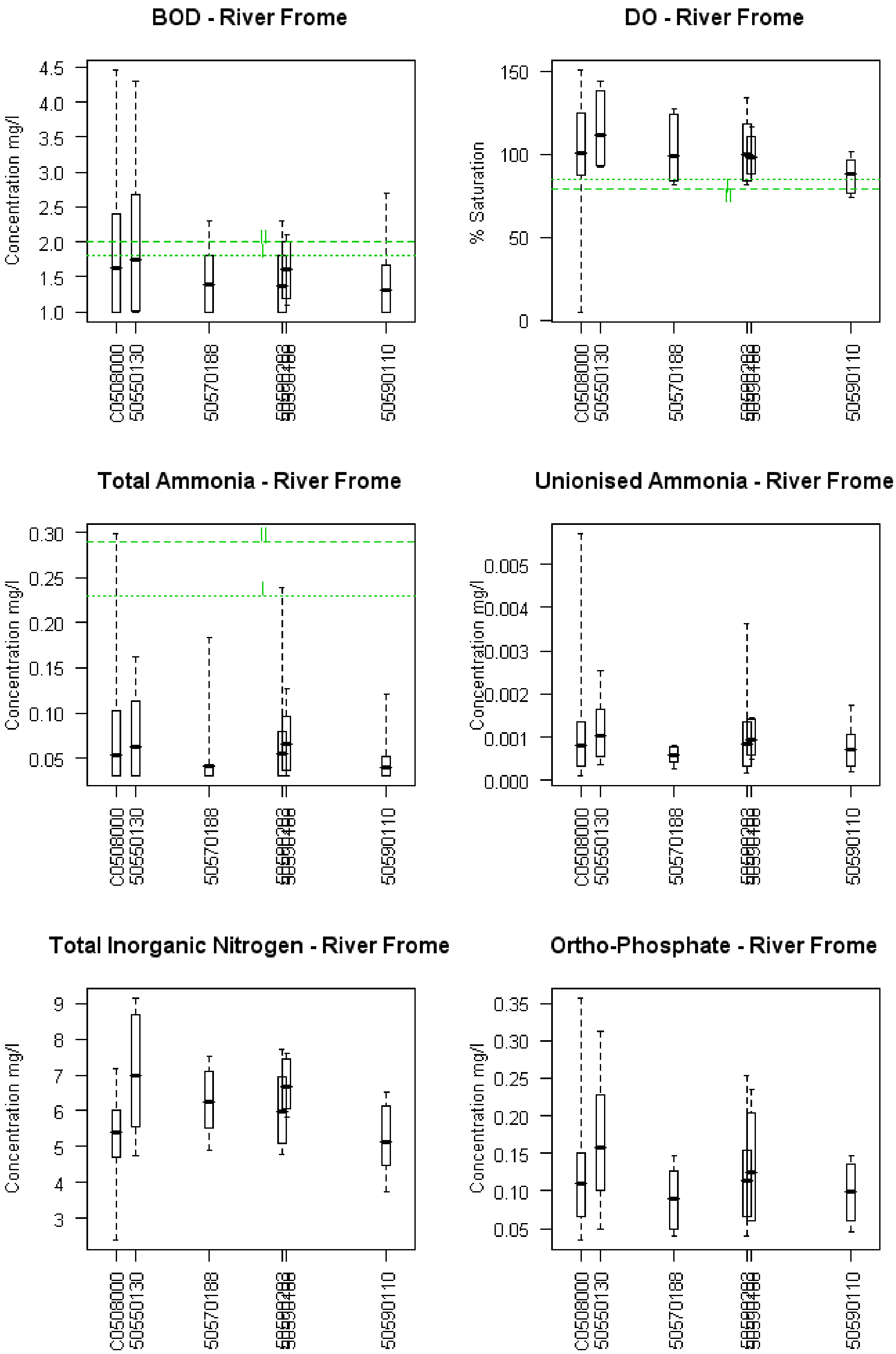

Figure 44. Box and whisker plots describing concentration profiles of organic pollution determinands in the River Frome (mean, 10^{th} and 90^{th} percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream). See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

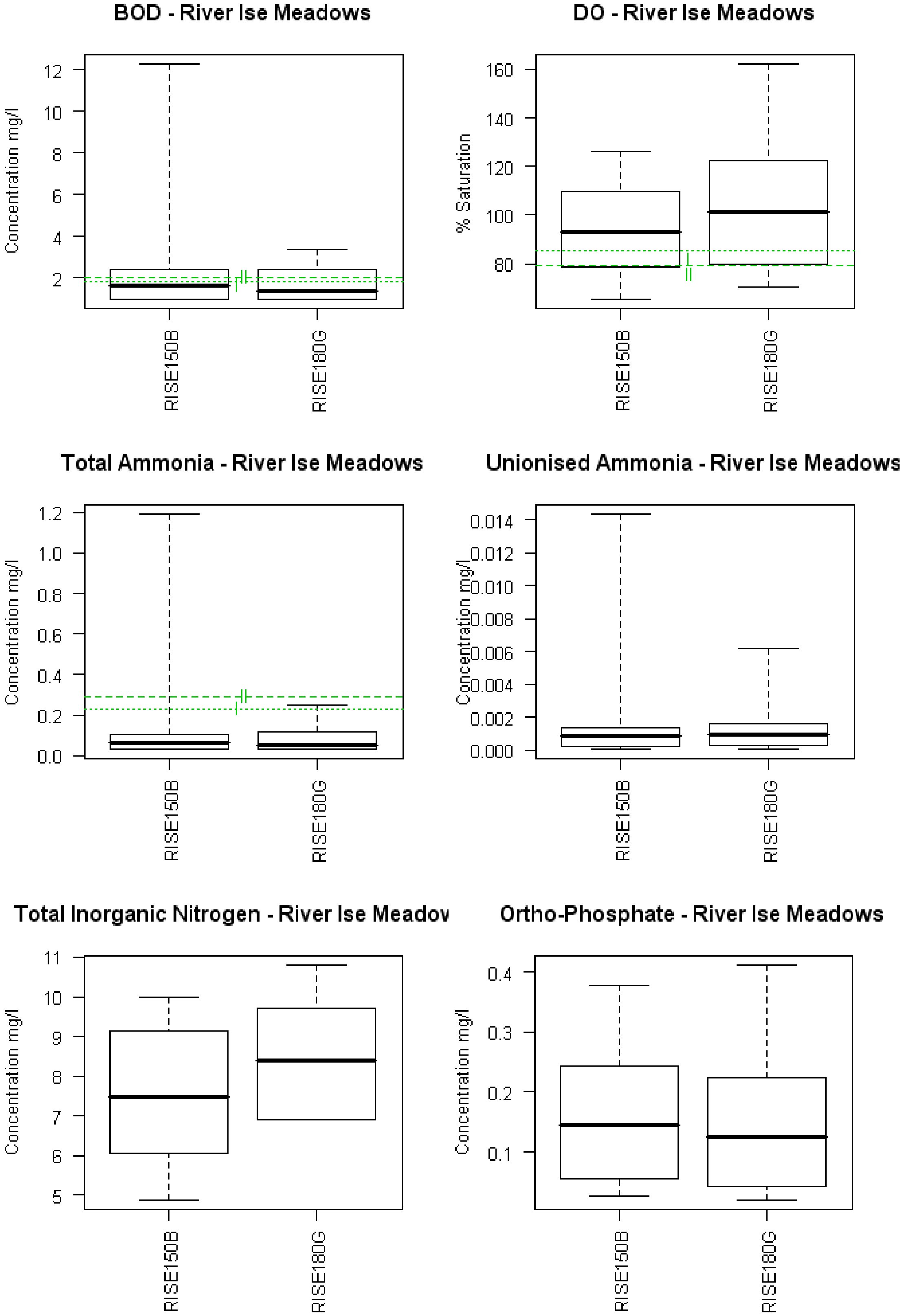

Figure 45. Box and whisker plots describing concentration profiles of organic pollution determinands in the River Ise Meadows (mean, 10th and 90th percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream). See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

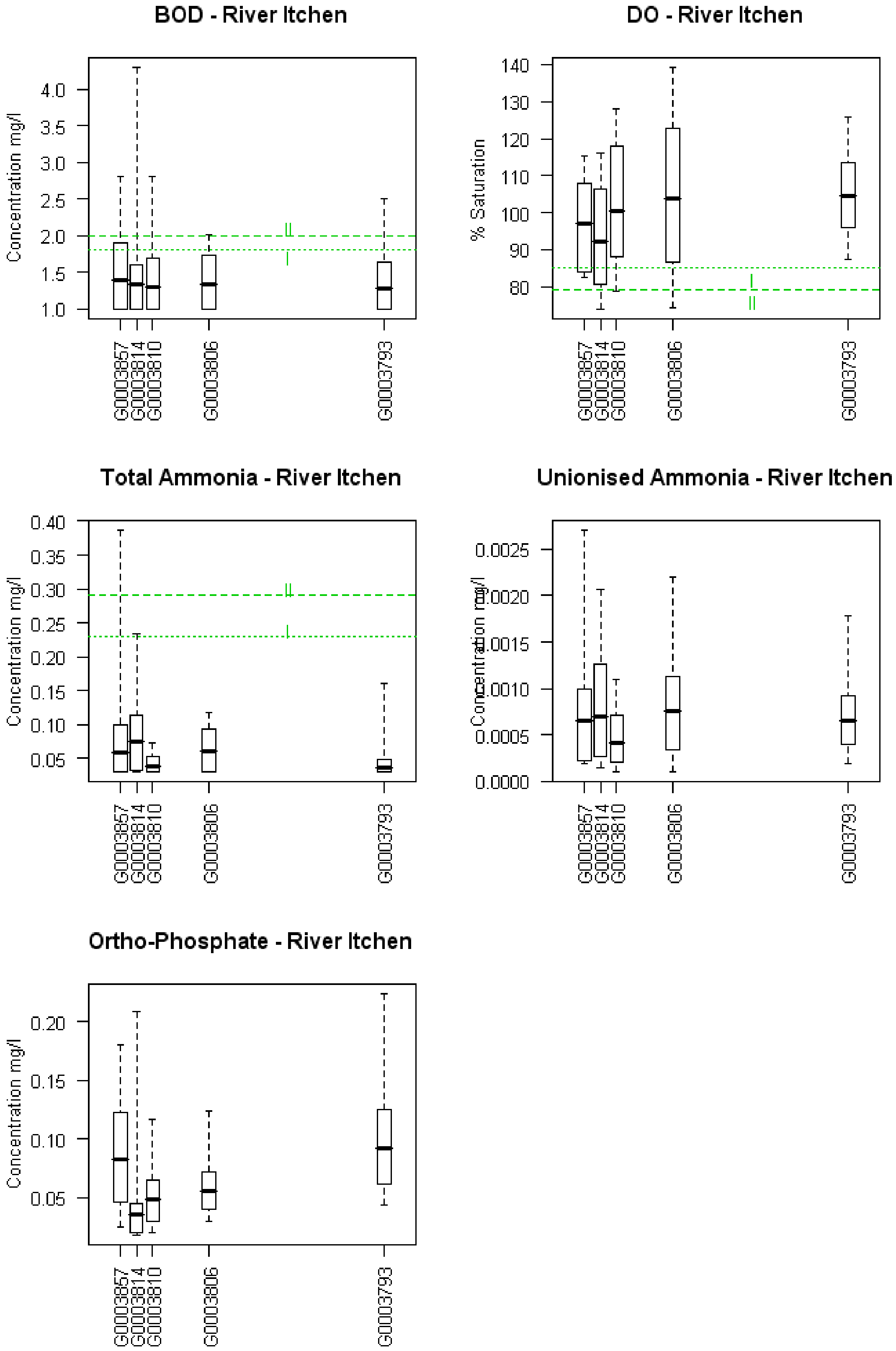

Figure 46. Box and whisker plots describing concentration profiles of organic pollution determinands in the River Itchen (mean, 10^{th} and 90^{th} percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream). See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

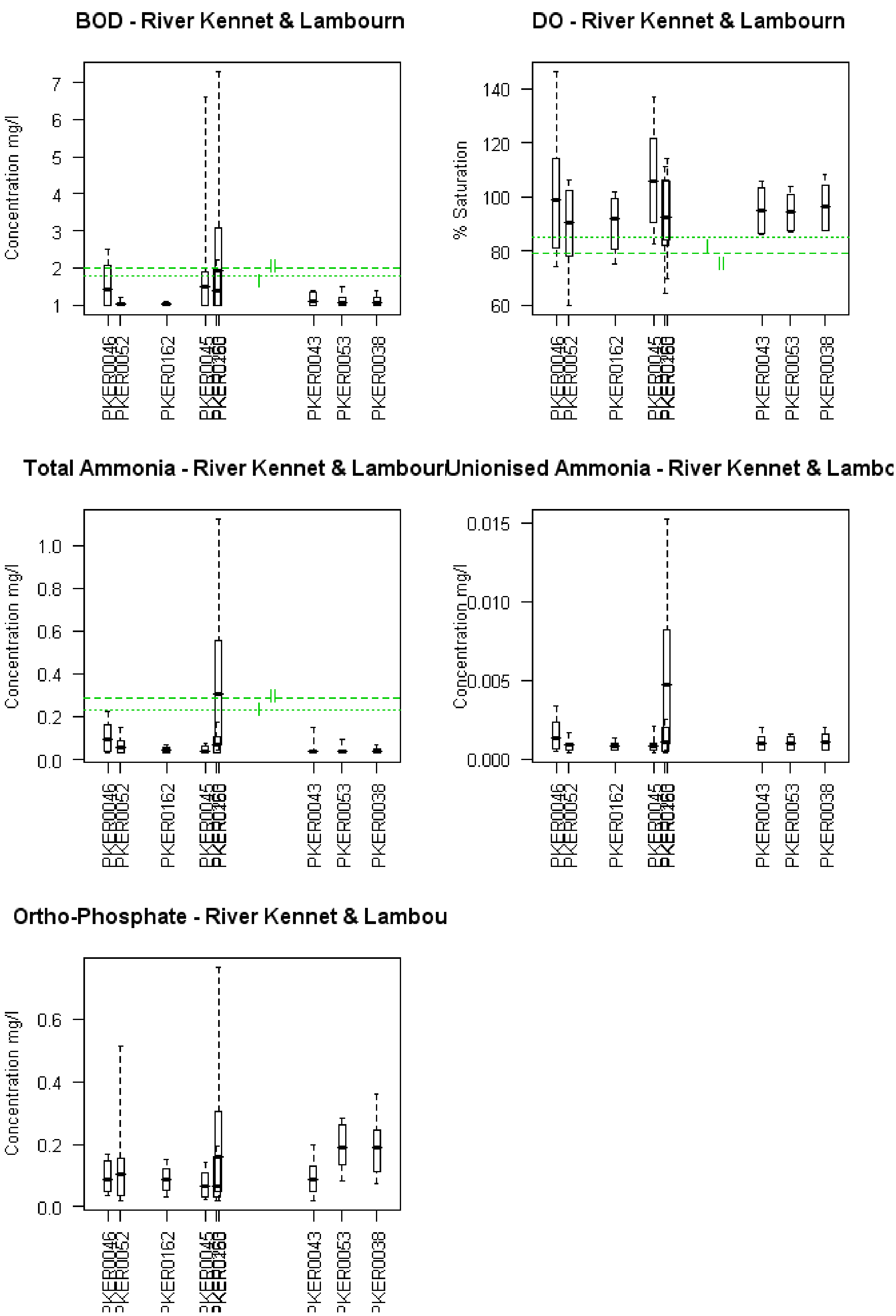

Figure 47. Box and whisker plots describing concentration profiles of organic pollution determinands in the River Kennet and River Lambourn (mean, 10th and 90th percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream). See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

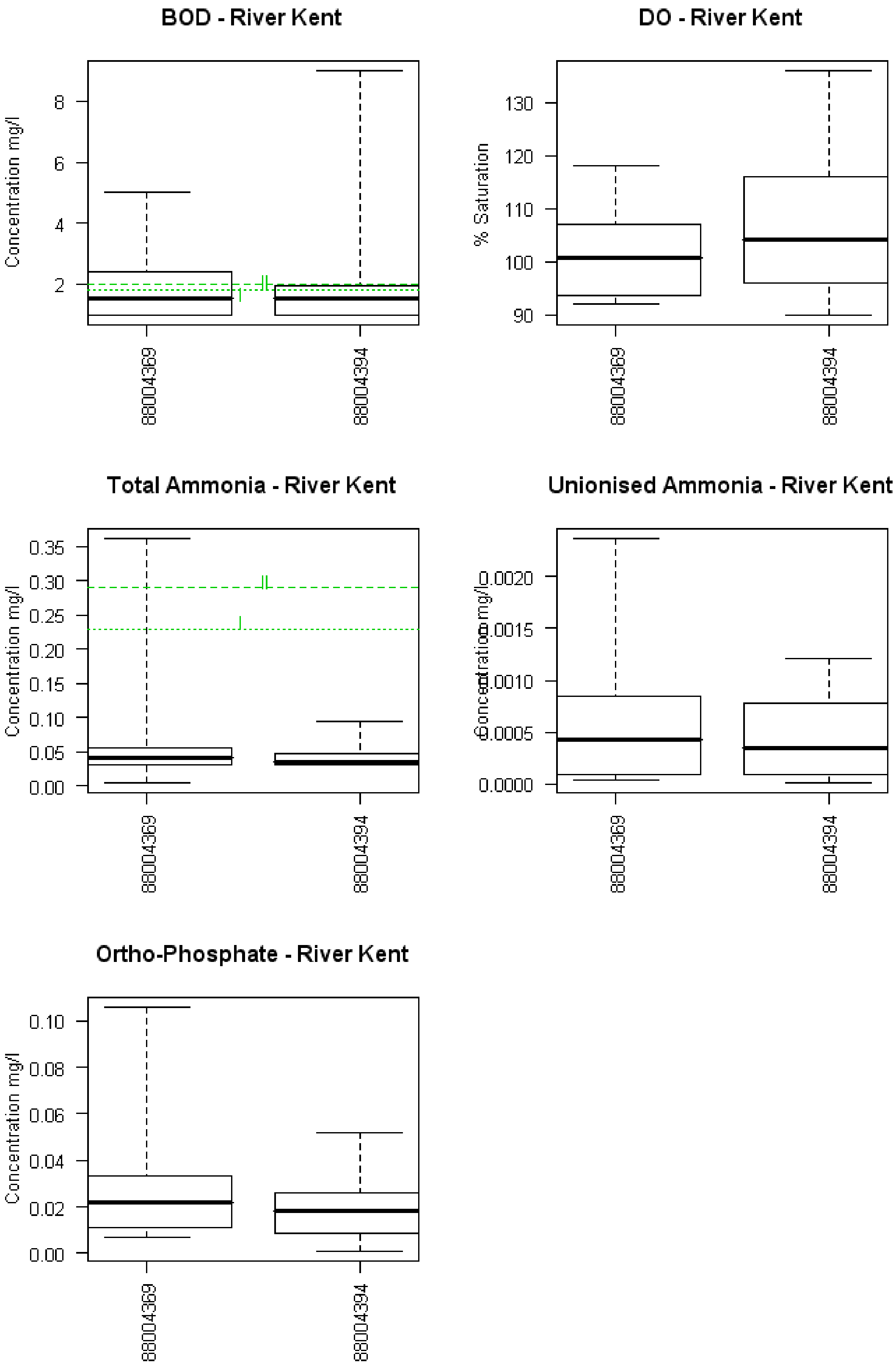

Figure 48. Box and whisker plots describing concentration profiles of organic pollution determinands in the River Kent (mean, 10th and 90th percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream). See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

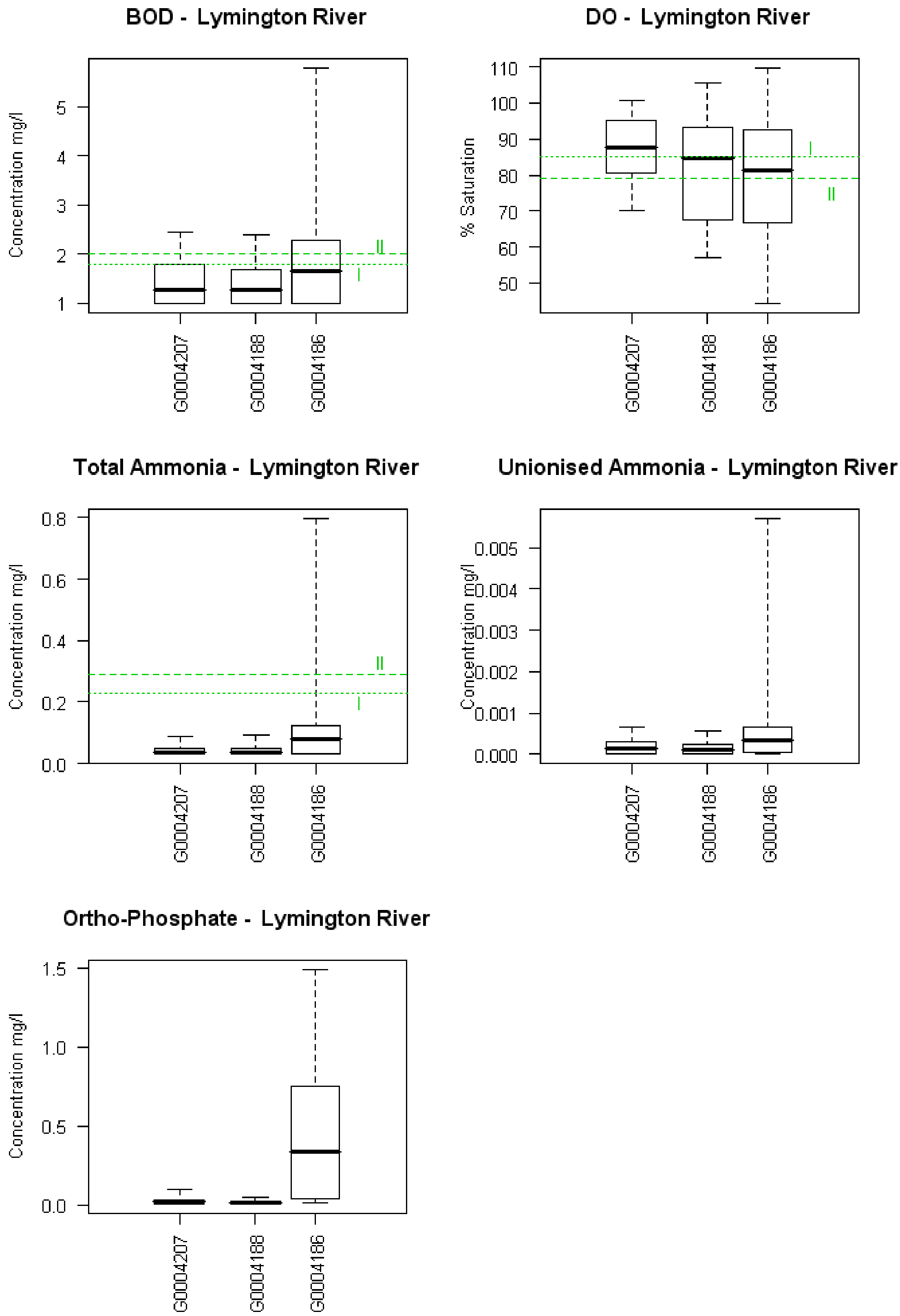

Figure 49. Box and whisker plots describing concentration profiles of organic pollution determinands in the Lymington River (mean, 10th and 90th percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream). See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

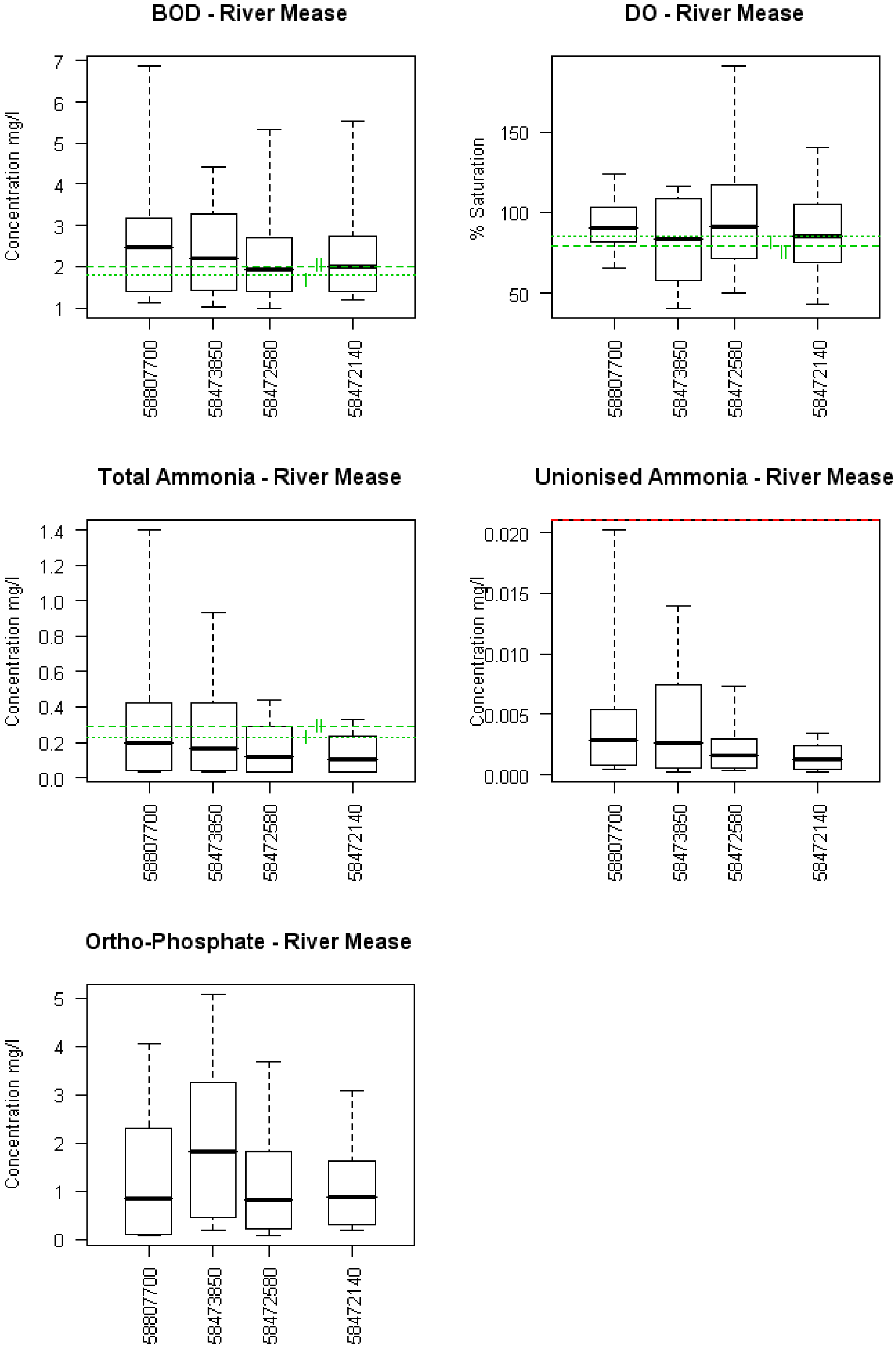

Figure 50. Box and whisker plots describing concentration profiles of organic pollution determinands in the River Mease (mean, 10th and 90th percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream). See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

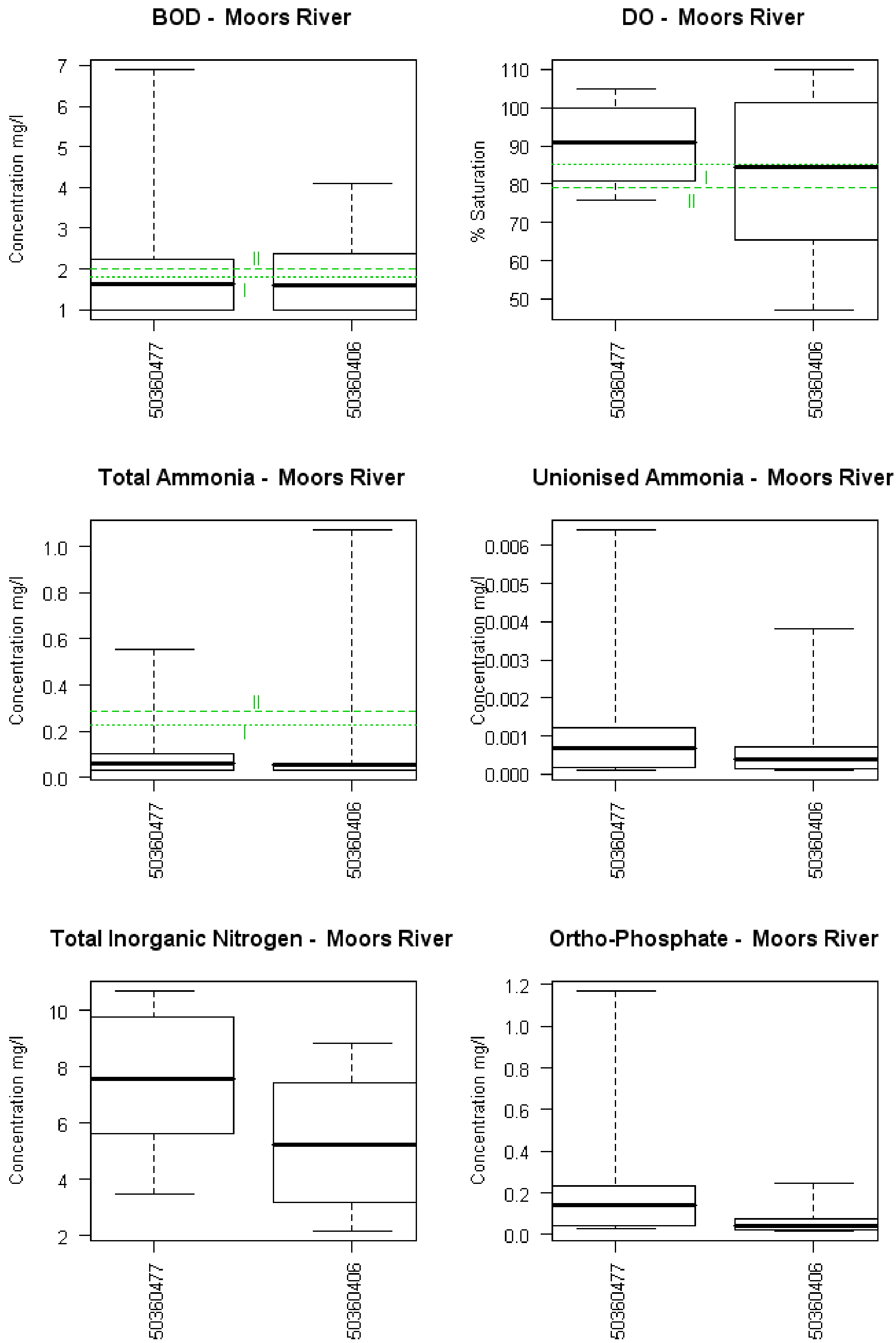

Figure 51. Box and whisker plots describing concentration profiles of organic pollution determinands in the Moors River (mean, 10^{th} and 90^{th} percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream). See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

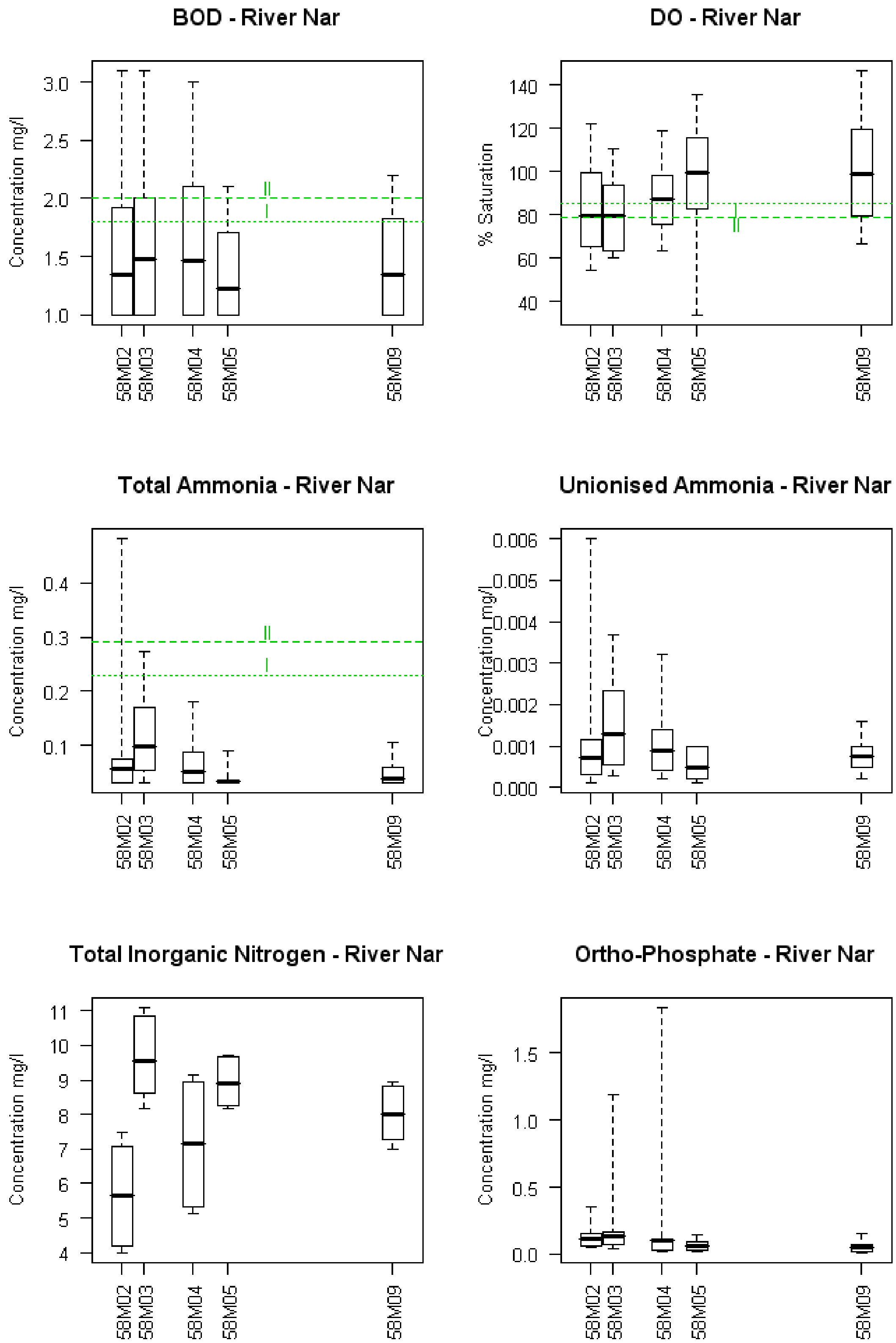

Figure 52. Box and whisker plots describing concentration profiles of organic pollution determinands in the River Nar (mean, 10th and 90th percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream). See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

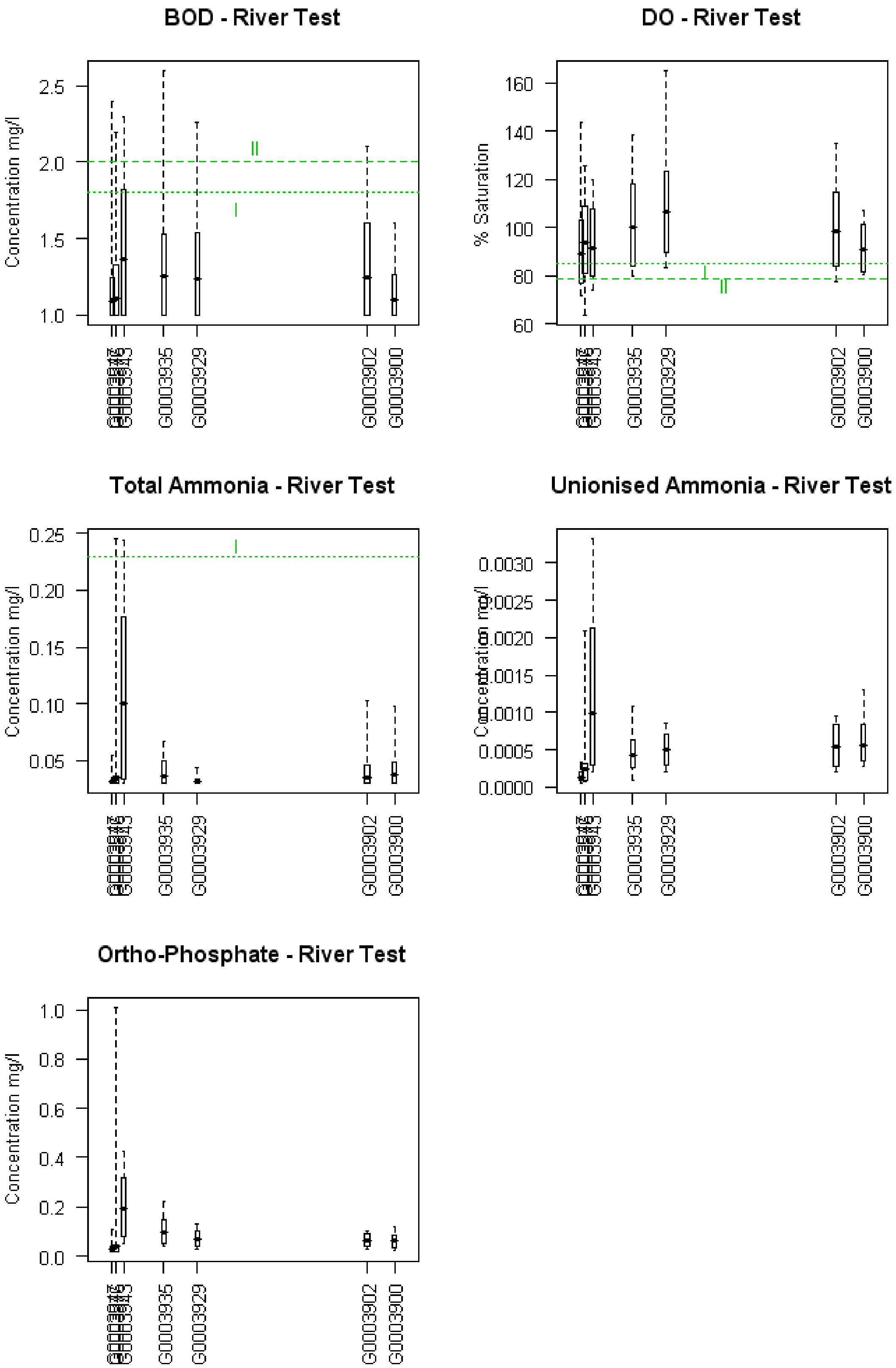

Figure 53. Box and whisker plots describing concentration profiles of organic pollution determinands in the River Test (mean, 10th and 90th percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream). See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

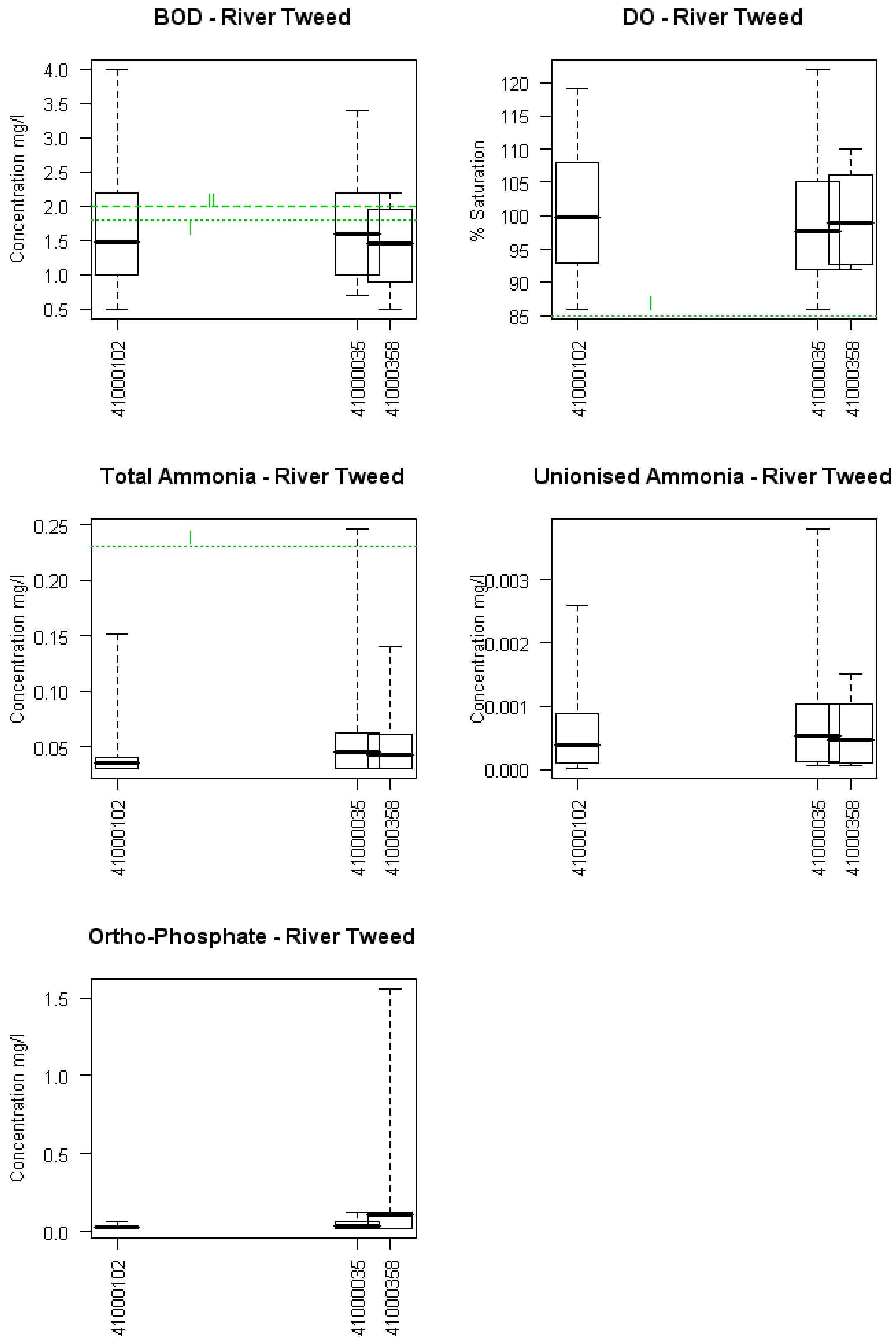

Figure 54. Box and whisker plots describing concentration profiles of organic pollution determinands in the River Tweed (mean, 10^{th} and 90^{th} percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream). See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

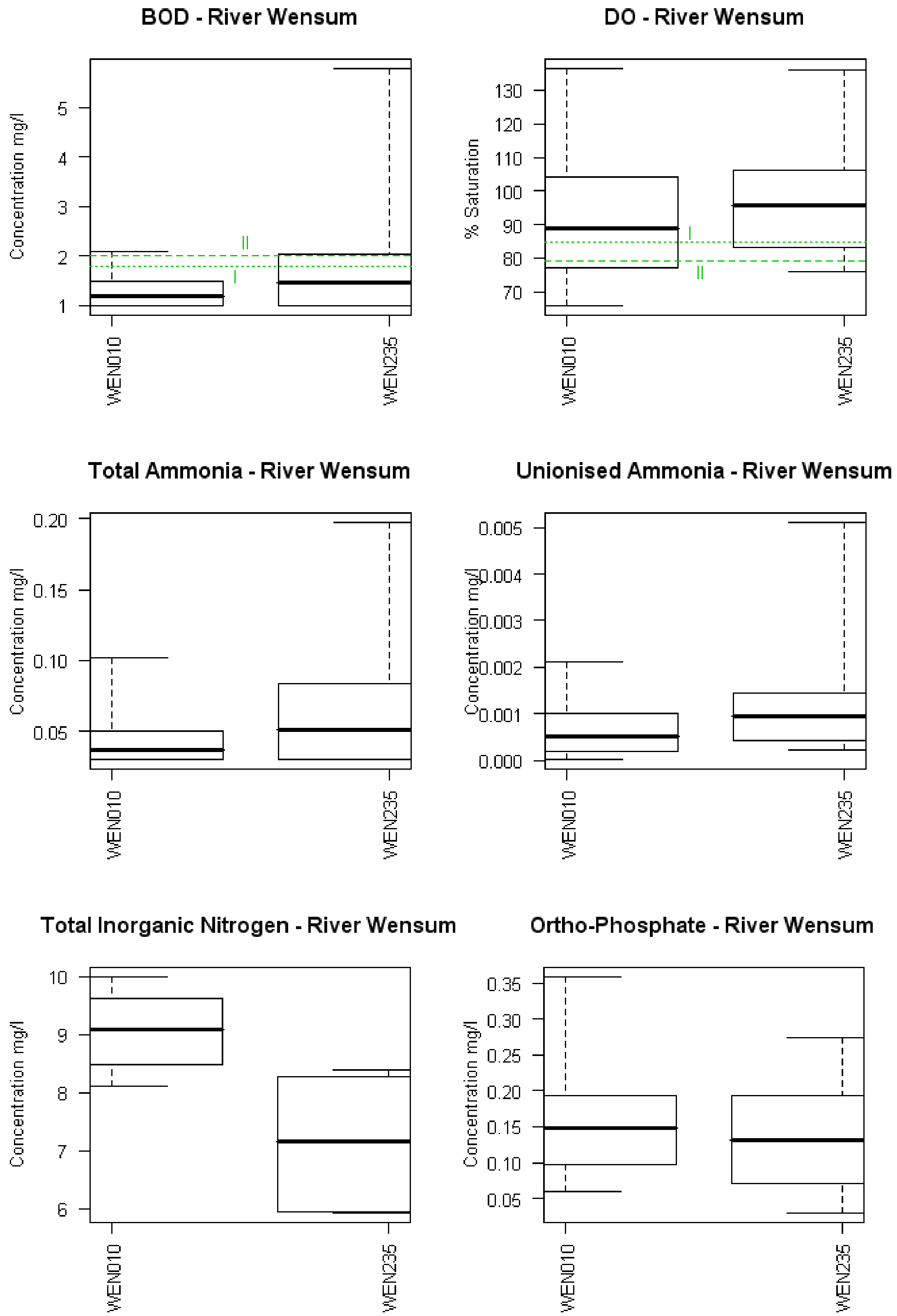

Figure 55. Box and whisker plots describing concentration profiles of organic pollution determinands in the River Wensum (mean, 10th and 90th percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream). See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

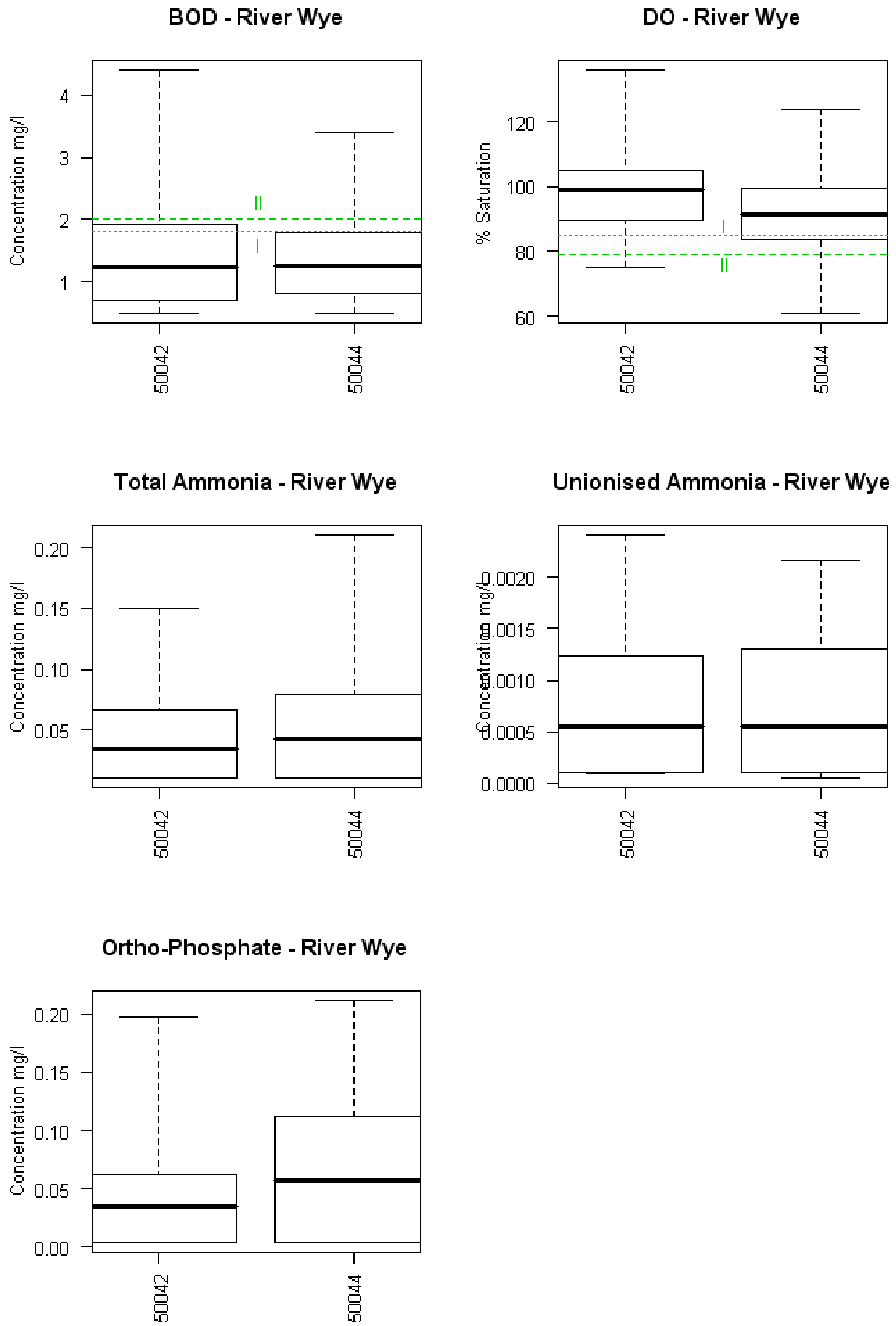

Figure 56. Box and whisker plots describing concentration profiles of organic pollution determinands in the River Wye (mean, 10th and 90th percentiles, range). Sites along the x axis are arranged in relative spatial positions (upstream to downstream). See Table 35 for site names. Horizontal lines indicate proposed thresholds I and II applicable dependent upon river type.

6.3 Limitations of Analysis

As with any data analysis, the results presented here are only as good as the data used. This was particularly apparent with the species level analysis where a limited data set, both in terms of the range of species and the length of environmental gradients covered, compromised the analysis to such an extent that only tentative conclusions could be made about the more common species. It was a lack of species level data was from the more polluted end of the gradient that caused this problem: CEH have large holdings of species level data from unpolluted sites, but these could not be included in the analysis without biasing the results, and erroneously over-estimating species sensitivities.

The range of species included in the biological data available influenced the family level analysis. Certain taxa were not frequent enough to make a confident assessment of the range of conditions which they can tolerate. There is an inherent difficulty in assessing the requirements of rare taxa: Rare taxa are likely to be infrequent, if not lacking, from any data set, and it is difficult to establish a reason why they are lacking from the sites where they are absent. Whilst passive inclusion of infrequent taxa in the anlyses can give some indication of their requirements, confident assessment would require the collection of data targeted at these rare taxa. A focus on rare taxa in new data collection is recommended as their inclusion in analyses influences the confidence in any targets set to protect them.

It should be further stressed that the analyses presented here are based on recent data and, thus, cannot offer any guidance on taxa that have been lost historically from river types that have suffered widespread impacts. This may be true of taxa from large deep rivers, such as the stonefly *Isogenus nebeclua*.

The quality of the chemical data also had an effect on the family level analyses. Whilst stringent rules were applied to ensure matching between sites sampled for chemistry and those sampled for biology, a restricted range of deterrminands was available from all sites. The range of determinands sampled did not include unionised ammonia, which would be expected to have more explanatory power than total ammonia.

It should be stressed here that the data used to compile the summary of compliance (Section 6.2) are from specific GQA routine monitoring stations whereas the target thresholds defined in section 5 relate to the entire length of the designated sites (excepting reasonably sized mixing zones downstream of sewage treatment works). Water quality will need to be modelled to provide a full evaluation conditions relative to the set thresholds in order to achieve conservation objectives.

A further consideration is the quality of the wider river network: The resilience of the biological community of a site is dependent upon the rate of supply of colonists from neighbouring populations. This is of particular importance with respect to the rate of recovery of a site after a pollution event, but in general, the persistence of a sensitive species in a protected site is less likely if the surrounding landscape is dominated by poor quality sites. This effect has implications for conservation of the biological community in designated sites, but will have had an influence on the analyses by adding noise to the data.

Overall, the thresholds proposed are the best given the evidence available. By setting the thresholds at concentrations below which 80% of the populations of the most sensitive taxa occur, we increase the confidence that the thresholds provide adequate protection under a range of environmental conditions. This precautionary approach was adopted, rather than setting the thresholds at a higher concentration, nearer to the limit of tolerance of the most sensitive taxa, to provide more confidence in the thresholds. The lack of confidence in the species level analysis does add uncertainty to the thresholds, as only the reponse of the more common taxa could be established. Without further data collection, preferably targeted at rare taxa, it is not possible to improve the confidence that all species are adequately protected.

7. Conclusions

It is recommended that thresholds of organic pollution for sites with national and international designations for wildlife, including Sites of Special Scientific Interest (SSSIs) and Special Areas of Conservation (SACs) are set at

I: 10th %ile Dissolved Oxygen saturation = 85%,
Mean BOD = 1.8 mg l^{-1}
90th %ile Total Ammonia (NH_3 -N) = 0.23 mg l^{-1}

II: 10th %ile Dissolved Oxygen saturation = 79%,
Mean BOD = 2.0 mg l^{-1},
90th %ile Total Ammonia (NH_3 -N) = 0.29 mg l^{-1}

These thresholds should be applied to the NE river types, thus:

Dominant Catchment Geology		Threshold		
		1. Head water	2. River	3. Large River
A	Hard upland geologies (all land over 330m) – impermeable poor geologies	I	II	II
B	Other Cambrian-Devonian geologies – hard mudstones and sandstones	I	I	II
C	Jurassic and Cretaceous limestones – soft limestone and chalk	I	II	II
D	Triassic sandstones and mudstones – soft sandstones and mudstones in lowland areas	I	I	II
E	Mesozoic clay vales and Tertiary clays – impermeable rich geologies	I	II	II

8. Recommendations

To ensure that the best evidence available is used to generate targets for the conservation of the whole community, it is recommended that species level data are generated from sites suffering from organic pollution and analyses are repeated using species level data. It is also recommended that data collection is targeted at rare taxa, and that these taxa are included in future analyses.

Despite the extensive body of work that has been undertaken describing the effects of organic pollution on rivers, it is suggested that a more thorough understanding is required at the field scale. Large scale manipulative experiments are required, together with mechanistic models, to relate laboratory experiments to field scale responses.

Further work is also required to understand the effects of organic pollution via nutrient enrichment, as opposed to direct toxic effects. Organic pollution represents a major input of nutrients to rivers, with profound impacts on river communities: To understand the full impact of organic pollution on rivers it is necessary to quantify the impact via eutrophication in addition to the results presented here on toxic effects.

Using the information from the family level analysis presented here it is suggested that an index, directly relating macroinvertebrates to organic pollution, is developed and tested. Such an index could be used to diagnose those sites where organic pollution was having a significant impact.

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Appendix 1 – Matching NE and JNCC River Typologies with RIVPACS Classification using Paired Sites

Table A1.1. Match of NE river classification to RIVPACS by common sites (Sites shown in red are classified as more than one type, either 1 and 2 or A or B, by NE). Each entry indicates a river section within the named SSSI which contains a site from which a RIVPACS reference site sample was collected.

	1	2	3
A	River Coquet River Derwent and Tributaries River Derwent and Tributaries River Derwent and Tributaries River Barle River Barle River Barle River Camel and Tributaries River Camel and Tributaries	River Coquet River Derwent and Tributaries River Derwent and Tributaries River Derwent and Tributaries Tweed - Till Catchment Tweed - Till Catchment River Teme River Derwent and Tributaries River Derwent and Tributaries River Derwent and Tributaries River Camel and Tributaries River Camel and Tributaries	Lower Tweed & Whiteadder Lower Tweed & Whiteadder Lower Tweed & Whiteadder River Wye
B	Lathkill Dale River Barle River Barle River Barle River Camel and Tributaries River Camel and Tributaries	River Coquet River Coquet Dove Valley and Biggin Dale Dove Valley and Biggin Dale Till Riverbanks Till Riverbanks River Camel and Tributaries River Lugg River Lugg River Lugg River Lugg River Lugg River Lugg River Lugg River Teme River Teme River Teme River Camel and Tributaries River Camel and Tributaries	River Wye River Wye River Wye
C	River Itchen Moors River System Moors River System Moors River System Moors River System Moors River System Moors River System Moors River System River Hull Headwaters River Hull Headwaters River Hull Headwaters	River Avon System River Avon System River Avon System River Avon System River Avon System Bere Stream River Frome River Frome River Frome River Itchen River Itchen River Itchen River Test River Kennet River Lambourn River Wensum River Wensum River Wensum River Wensum River Hull Headwaters River Hull Headwaters River Hull Headwaters	
D	River Blythe River Eden And Tributaries	River Axe River Axe River Blythe River Blythe River Eden And Tributaries River Eden And Tributaries River Eden And Tributaries	
E		River Itchen Moors River System River Test River Test River Avon System River Avon System River Beult River Beult River Beult River Beult River Wensum	River Derwent River Derwent River Derwent

Table A1.2. Further SSSI sites which contained a river section matched to RIVPACS reference sites but for which there was no NE River Classification.

Cornmill Stream and Old River Lea
Lymington River
Malham-Arncliffe
River Ehen (Ennerdale Water to Keekle Confluence)
River Ribble (Long Preston Deeps)
River Wharfe

Table A1.3. Match of NE river classification to RIVPACS 9 endgroup classification by common sites (Sites shown in red are classified as more than one type, either 1 and 2 or A or B, by NE). Names of SSSI sites containing river sections with matches to RIVPACS references sites are given in Table 19. NE typology is given in Table 16 and RIVPACS 9 endgroup classification in Table 18.

	1											
A	4	6	6	6	1	4	4	4	1			
B	5	4	4	1	5	4						
C	8	7	8	2	8	8	8	2	2	9	8	8
D	8	1										
E												

	2																				
A	3	6	6	1	6	3	4	6	6	6	1	4									
B	4	6	4	6	6	6	7	6	5	4	5	8	7	6	7	7	5	5	5	4	
C	7	7	7	8	7	7	7	8	5	7	7	7	8	7	7	9	9	9	9	8	8
D	6	6	7	9	6	6	6														
E	7	9	7	7	7	7	9	9	9	9	7										

	3			
A	6	6	6	6
B	7	7		
C				
D				
E	7	7	7	

Table A1.4. Match of NE river classification to RIVPACS 4 endgroup classification by common sites (Sites shown in red are classified as more than one type, either 1 and 2 or A or B, by NE). Names of SSSI sites containing river sections with matches to RIVPACS references sites are given in Table 19 and NE typology is given in Table 16.

1 = Small streams throughout Great Britain
2 = Upland streams and rivers. Mainly in Scotland and N England
3 = Intermediate streams and rivers. Mainly N England, Wales and SW England
4 = Lowland streams and rivers. Mainly S England

	1											
A	2	3	3	3	1	2	2	2	1			
B	3	2	2	1	3	2						
C	4	4	4	1	4	4	4	1	1	4	4	4
D	4	1										
E												

	2																				
A	2	3	3	1	3	2	2	3	3	3	1	2									
B	2	3	2	3	3	3	4	3	3	2	3	4	4	3	4	4	3	3	3	2	
C	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4
D	3	3	4	4	3	3	3														
E	4	4	4	4	4	4	4	4	4	4	4										

	3			
A	3	3	3	3
B	4	4		
C				
D				
E	4	4	4	

Table A1.5. Match of NE river classification to RIVPACS system A catchment size by common sites (Sites shown in red are classified as more than one type, either 1 and 2 or A or B, by NE). Names of SSSI sites containing river sections with matches to RIVPACS references sites are given in Table 19.
S = Small Catchment, M = Medium Catchment, L = Large Catchment.

	1	2	3
A	S M M M S S S M S	M M M S M S M M M M S S	L L L L
B	S S M S S S	M M M S M M S L M S M S M M M L L L S S	L L
C	S S S S S S S S S S M M	L L L S M M M M M M M M M M M M M M S M M	
D	S S	M M M M M L M	
E		M S L M M M M M M M M	L L L

Table A1.6. Match of NE river classification to RIVPACS system A altitude by common sites (Sites shown in red are classified as more than one type, either 1 and 2 or A or B). Names of SSSI sites containing river sections with matches to RIVPACS references sites are given in Table 19.
L = Low Altitude, M = Medium Altitude, (H = High Altitude).

	1	2	3
A	M M M M M M M M M	M M M M M M M M M M M M	M M M M
B	M M M M M M	M M M M L M L M M M M L L L L L L L M M	M M
C	L L L L L L L L L L L L	L L L L L L L L L L L L L L L L L L L L L	
D	L M	L L L L M M M	
E		L L L L L L L L L L L	L L L

Table A1.7. Match of NE river classification to RIVPACS system A geology by common sites (Sites shown in red are classified as more than one type, either 1 and 2 or A or B). Names of SSSI sites with matches to RIVPACS references sites are given in Table 19.
S = Siliceous Geology, C = Calcareous Geology (O = Organic Geology).

	1	2	3
A	C S S S S S S S S	C S S S C S C S S S S S	S S S C
B	C S S S S S	C C C C C C C C C C C C C S C C C C S S	C C
C	C S S S S S S S C C C C	C C C C C C C C C C C C C C C C C C C C C	
D	C C	C C C C C C C	
E		C S C C C C C C C C C	C C C

Table A1.8. Representation of JNCC river types within nationally selected SSSI rivers in England.

River (system) name	I	II	III	V	VI	VII	VIII	IX	X
Avon	■	■	■						
Axe				■					
Barle							■		■
Buelt		■							
Blythe		■		■					
Camel				■			■		
Coquet					■	■		■	
Derwent					■		■		■
Derwent (lower)			■	■					
Eden					■		■		■
Frome (lower)	■		■						
Hull headwaters			■						
Itchen			■						
Kennet	■		■						
Lambourn			■						
Lugg		■		■					
Lymington		■							
Malham streams								■	
Moors			■	■					
Teme				■	■				
Test			■						
Tweed				■	■	■	■		
Wensum	■		■						
Wye				■					

Table A1.9a. SSSI Rivers ranked by JNCC river type representation.

River (system) name	I	II	III	V	VI	VII	VIII	IX	X
Avon	■	■	■						
Frome (lower)	■		■						
Kennet	■		■						
Wensum	■		■						
Hull headwaters			■						
Itchen			■						
Lambourn			■						
Test			■						
Derwent (lower)			■	■					
Moors			■	■					
Lugg		■		■			■		
Blythe		■		■					
Buelt		■							
Lymington		■							
Axe				■					
Wye				■					
Tweed				■	■	■			
Teme				■	■				
Camel				■			■		
Coquet					■	■		■	
Derwent					■		■		■
Eden					■		■		■
Barle							■		■
Malham streams								■	

Table A1.9b. RIVPACS 9 endgroup occurrence in SSSI rivers ranked by JNCC river type representation.

River (system) name	9	8	7	6	5	4	3	2	1
Avon		■	■						
Frome (lower)		■	■						
Kennet			■						
Wensum	■		■					■	
Hull headwaters	■	■							
Itchen		■	■		■				
Lambourn			■						
Test			■						
Derwent (lower)			■					■	
Moors	■	■	■					■	
Lugg		■	■	■	■	■			
Blythe	■	■	■						
Buelt	■								
Lymington			■		■			■	■
Axe				■					
Wye			■	■					
Tweed				■			■		
Teme			■		■	■			
Camel				■	■	■			■
Coquet				■		■	■		
Derwent				■					■
Eden				■					■
Barle						■			■
Malham streams							■	■	

Table A1.10a. SSSI Rivers ranked by RIVPACS 9 endgroup occurrence.

River (system) name	1	2	3	4	5	6	7	8	9
Malham streams		■	■						
Barle	■			■					
Lugg				■	■	■			
Camel				■	■	■			
Derwent	■					■			
Eden	■					■			
Coquet			■	■		■			
Tweed			■			■			
Axe						■			
Wye						■	■		
Kennet							■		
Lambourn							■		
Test							■		
Derwent (lower)		■					■		
Lymington	■				■		■		
Teme				■	■		■		
Itchen					■		■	■	
Avon							■	■	
Frome (lower)							■	■	
Moors							■	■	■
Blythe							■	■	■
Wensum		■					■		■
Hull headwaters								■	■
Buelt									■

Table A1.10b. JNCC river type representation in SSSI Rivers ranked by RIVPACS 9 endgroup occurrence.

River (system) name	X	IX	VIII	VII	VI	V	III	II	I
Malham streams		■							
Barle	■		■						
Lugg			■			■		■	
Camel			■			■			
Derwent	■		■		■				
Eden	■		■		■				
Coquet		■		■	■				
Tweed				■	■	■			
Axe						■			
Wye						■			
Kennet							■		■
Lambourn							■		
Test							■		
Derwent (lower)						■	■		
Lymington						■		■	
Teme					■	■			
Itchen								■	
Avon							■	■	■
Frome (lower)							■		■
Moors						■	■		
Blythe						■		■	
Wensum							■		■
Hull headwaters									■
Buelt								■	

Appendix 2 – Water Quality Data on River SSSI Sites

Table A2.1. Water Quality statistics for the River Avon (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
50210705	pH - as pH units		7.93	0.23	7.55	7.69	7.93	8.15	8.30	56		0
	Temperature Water	ºC	10.83	3.90	4.70	5.49	10.50	15.96	16.87	56		0
	BOD ATU	mg/l	1.64	0.95	1.00	1.00	1.45	2.10	3.00	56	1	6
	Ammonia - as N	mg/l	0.05	0.03	0.03	0.03	0.03	0.08	0.10	56	0.03	22
	Nitrogen Kjeldahl - as N	mg/l	1.29	0.43	0.80	0.83	1.21	1.90	2.09	14		0
	Nitrogen Total Oxidised - as N	mg/l	5.34	1.55	3.51	3.65	4.96	7.72	8.00	56		0
	Nitrate	mg/l	5.31	1.54	3.49	3.64	4.93	7.68	7.97	56		0
	Nitrite	mg/l	0.03	0.02	0.01	0.01	0.03	0.05	0.07	56		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56	0.0004	22
	Solids Suspended @105C	mg/l	14.05	17.30	3.00	3.54	7.25	39.35	48.68	50	6	12
	Hardness Total	mg/l	342.11	18.96	311.65	322.30	345.50	361.70	363.85	44		0
	Alkalinity pH 4.5	mg/l	263.81	18.32	236.00	236.60	270.50	282.90	284.00	42		0
	Hardness Calcium	mg/l	323.75	28.97	277.50	292.50	332.50	346.25	346.88	6		0
	Hardness Magnesium	mg/l	11.70	0.95	10.18	10.60	12.01	12.48	12.62	6		0
	Ortho-Phosphate	mg/l	0.28	0.08	0.17	0.17	0.27	0.39	0.41	56		0
	Phosphate	mg/l	0.30	0.08	0.18	0.20	0.30	0.41	0.45	56		0
	Chlorophyll-A	ug/l	8.28	6.96	2.65	2.85	5.40	15.50	20.80	26		0
	Nitrogen Total Inorganic (Calculated)	mg/l	5.39	1.56	3.54	3.68	5.00	7.78	8.04	56		0
	Copper Dissolved - as Cu	ug/l	2.42	0.32	1.55	2.50	2.50	2.50	2.50	56	2.5	50
	Zinc - as Zn	ug/l	6.85	3.45	5.00	5.00	5.00	11.55	13.53	56	5	33
	DO % (Instrumental)	%	93.82	10.14	80.45	81.55	92.15	106.70	111.10	56		0
	DO conc. (Instrumental)	mg/l	10.46	1.58	8.29	8.71	10.10	12.40	13.10	56		0
50211448	pH - as pH units		7.67	0.23	7.24	7.39	7.75	7.90	7.90	49		0
	Temperature Water	ºC	10.33	2.31	6.65	7.29	10.29	13.17	13.51	50		0
	BOD ATU	mg/l	1.75	0.55	1.10	1.20	1.60	2.32	2.60	49	1	1
	Ammonia - as N	mg/l	0.21	0.12	0.09	0.11	0.19	0.35	0.48	49		0

	Nitrogen Total Oxidised - as N	mg/l	8.50	0.85	6.87	7.10	8.68	9.38	9.39	49		0
	Nitrate	mg/l	8.45	0.84	6.81	7.06	8.63	9.31	9.35	49		0
	Nitrite	mg/l	0.05	0.02	0.03	0.03	0.04	0.08	0.09	49		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48		0
	Solids Suspended @105C	mg/l	17.30	0.00	17.30	17.30	17.30	17.30	17.30	1		0
	Hardness Total	mg/l	317.96	26.03	262.60	277.00	327.00	342.00	342.00	47		0
	Alkalinity pH 4.5	mg/l	231.48	18.77	190.05	200.60	239.50	249.00	252.85	44		0
	Hardness Calcium	mg/l	282.50	22.50	255.63	258.75	281.25	307.50	310.00	6		0
	Hardness Magnesium	mg/l	12.03	0.24	11.71	11.77	11.99	12.32	12.35	6		0
	Ortho-Phosphate	mg/l	0.32	0.13	0.20	0.20	0.26	0.55	0.61	49		0
	Phosphate	mg/l	0.44	0.08	0.36	0.37	0.41	0.54	0.56	5		0
	Nitrogen Total Inorganic (Calculated)	mg/l	8.71	0.87	7.14	7.42	8.79	9.58	9.68	49		0
	Copper Dissolved - as Cu	ug/l	2.56	0.27	2.50	2.50	2.50	2.50	2.61	50	2.5	46
	Zinc - as Zn	ug/l	7.68	4.17	5.00	5.00	5.95	12.74	15.28	50	5	20
	DO % (Instrumental)	%	87.39	4.96	80.08	82.48	87.50	92.92	93.76	49		0
	DO conc. (Instrumental)	mg/l	9.81	0.84	8.88	8.98	9.61	10.90	11.00	49		0
50230245	pH - as pH units		8.09	0.23	7.76	7.79	8.06	8.31	8.37	28		0
	Temperature Water	ºC	11.47	3.62	7.02	7.47	11.46	16.46	16.99	28		0
	BOD ATU	mg/l	1.36	0.34	1.00	1.00	1.30	1.76	1.94	28	1	4
	Ammonia - as N	mg/l	0.03	0.01	0.03	0.03	0.03	0.05	0.06	28	0.03	21
	Nitrogen Total Oxidised - as N	mg/l	6.12	0.67	5.19	5.26	6.11	6.91	6.97	28		0
	Nitrate	mg/l	6.10	0.67	5.17	5.24	6.09	6.89	6.96	28		0
	Nitrite	mg/l	0.02	0.01	0.01	0.02	0.02	0.03	0.03	28		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28	0.00082	21
	Hardness Total	mg/l	262.33	9.41	254.00	254.00	261.00	272.00	277.00	6		0
	Alkalinity pH 4.5	mg/l	195.67	8.54	184.00	186.00	195.50	205.50	205.75	6		0
	Ortho-Phosphate	mg/l	0.11	0.03	0.06	0.07	0.11	0.15	0.15	28		0
	Nitrogen Total Inorganic (Calculated)	mg/l	6.16	0.67	5.22	5.29	6.14	6.94	7.00	28		0
	Copper Dissolved - as Cu	ug/l	2.17	0.62	0.97	1.07	2.50	2.50	2.50	18	2.5	15
	Zinc - as Zn	ug/l	7.18	4.14	5.00	5.00	5.00	12.10	14.80	17	5	9

	DO % (Instrumental)	%	109.71	13.89	93.13	95.01	105.25	129.85	132.28	28		0
	DO conc. (Instrumental)	mg/l	11.94	1.29	9.90	10.34	12.00	13.73	14.06	28		0
50240488	pH - as pH units		7.96	0.15	7.78	7.80	7.96	8.13	8.18	29		0
	Temperature Water	ºC	11.22	3.24	6.19	7.23	11.67	15.54	16.13	30		0
	BOD ATU	mg/l	1.42	0.33	1.00	1.07	1.40	1.90	2.01	30	1	2
	Ammonia - as N	mg/l	0.07	0.04	0.03	0.03	0.07	0.12	0.13	30	0.03	2
	Nitrogen Total Oxidised - as N	mg/l	7.05	0.88	5.58	5.72	7.10	8.09	8.28	30		0
	Nitrate	mg/l	6.99	0.89	5.48	5.61	7.04	8.06	8.24	30		0
	Nitrite	mg/l	0.06	0.02	0.03	0.03	0.05	0.08	0.11	30		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29	0.00049	2
	Hardness Total	mg/l	250.00	7.00	243.70	244.40	250.00	255.60	256.30	2		0
	Alkalinity pH 4.5	mg/l	180.57	12.25	167.30	167.60	179.00	194.00	198.50	7		0
	Ortho-Phosphate	mg/l	0.18	0.05	0.12	0.12	0.17	0.25	0.26	30		0
	Nitrogen Total Inorganic (Calculated)	mg/l	7.12	0.89	5.65	5.79	7.18	8.27	8.34	30		0
	Copper Dissolved - as Cu	ug/l	2.25	0.56	1.38	1.75	2.50	2.50	2.50	6	2.5	6
	Zinc - as Zn	ug/l	6.23	1.64	5.00	5.00	5.50	8.20	8.90	6	5	2
	DO % (Instrumental)	%	99.48	7.34	89.12	90.66	99.20	107.10	111.80	29		0
	DO conc. (Instrumental)	mg/l	10.89	0.94	9.47	9.71	10.70	12.16	12.46	29		0
50250551	pH - as pH units		7.98	0.13	7.74	7.81	8.00	8.14	8.16	29		0
	Temperature Water	ºC	10.68	2.84	6.22	6.56	10.79	14.34	14.51	30		0
	BOD ATU	mg/l	1.33	0.33	1.00	1.00	1.29	1.81	2.07	30	1	5
	Ammonia - as N	mg/l	0.03	0.01	0.03	0.03	0.03	0.04	0.04	30	0.03	19
	Nitrogen Total Oxidised - as N	mg/l	5.93	0.71	4.84	4.91	5.77	6.93	7.08	30		0
	Nitrate	mg/l	5.90	0.72	4.79	4.87	5.73	6.92	7.07	30		0
	Nitrite	mg/l	0.03	0.01	0.01	0.01	0.03	0.04	0.04	30		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29	0.00023	18
	Hardness Total	mg/l	255.00	0.00	255.00	255.00	255.00	255.00	255.00	2		0
	Alkalinity pH 4.5	mg/l	192.43	9.44	180.60	181.20	190.00	205.20	206.10	7		0
	Ortho-Phosphate	mg/l	0.09	0.02	0.06	0.07	0.09	0.12	0.13	30		0
	Nitrogen Total Inorganic (Calculated)	mg/l	5.97	0.71	4.88	4.95	5.80	6.96	7.11	30		0

	Copper Dissolved - as Cu	ug/l	2.25	0.56	1.38	1.75	2.50	2.50	2.50	6	2.5	6
	Zinc - as Zn	ug/l	7.38	2.85	5.00	5.00	6.20	10.95	11.83	6	5	3
	DO % (Instrumental)	%	101.78	8.61	87.64	91.20	101.60	110.34	117.58	29		0
	DO conc. (Instrumental)	mg/l	11.26	1.03	9.77	9.99	11.30	12.56	12.86	29		0
50260330	pH - as pH units		7.94	0.11	7.83	7.83	7.90	8.08	8.08	6		0
	Temperature Water	ºC	13.56	1.40	11.88	11.88	13.50	15.30	15.30	6		0
	BOD ATU	mg/l	1.77	0.19	1.59	1.59	1.69	2.04	2.04	6		0
	Ammonia - as N	mg/l	0.13	0.02	0.10	0.10	0.13	0.16	0.16	6		0
	Nitrogen Total Oxidised - as N	mg/l	5.77	0.23	5.47	5.47	5.82	6.02	6.02	6		0
	Nitrate	mg/l	5.72	0.23	5.40	5.40	5.79	5.96	5.96	6		0
	Nitrite	mg/l	0.05	0.02	0.03	0.03	0.06	0.07	0.07	6		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6		0
	Ortho-Phosphate	mg/l	0.13	0.03	0.09	0.09	0.14	0.15	0.15	6		0
	Nitrogen Total Inorganic (Calculated)	mg/l	5.90	0.24	5.60	5.60	5.92	6.18	6.18	6		0
	DO % (Instrumental)	%	95.03	11.79	86.30	86.30	87.10	111.70	111.70	6		0
	DO conc. (Instrumental)	mg/l	9.89	1.50	8.70	8.70	8.97	12.00	12.00	6		0
50260338	pH - as pH units		7.86	0.27	7.48	7.59	7.84	8.14	8.30	11		0
	Temperature Water	ºC	11.91	4.27	6.02	6.39	13.15	17.50	17.75	11		0
	BOD ATU	mg/l	1.75	0.45	1.33	1.33	1.62	2.31	2.55	10		0
	Ammonia - as N	mg/l	0.10	0.03	0.06	0.06	0.10	0.14	0.15	11		0
	Nitrogen Total Oxidised - as N	mg/l	5.87	0.64	5.08	5.10	5.73	6.76	6.77	10		0
	Nitrate	mg/l	5.80	0.67	4.97	4.98	5.68	6.74	6.75	10		0
	Nitrite	mg/l	0.07	0.04	0.03	0.03	0.07	0.13	0.13	10		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11		0
	Solids Suspended @105C	mg/l	8.75	1.85	7.09	7.27	8.75	10.23	10.42	2		0
	Ortho-Phosphate	mg/l	0.13	0.03	0.09	0.10	0.14	0.16	0.17	10		0
	Nitrogen Total Inorganic (Calculated)	mg/l	5.97	0.65	5.18	5.19	5.81	6.86	6.88	10		0
	Copper Dissolved - as Cu	ug/l	1.65	0.42	1.09	1.18	1.75	2.04	2.07	4	1	1
	Zinc - as Zn	ug/l	5.43	0.68	5.00	5.00	5.05	6.15	6.38	4	5	2
	DO % (Instrumental)	%	89.65	13.44	76.80	79.50	85.35	104.40	113.85	10		0

	DO conc. (Instrumental)	mg/l	9.64	1.82	7.66	7.69	9.33	11.95	12.63	10		0
50260409	pH - as pH units		7.92	0.22	7.68	7.69	7.90	8.19	8.24	22		0
	Temperature Water	ºC	11.94	4.01	5.58	6.63	13.23	16.98	17.19	22		0
	BOD ATU	mg/l	1.56	0.48	1.00	1.00	1.47	2.09	2.10	22	1	3
	Ammonia - as N	mg/l	0.05	0.03	0.03	0.03	0.04	0.09	0.09	22	0.03	6
	Nitrogen Total Oxidised - as N	mg/l	6.11	0.74	4.95	5.23	6.00	6.96	7.21	22		0
	Nitrate	mg/l	6.06	0.76	4.87	5.16	5.95	6.95	7.19	22		0
	Nitrite	mg/l	0.04	0.02	0.02	0.02	0.03	0.08	0.08	22		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22	0.00069	6
	Hardness Total	mg/l	267.67	14.29	239.00	258.00	268.00	281.00	286.00	21		0
	Alkalinity pH 4.5	mg/l	209.14	11.37	185.00	201.00	211.00	222.00	225.00	21		0
	Ortho-Phosphate	mg/l	0.12	0.03	0.08	0.09	0.12	0.16	0.18	22		0
	Nitrogen Total Inorganic (Calculated)	mg/l	6.16	0.74	5.01	5.27	6.04	7.00	7.26	22		0
	Copper Dissolved - as Cu	ug/l	1.76	0.56	1.00	1.03	1.55	2.50	2.50	22	2.5	9
	Zinc - as Zn	ug/l	5.55	1.21	5.00	5.00	5.00	6.57	8.88	22	5	15
	DO % (Instrumental)	%	95.98	20.15	74.56	75.74	93.00	118.68	123.04	22		0
	DO conc. (Instrumental)	mg/l	10.44	2.44	7.27	7.48	10.33	12.86	12.90	22		0
50260443	pH - as pH units		8.07	0.18	7.80	7.82	8.10	8.31	8.34	22		0
	Temperature Water	ºC	12.36	3.61	6.98	7.54	12.70	17.40	17.42	23		0
	BOD ATU	mg/l	1.36	0.54	1.00	1.00	1.18	1.84	2.09	22	1	5
	Ammonia - as N	mg/l	0.03	0.01	0.03	0.03	0.03	0.03	0.03	23	0.03	19
	Nitrogen Total Oxidised - as N	mg/l	5.94	0.73	4.93	5.00	5.97	6.96	7.10	22		0
	Nitrate	mg/l	5.92	0.73	4.91	4.99	5.95	6.93	7.09	22		0
	Nitrite	mg/l	0.02	0.00	0.01	0.01	0.02	0.02	0.03	22		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22	0.00029	18
	Hardness Total	mg/l	285.00	0.00	285.00	285.00	285.00	285.00	285.00	1		0
	Alkalinity pH 4.5	mg/l	228.00	0.00	228.00	228.00	228.00	228.00	228.00	1		0
	Ortho-Phosphate	mg/l	0.10	0.02	0.06	0.06	0.10	0.13	0.14	22		0
	Nitrogen Total Inorganic (Calculated)	mg/l	5.97	0.73	4.96	5.03	6.00	6.99	7.13	22		0
	Copper Dissolved - as Cu	ug/l	1.60	0.69	1.00	1.00	1.20	2.50	2.50	22	2.5	15

	Zinc - as Zn	ug/l	5.04	0.17	5.00	5.00	5.00	5.00	5.00	22	5	20
	DO % (Instrumental)	%	101.71	7.56	90.86	91.95	102.70	110.66	112.13	22		0
	DO conc. (Instrumental)	mg/l	10.91	0.89	9.78	9.87	11.10	11.90	12.19	22		0
50260464	pH - as pH units		7.89	0.15	7.68	7.73	7.87	8.05	8.10	9		0
	Temperature Water	ºC	12.29	3.39	7.02	7.66	12.61	16.64	16.72	10		0
	BOD ATU	mg/l	1.54	0.38	1.11	1.22	1.43	2.00	2.19	10	1	1
	Ammonia - as N	mg/l	0.08	0.03	0.04	0.05	0.06	0.12	0.12	10		0
	Nitrogen Total Oxidised - as N	mg/l	6.31	0.52	5.62	5.78	6.24	6.99	7.09	10		0
	Nitrate	mg/l	6.27	0.53	5.54	5.73	6.21	6.97	7.07	10		0
	Nitrite	mg/l	0.05	0.03	0.02	0.02	0.04	0.09	0.09	10		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9		0
	Ortho-Phosphate	mg/l	0.15	0.02	0.12	0.12	0.15	0.18	0.19	10		0
	Nitrogen Total Inorganic (Calculated)	mg/l	6.39	0.52	5.71	5.84	6.30	7.05	7.15	10		0
	Copper Dissolved - as Cu	ug/l	1.42	0.22	1.09	1.18	1.45	1.71	1.76	10	1	1
	Zinc - as Zn	ug/l	6.44	1.91	5.00	5.00	6.20	7.56	9.63	10	5	4
	DO % (Instrumental)	%	85.87	12.00	67.79	68.37	88.55	98.66	98.93	10		0
	DO conc. (Instrumental)	mg/l	9.27	1.77	7.05	7.08	9.41	11.23	11.37	10		0
50260521	pH - as pH units		7.84	0.13	7.65	7.68	7.85	7.97	8.02	9		0
	Temperature Water	ºC	12.37	3.22	7.07	7.64	12.66	16.09	16.26	9		0
	BOD ATU	mg/l	1.36	0.41	1.00	1.00	1.19	1.77	2.04	9	1	3
	Ammonia - as N	mg/l	0.03	0.00	0.03	0.03	0.03	0.04	0.04	9	0.03	7
	Nitrogen Total Oxidised - as N	mg/l	5.83	0.51	5.23	5.29	5.73	6.64	6.69	9		0
	Nitrate	mg/l	5.81	0.51	5.21	5.27	5.72	6.63	6.68	9		0
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.01	0.02	0.03	9		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9	0.00031	7
	Solids Suspended @105C	mg/l	7.60	3.00	4.90	5.20	7.60	10.00	10.30	2		0
	Ortho-Phosphate	mg/l	0.11	0.02	0.07	0.08	0.11	0.14	0.14	9		0
	Nitrogen Total Inorganic (Calculated)	mg/l	5.86	0.51	5.26	5.33	5.76	6.67	6.72	9		0
	Copper Dissolved - as Cu	ug/l	3.48	3.89	1.03	1.06	1.35	7.59	8.90	4	1	1
	Zinc - as Zn	ug/l	5.80	0.84	5.06	5.12	5.50	6.72	6.96	4	5	1

	DO % (Instrumental)	%	89.13	10.19	72.02	73.94	89.70	99.40	101.00	9		0
	DO conc. (Instrumental)	mg/l	9.58	1.54	7.51	7.59	8.98	11.38	11.54	9		0
50280344	pH - as pH units		7.78	0.20	7.40	7.43	7.84	8.00	8.01	11		0
	Temperature Water	ºC	11.93	4.00	5.83	6.04	14.03	16.10	16.70	11		0
	BOD ATU	mg/l	1.28	0.48	1.00	1.00	1.03	1.55	2.11	11	1	5
	Ammonia - as N	mg/l	0.04	0.01	0.03	0.03	0.05	0.05	0.07	11	0.03	4
	Nitrogen Total Oxidised - as N	mg/l	5.15	0.91	3.96	4.17	5.07	6.49	6.50	11		0
	Nitrate	mg/l	5.12	0.91	3.92	4.14	5.01	6.45	6.46	11		0
	Nitrite	mg/l	0.04	0.01	0.03	0.03	0.04	0.05	0.06	11		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11	0.00073	4
	Solids Suspended @105C	mg/l	6.50	1.30	5.33	5.46	6.50	7.54	7.67	2		0
	Alkalinity PH 4.5	mg/l	161.00	0.00	161.00	161.00	161.00	161.00	161.00	1		0
	Ortho-Phosphate	mg/l	0.15	0.05	0.11	0.12	0.14	0.17	0.24	11		0
	Nitrogen Total Inorganic (Calculated)	mg/l	5.20	0.91	4.01	4.22	5.10	6.54	6.55	11		0
	DO % (Instrumental)	%	91.73	7.75	80.65	83.50	94.90	101.10	101.35	11		0
	DO conc. (Instrumental)	mg/l	9.98	1.50	7.98	8.00	9.75	12.00	12.35	11		0
50280445	pH - as pH units		7.70	0.10	7.57	7.61	7.68	7.84	7.87	9		0
	Temperature Water	ºC	12.98	3.68	7.11	7.76	14.50	16.50	16.85	9		0
	BOD ATU	mg/l	2.62	2.13	1.17	1.34	2.01	3.69	6.10	9	1	1
	Ammonia - as N	mg/l	0.33	0.16	0.16	0.16	0.31	0.48	0.59	9		0
	Nitrogen Total Oxidised - as N	mg/l	6.49	0.95	5.07	5.34	6.59	7.49	7.56	9		0
	Nitrate	mg/l	6.40	0.95	4.98	5.25	6.49	7.41	7.44	9		0
	Nitrite	mg/l	0.09	0.04	0.05	0.05	0.09	0.14	0.15	9		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.01	0.01	9		0
	Solids Suspended @105C	mg/l	5.44	1.70	3.00	3.00	6.30	7.08	7.44	9	3	1
	Ortho-Phosphate	mg/l	0.28	0.08	0.19	0.20	0.27	0.41	0.43	9		0
	Phosphate	mg/l	0.34	0.09	0.26	0.27	0.30	0.44	0.49	9		0
	Nitrogen Total Inorganic (Calculated)	mg/l	6.82	0.99	5.41	5.61	6.90	7.97	8.16	9		0
	Copper Dissolved - as Cu	ug/l	2.14	0.59	1.60	1.60	1.80	2.92	3.16	9		0
	Zinc - as Zn	ug/l	7.20	2.49	5.00	5.00	6.50	10.98	11.54	9	5	3

	DO % (Instrumental)	%	81.77	13.72	60.28	67.36	81.40	95.60	96.40	9		0
	DO conc. (Instrumental)	mg/l	8.73	2.06	6.08	6.75	7.96	11.34	11.62	9		0
50280463	pH - as pH units		7.69	0.18	7.40	7.45	7.73	7.83	7.92	9		0
	Temperature Water	ºC	11.41	3.76	6.22	6.39	13.80	14.99	15.56	9		0
	BOD ATU	mg/l	2.16	2.47	1.03	1.06	1.21	3.25	6.18	9	1	1
	Ammonia - as N	mg/l	0.05	0.02	0.03	0.03	0.04	0.07	0.07	9	0.03	2
	Nitrogen Total Oxidised - as N	mg/l	5.27	0.86	4.18	4.27	5.08	6.33	6.44	9		0
	Nitrate	mg/l	5.23	0.86	4.15	4.24	5.03	6.30	6.41	9		0
	Nitrite	mg/l	0.04	0.01	0.02	0.02	0.03	0.05	0.06	9		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9	0.00073	2
	Solids Suspended @105C	mg/l	6.51	2.46	3.90	4.60	5.75	10.11	10.71	8		0
	Alkalinity PH 4.5	mg/l	168.00	0.00	168.00	168.00	168.00	168.00	168.00	1		0
	Ortho-Phosphate	mg/l	0.13	0.03	0.08	0.10	0.14	0.16	0.16	9		0
	Phosphate	mg/l	0.16	0.03	0.11	0.12	0.16	0.20	0.20	8		0
	Nitrogen Total Inorganic (Calculated)	mg/l	5.32	0.86	4.21	4.31	5.12	6.38	6.49	9		0
	DO % (Instrumental)	%	87.10	10.61	70.00	76.80	86.80	98.52	99.16	9		0
	DO conc. (Instrumental)	mg/l	9.61	1.73	7.17	7.82	10.10	11.60	12.00	9		0
50280545	pH - as pH units		7.95	0.26	7.67	7.70	7.84	8.30	8.40	11		0
	Temperature Water	ºC	11.86	3.89	5.62	5.73	12.37	16.90	17.05	11		0
	BOD ATU	mg/l	1.66	0.39	1.13	1.18	1.54	2.13	2.16	11		0
	Ammonia - as N	mg/l	0.08	0.02	0.05	0.07	0.08	0.10	0.12	11		0
	Nitrogen Total Oxidised - as N	mg/l	5.85	0.72	4.79	4.98	5.75	6.68	6.71	11		0
	Nitrate	mg/l	5.79	0.74	4.69	4.87	5.70	6.65	6.67	11		0
	Nitrite	mg/l	0.06	0.02	0.04	0.04	0.05	0.09	0.10	11		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11		0
	Solids Suspended @105C	mg/l	6.40	1.20	5.32	5.44	6.40	7.36	7.48	2		0
	Hardness Total	mg/l	272.00	0.00	272.00	272.00	272.00	272.00	272.00	1		0
	Alkalinity PH 4.5	mg/l	210.00	0.00	210.00	210.00	210.00	210.00	210.00	1		0
	Ortho-Phosphate	mg/l	0.15	0.02	0.12	0.12	0.14	0.17	0.18	11		0
	Nitrogen Total Inorganic (Calculated)	mg/l	5.93	0.72	4.87	5.06	5.83	6.77	6.82	11		0

	Copper Dissolved - as Cu	ug/l	1.57	0.61	1.00	1.00	1.30	2.50	2.75	11	2.5	3
	Zinc - as Zn	ug/l	7.48	6.89	5.00	5.00	5.00	6.60	17.90	11	5	8
	DO % (Instrumental)	%	87.66	14.46	69.35	70.40	87.00	105.40	111.80	11		0
	DO conc. (Instrumental)	mg/l	9.58	1.97	6.68	6.80	10.30	11.70	12.10	11		0
50280572	pH - as pH units		7.90	0.15	7.69	7.79	7.87	8.02	8.12	10		0
	Temperature Water	ºC	12.50	3.43	6.97	8.03	14.05	15.67	16.44	10		0
	BOD ATU	mg/l	1.51	0.33	1.13	1.15	1.42	1.91	2.00	10		0
	Ammonia - as N	mg/l	0.05	0.02	0.03	0.03	0.05	0.07	0.07	10	0.03	3
	Nitrogen Total Oxidised - as N	mg/l	5.96	0.70	5.05	5.19	5.73	6.90	6.92	10		0
	Nitrate	mg/l	5.92	0.71	5.00	5.13	5.68	6.87	6.89	10		0
	Nitrite	mg/l	0.05	0.01	0.03	0.03	0.05	0.06	0.07	10		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10	0.00076	3
	Solids Suspended @105C	mg/l	5.90	0.70	5.27	5.34	5.90	6.46	6.53	2		0
	Ortho-Phosphate	mg/l	0.20	0.06	0.12	0.12	0.22	0.27	0.28	10		0
	Nitrogen Total Inorganic (Calculated)	mg/l	6.01	0.71	5.09	5.22	5.76	6.98	7.00	10		0
	Copper Dissolved - as Cu	ug/l	1.48	0.35	1.05	1.09	1.60	1.91	1.96	10	1	1
	Zinc - as Zn	ug/l	5.96	1.37	5.00	5.00	5.00	8.32	8.41	10	5	6
	DO % (Instrumental)	%	95.36	7.57	85.67	87.74	94.80	102.84	107.52	10		0
	DO conc. (Instrumental)	mg/l	10.21	1.29	8.69	8.76	9.73	12.03	12.17	10		0
C0217000	pH - as pH units		7.97	0.26	7.69	7.71	7.91	8.32	8.41	10		0
	Temperature Water	ºC	12.03	4.16	5.62	5.73	12.40	17.20	17.95	11		0
	BOD ATU	mg/l	1.48	0.32	1.04	1.06	1.43	1.84	1.92	10		0
	Ammonia - as N	mg/l	0.06	0.02	0.04	0.05	0.06	0.09	0.10	10	0.03	1
	Nitrogen Total Oxidised - as N	mg/l	5.72	0.65	4.78	4.92	5.74	6.53	6.60	10		0
	Nitrate	mg/l	5.64	0.68	4.66	4.78	5.67	6.50	6.56	10		0
	Nitrite	mg/l	0.07	0.03	0.04	0.04	0.06	0.12	0.13	10		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10	0.00066	1
	Solids Suspended @105C	mg/l	7.65	0.15	7.52	7.53	7.65	7.77	7.79	2		0
	Ortho-Phosphate	mg/l	0.15	0.02	0.12	0.12	0.14	0.17	0.18	10		0
	Nitrogen Total Inorganic (Calculated)	mg/l	5.78	0.66	4.84	4.98	5.80	6.62	6.69	10		0

DO % (Instrumental)	%	88.24	15.05	69.45	70.20	89.00	108.80	114.00	11	0
DO conc. (Instrumental)	mg/l	9.62	2.04	6.60	6.80	10.10	11.70	12.20	11	0

Table A2.2. Water Quality statistics for the River Axe (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
70220119	pH - as pH units		7.91	0.27	7.50	7.60	7.90	8.28	8.39	63		0
	Conductivity @20C	uS/cm	374.57	63.01	242.65	288.10	383.50	443.70	457.40	44		0
	Temperature Water	ºC	10.76	4.33	4.89	5.93	10.00	17.82	18.09	63		0
	BOD ATU	mg/l	1.88	1.22	1.00	1.00	1.50	3.40	4.48	63	1	11
	Ammonia - as N	mg/l	0.13	0.10	0.03	0.03	0.10	0.27	0.31	63	0.03	11
	Nitrogen Total Oxidised - as N	mg/l	4.51	0.87	3.08	3.52	4.47	5.48	5.95	63		0
	Nitrate	mg/l	4.47	0.86	3.07	3.48	4.42	5.42	5.90	63		0
	Nitrite	mg/l	0.05	0.02	0.02	0.02	0.04	0.07	0.09	63		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63	0.001	11
	Solids Suspended @105C	mg/l	17.32	22.95	3.00	3.00	6.00	52.26	75.12	44	3	12
	Solids Non-Volatile @500C	mg/l	28.17	15.72	20.00	20.00	20.00	63.20	65.00	30	20	21
	Hardness Total	mg/l	183.76	40.67	108.03	132.20	191.00	235.20	238.10	39		0
	Alkalinity pH 4.5	mg/l	131.29	32.91	78.00	92.00	136.00	164.00	174.00	41		0
	Hardness Calcium	mg/l	115.42	60.59	21.25	42.50	133.50	170.25	173.38	6		0
	Hardness Magnesium	mg/l	20.49	10.30	3.58	7.15	26.81	27.49	27.64	6		0
	Chloride Ion - as Cl	mg/l	23.80	3.00	17.60	21.24	24.05	27.11	27.20	44		0
	Ortho-Phosphate	mg/l	0.21	0.09	0.11	0.13	0.18	0.31	0.35	63		0
	Ortho Phosphate Dissolved	mg/l	0.13	0.00	0.13	0.13	0.13	0.14	0.14	2		0
	Phosphate	mg/l	0.16	0.04	0.10	0.12	0.17	0.21	0.21	14		0
	Phosphorus Total - as P	mg/l	0.19	0.05	0.12	0.14	0.19	0.25	0.27	14		0
	Nitrogen Total Inorganic (Calculated)	mg/l	4.65	0.88	3.13	3.74	4.54	5.83	6.17	63		0
	Copper Dissolved - as Cu	ug/l	2.52	0.67	1.61	1.70	2.50	3.18	3.57	63	2.5	34
	Zinc - as Zn	ug/l	8.30	6.04	5.00	5.00	5.00	15.10	18.96	63	5	32
	DO % (Instrumental)	%	94.27	8.72	80.91	85.00	94.00	106.80	110.70	63		0
	DO conc. (Instrumental)	mg/l	10.51	1.33	8.26	9.09	10.50	11.78	12.47	63		0

70220140	pH - as pH units		7.92	0.31	7.35	7.60	8.00	8.20	8.45	65		0
	Conductivity @20C	uS/cm	370.31	64.83	253.20	275.40	386.00	443.80	449.40	45		0
	Temperature Water	ºC	11.02	4.73	3.62	5.86	10.30	18.24	19.14	65		0
	BOD ATU	mg/l	1.85	1.18	1.00	1.00	1.40	3.44	4.12	65	1	15
	Ammonia - as N	mg/l	0.10	0.08	0.03	0.03	0.08	0.20	0.27	65	0.03	13
	Nitrogen Total Oxidised - as N	mg/l	4.36	0.90	2.75	3.32	4.42	5.35	5.55	65		0
	Nitrate	mg/l	4.31	0.89	2.70	3.28	4.35	5.33	5.51	65		0
	Nitrite	mg/l	0.04	0.02	0.02	0.02	0.04	0.07	0.08	65		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	65	0.0008	13
	Solids Suspended @105C	mg/l	16.35	32.86	3.00	3.00	4.30	51.49	71.80	60	3	20
	Solids Non-Volatile @500C	mg/l	30.03	28.17	20.00	20.00	20.00	53.90	64.15	40	20	32
	Hardness Total	mg/l	178.77	40.88	101.00	116.00	191.00	225.00	227.00	41		0
	Alkalinity pH 4.5	mg/l	130.30	33.82	76.20	82.60	136.00	167.00	174.40	43		0
	Hardness Calcium	mg/l	137.38	44.96	69.19	74.88	163.50	173.75	175.88	6		0
	Hardness Magnesium	mg/l	24.25	4.31	17.33	19.99	25.99	26.77	26.92	6		0
	Chloride Ion - as Cl	mg/l	23.83	2.74	19.20	20.78	24.00	26.72	27.14	45		0
	Ortho-Phosphate	mg/l	0.20	0.09	0.11	0.12	0.18	0.30	0.34	65		0
	Ortho Phosphate Dissolved	mg/l	0.11	0.01	0.11	0.11	0.11	0.12	0.12	2		0
	Phosphate	mg/l	0.18	0.03	0.15	0.15	0.18	0.22	0.22	4		0
	Phosphorus Total - as P	mg/l	0.20	0.09	0.13	0.14	0.18	0.25	0.32	19		0
	Nitrogen Total Inorganic (Calculated)	mg/l	4.46	0.89	2.95	3.43	4.48	5.42	5.71	65		0
	Copper Dissolved - as Cu	ug/l	2.66	0.92	1.40	1.54	2.50	3.30	4.68	65	2.5	34
	Zinc - as Zn	ug/l	9.85	8.62	5.00	5.00	5.00	18.60	27.56	65	5	33
	DO % (Instrumental)	%	95.46	11.19	81.20	83.76	94.00	112.60	120.80	65		0
	DO conc. (Instrumental)	mg/l	10.57	1.42	8.44	8.84	10.60	12.06	13.24	65		0
70230103	Lead Dissolved - as Pb	ug/l	2.00	0.00	2.00	2.00	2.00	2.00	2.00	6	2	6
	pH - as pH units		7.92	0.34	7.17	7.50	8.00	8.30	8.37	55		0
	Conductivity @20C	uS/cm	387.64	59.86	283.20	294.80	401.00	455.80	469.20	47		0
	Temperature Water	ºC	10.62	3.79	4.50	6.34	9.60	15.68	16.62	55		0
	BOD ATU	mg/l	2.03	1.25	1.00	1.00	1.60	3.70	4.33	55	1	5
	Mercury - as Hg	ug/l	0.01	0.00	0.01	0.01	0.01	0.02	0.02	6	0.01	3

Cadmium - as Cd	ug/l	0.11	0.01	0.10	0.10	0.10	0.12	0.13	6	0.1	5
Ammonia - as N	mg/l	0.09	0.07	0.03	0.03	0.06	0.19	0.23	55	0.03	17
Nitrogen Total Oxidised - as N	mg/l	4.81	0.73	3.54	3.91	4.88	5.84	6.00	55		0
Nitrate	mg/l	4.77	0.73	3.50	3.87	4.84	5.80	5.95	55		0
Nitrite	mg/l	0.03	0.02	0.01	0.02	0.03	0.06	0.06	55		0
Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	55	0.0004	17
Solids Suspended @105C	mg/l	17.51	29.21	3.00	3.00	6.00	41.50	74.17	47	3	14
Solids Non-Volatile @500C	mg/l	28.09	20.44	20.00	20.00	20.00	34.00	73.55	34	20	24
Hardness Total	mg/l	188.06	41.41	126.00	131.50	199.50	233.50	237.75	16		0
Alkalinity pH 4.5	mg/l	146.23	41.69	90.30	92.80	149.00	192.80	211.00	39		0
Hardness Calcium	mg/l	161.50	30.50	134.05	137.10	161.50	185.90	188.95	2		0
Hardness Magnesium	mg/l	15.66	1.80	14.04	14.22	15.66	17.11	17.29	2		0
Chloride Ion - as Cl	mg/l	25.89	4.55	20.30	21.00	24.70	32.56	34.91	47		0
Ortho-Phosphate	mg/l	0.22	0.11	0.09	0.11	0.19	0.38	0.41	55		0
Ortho Phosphate Dissolved	mg/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	2		0
Phosphate	mg/l	0.16	0.06	0.08	0.10	0.15	0.23	0.26	12		0
Phosphorus Total - as P	mg/l	0.17	0.05	0.11	0.12	0.17	0.23	0.26	12		0
Chromium Dissolved - as Cr	ug/l	0.55	0.11	0.50	0.50	0.50	0.65	0.73	6	0.5	5
Nickel Dissolved - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	6	5	6
Nitrogen Total Inorganic (Calculated)	mg/l	4.89	0.73	3.72	3.96	4.92	5.97	6.06	55		0
Copper Dissolved - as Cu	ug/l	2.54	0.48	1.80	2.10	2.50	3.10	3.53	16	2.5	9
Zinc - as Zn	ug/l	9.61	6.22	5.00	5.00	8.15	15.45	20.55	16	5	6
DO % (Instrumental)	%	97.45	6.43	87.12	90.00	97.00	105.40	108.00	55		0
DO conc. (Instrumental)	mg/l	10.88	1.06	9.43	9.59	10.80	12.10	12.49	55		0

Table A2.3. Water Quality statistics for the River Barle (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
70581171	pH - as pH units		7.39	0.42	6.60	6.80	7.50	7.75	7.83	70		0
	Temperature Water	ºC	9.89	3.19	5.73	6.36	9.50	14.20	15.28	70		0
	BOD ATU	mg/l	1.13	0.24	1.00	1.00	1.00	1.50	1.70	70	1	41
	Ammonia - as N	mg/l	0.03	0.00	0.03	0.03	0.03	0.03	0.03	70	0.03	63
	Nitrogen Total Oxidised - as N	mg/l	0.66	0.23	0.34	0.39	0.64	1.01	1.11	70		0
	Nitrate	mg/l	0.65	0.23	0.34	0.39	0.63	1.01	1.11	70		0
	Nitrite	mg/l	0.01	0.00	0.00	0.00	0.00	0.01	0.01	70	0.004	60
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	70	0.0002	63
	Solids Suspended @105C	mg/l	4.84	6.89	3.00	3.00	3.00	5.76	12.92	50	3	38
	Hardness Total	mg/l	20.55	5.22	12.18	14.30	21.30	27.40	28.40	17		0
	Alkalinity pH 4.5	mg/l	17.32	4.65	10.00	10.00	18.00	22.21	24.85	44	10	15
	Hardness Calcium	mg/l	15.38	0.13	15.26	15.28	15.38	15.48	15.49	2		0
	Hardness Magnesium	mg/l	6.05	0.02	6.03	6.03	6.05	6.06	6.07	2		0
	Ortho-Phosphate	mg/l	0.02	0.01	0.01	0.01	0.02	0.02	0.02	70	0.01	65
	Nitrogen Total Inorganic (Calculated)	mg/l	0.69	0.23	0.37	0.42	0.67	1.04	1.14	70		0
	Copper Dissolved - as Cu	ug/l	2.35	0.46	1.20	2.50	2.50	2.50	2.50	21	2.5	19
	Copper - as Cu	ug/l	1.98	0.91	0.72	1.03	2.50	2.50	2.50	4	2.5	3
	Zinc - as Zn	ug/l	6.22	4.46	5.00	5.00	5.00	5.80	9.00	21	5	18
	DO % (Instrumental)	%	97.28	4.59	88.45	90.90	98.00	102.00	105.00	70		0
	DO conc. (Instrumental)	mg/l	11.04	0.99	9.41	9.76	11.10	12.30	12.60	70		0

Table A2.4. Water Quality statistics for the River Blythe (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
63987300	pH - as pH units		7.40	0.24	7.1	7.1	7.4	7.61	7.7	70		0
	Conductivity @20C	uS/cm	526.87	107.76	328.5	386	540	653	696	71		0
	Temperature Water	ºC	10.37	3.90	4.145	5.24	10.35	15.24	16.175	70		0
	BOD ATU	mg/l	1.98	1.16	1.1	1.25	1.64	2.76	3.215	71	1.68	6
	Ammonia - as N	mg/l	0.13	0.27	0.03	0.03	0.05	0.271	0.3655	71	0.03	16
	Nitrogen Total Oxidised - as N	mg/l	7.57	3.35	3.025	3.34	7.18	13.2	14.4	71		0
	Nitrate	mg/l	7.63	2.91	4.058	4.37	7.26	11.58	13.71	35		0
	Nitrite	mg/l	0.04	0.05	0.008	0.009	0.03	0.0652	0.1238	35		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00061	0.00124	0.00008	0.0001	0.00023	0.001216	0.00222	69	0.0002	14
	Solids Suspended @105C	mg/l	9.08	6.60	3	3	7	19	21.5	71	3	9
	Hardness Total	mg/l	187.98	32.44	136.6	143.6	191	226	231.6	49		0
	Alkalinity pH 4.5	mg/l	131.11	21.12	94.16	106.6	133	153.2	157.2	49		0
	Chloride Ion - as Cl	mg/l	53.45	19.44	27.35	33.8	53.5	74.7	92.1	71		0
	Ortho-Phosphate	mg/l	1.71	1.18	0.5595	0.614	1.37	3.4	3.74	71		0
	Chlorophyll	ug/l	8.36	12.22	1.403	1.765	4.325	15.1	28.33	58		0
	Copper Dissolved - as Cu	ug/l	6.99	2.19	4.57	4.85	6.39	9.48	12.15	71		0
	Zinc - as Zn	ug/l	24.49	11.82	13.55	14.3	22.7	33.4	41.3	71		0
	DO % (Instrumental)	%	82.28	18.48	60.5	64	78	101	118.5	71		0
	DO conc. (Instrumental)	mg/l	9.26	2.35	6.1955	6.602	8.895	12.08	13.355	70		0

Table A2.5. Water Quality statistics for the River Buelt (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
E0000531	pH - as pH units		7.78	0.37	7.26	7.42	7.75	8.19	8.72	57		0
	Conductivity @20C	uS/cm	392.19	49.78	326.50	346.00	405.50	447.50	463.50	16		0
	Temperature Water	ºC	12.54	5.05	4.37	4.90	12.72	18.98	20.06	57		0
	BOD ATU	mg/l	2.18	1.06	1.02	1.19	1.80	4.00	4.20	56	3	3
	Ammonia - as N	mg/l	0.07	0.05	0.03	0.03	0.05	0.15	0.17	56	0.03	11
	Nitrogen Total Oxidised - as N	mg/l	3.80	2.56	0.89	1.26	3.36	5.83	7.41	56		0
	Nitrate	mg/l	3.77	2.55	0.87	1.24	3.33	5.77	7.37	56		0
	Nitrite	mg/l	0.03	0.02	0.01	0.01	0.03	0.06	0.07	56		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	55	0.0009	11
	Hardness Total	mg/l	156.46	25.90	121.40	125.80	155.00	182.60	199.40	35		0
	Alkalinity pH 4.5	mg/l	100.87	14.52	78.95	83.20	99.90	120.10	126.10	34		0
	Chloride Ion - as Cl	mg/l	35.66	4.55	28.93	31.75	35.65	39.90	40.85	16		0
	Ortho-Phosphate	mg/l	0.19	0.09	0.09	0.10	0.17	0.31	0.37	56		0
	Zinc Dissolved - as Zn	ug/l	12.17	16.39	5.00	5.00	6.00	17.65	51.33	26	5	10
	Copper Dissolved - as Cu	ug/l	4.39	2.93	2.50	2.50	3.45	6.10	9.78	42	2.5	13
	Copper - as Cu	ug/l	6.06	4.85	2.50	2.50	4.25	12.40	16.68	26	2.5	4
	Zinc - as Zn	ug/l	19.19	34.08	5.00	5.00	9.35	33.53	54.05	42	5	9
	DO % (Instrumental)	%	91.09	9.82	74.84	79.18	93.20	100.18	101.70	57		0
	DO conc. (Instrumental)	mg/l	9.99	1.52	7.82	8.15	9.65	12.24	12.64	34		0
E0000540	Lead Dissolved - as Pb	ug/l	2.00	0.00	2.00	2.00	2.00	2.00	2.00	11	2	11
	pH - as pH units		7.66	0.38	7.16	7.26	7.63	8.12	8.40	41		0
	Conductivity @20C	uS/cm	471.14	46.32	389.40	401.60	472.00	524.20	530.55	14		0
	Temperature Water	ºC	12.70	5.45	3.83	5.38	13.15	19.52	20.01	42		0
	BOD ATU	mg/l	2.21	1.40	1.00	1.01	1.70	3.79	5.38	42	3	6
	Mercury - as Hg	ug/l	0.01	0.01	0.01	0.01	0.01	0.02	0.03	11	0.01	7
	Cadmium - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	11	0.1	11
	Ammonia - as N	mg/l	0.08	0.04	0.03	0.03	0.06	0.13	0.15	42	0.03	4

	Nitrogen Total Oxidised - as N	mg/l	5.00	2.64	2.84	2.92	4.52	7.28	9.09	42		0
	Nitrate	mg/l	4.95	2.63	2.81	2.87	4.47	7.25	9.01	42		0
	Nitrite	mg/l	0.05	0.02	0.02	0.02	0.05	0.08	0.09	42		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	41	0.0009	4
	Hardness Total	mg/l	182.79	19.89	156.60	161.20	179.00	206.60	218.20	33		0
	Alkalinity pH 4.5	mg/l	123.25	21.14	87.60	97.20	126.00	151.20	159.80	33		0
	Chloride Ion - as Cl	mg/l	44.45	5.39	36.55	39.18	45.20	49.83	51.15	14		0
	Ortho-Phosphate	mg/l	0.38	0.31	0.11	0.13	0.25	0.87	1.03	42		0
	Phosphorus Total - as P	mg/l	0.20	0.07	0.13	0.14	0.19	0.27	0.33	11		0
	Zinc Dissolved - as Zn	ug/l	8.65	8.60	5.00	5.00	6.00	11.77	17.25	28	5	12
	Chromium Dissolved - as Cr	ug/l	0.70	0.54	0.50	0.50	0.50	0.80	1.60	11	0.5	9
	Nickel Dissolved - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	11	5	11
	Copper Dissolved - as Cu	ug/l	4.65	2.31	2.50	2.60	3.90	7.18	8.35	42	2.5	4
	Copper - as Cu	ug/l	6.31	4.11	2.61	2.87	4.80	11.61	15.03	28	2.5	1
	Zinc - as Zn	ug/l	13.02	12.40	5.00	5.00	8.60	26.72	30.22	42	5	6
	DO % (Instrumental)	%	74.48	25.61	23.41	35.99	83.30	100.09	105.28	42		0
	DO conc. (Instrumental)	mg/l	7.89	3.51	1.22	2.51	9.10	11.90	11.90	21		0
E0000544	Lead Dissolved - as Pb	ug/l	2.00	0.00	2.00	2.00	2.00	2.00	2.00	11	2	10
	pH - as pH units		7.62	0.37	7.02	7.21	7.63	8.07	8.32	43		0
	Conductivity @20C	uS/cm	463.07	69.29	326.90	351.60	486.00	539.20	547.20	15		0
	Temperature Water	ºC	12.26	5.27	3.33	4.95	12.43	18.96	20.22	43		0
	BOD ATU	mg/l	2.35	1.22	1.30	1.30	2.00	3.74	4.84	43		0
	Mercury - as Hg	ug/l	0.01	0.01	0.01	0.01	0.01	0.02	0.03	11	0.01	6
	Cadmium - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	11	0.1	11
	Ammonia - as N	mg/l	0.07	0.04	0.03	0.03	0.06	0.13	0.16	43	0.03	11
	Nitrogen Total Oxidised - as N	mg/l	4.87	2.49	2.56	2.76	4.32	6.81	8.94	43		0
	Nitrate	mg/l	4.82	2.48	2.53	2.74	4.29	6.78	8.88	43		0
	Nitrite	mg/l	0.05	0.03	0.02	0.02	0.04	0.08	0.09	43		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43	0.0012	11
	Hardness Total	mg/l	180.35	26.83	137.55	146.20	176.00	218.30	226.80	34		0
	Alkalinity pH 4.5	mg/l	122.60	24.09	84.65	90.79	124.50	150.30	162.10	34		0

	Chloride Ion - as Cl	mg/l	44.49	8.51	30.26	32.36	45.80	52.98	54.67	15		0
	Ortho-Phosphate	mg/l	0.41	0.38	0.12	0.12	0.25	0.98	1.08	43		0
	Phosphorus Total - as P	mg/l	0.25	0.11	0.14	0.14	0.24	0.44	0.44	11		0
	Zinc Dissolved - as Zn	ug/l	6.84	3.29	5.00	5.00	5.00	10.74	12.99	28	5	14
	Chromium Dissolved - as Cr	ug/l	0.57	0.14	0.50	0.50	0.50	0.80	0.85	11	0.5	8
	Nickel Dissolved - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	11	5	11
	Copper Dissolved - as Cu	ug/l	4.72	2.52	2.80	3.22	3.90	6.42	6.98	43	2.5	1
	Copper - as Cu	ug/l	5.58	2.97	3.14	3.55	4.70	7.67	10.63	28		0
	Zinc - as Zn	ug/l	14.96	12.64	5.00	5.00	11.60	31.66	37.01	43	5	6
	DO % (Instrumental)	%	77.74	22.73	42.32	47.48	78.40	101.84	109.19	43		0
	DO conc. (Instrumental)	mg/l	8.68	3.39	4.44	4.59	8.52	12.03	13.44	20		0
E0000546	pH - as pH units		7.55	0.45	7.14	7.26	7.58	7.91	8.08	56		0
	Conductivity @20C	uS/cm	514.40	112.09	312.20	350.00	542.00	629.40	644.00	15		0
	Temperature Water	ºC	11.26	4.37	2.90	4.55	12.15	16.35	16.81	56		0
	BOD ATU	mg/l	2.43	1.31	1.00	1.20	2.00	4.52	5.20	56	3	3
	Ammonia - as N	mg/l	0.13	0.17	0.03	0.03	0.08	0.22	0.27	56	0.03	3
	Nitrogen Total Oxidised - as N	mg/l	4.15	3.24	0.75	1.75	3.28	6.78	11.30	56	0.2	1
	Nitrate	mg/l	4.08	3.24	0.64	1.58	3.25	6.69	11.20	56		0
	Nitrite	mg/l	0.07	0.05	0.02	0.02	0.05	0.12	0.16	56		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56	0.0001	4
	Hardness Total	mg/l	223.24	38.87	152.10	168.80	229.00	270.10	283.35	34		0
	Alkalinity PH 4.5	mg/l	152.88	45.50	80.95	88.70	165.50	206.40	219.70	34		0
	Chloride Ion - as Cl	mg/l	45.23	10.53	27.30	31.60	46.60	57.20	58.78	15		0
	Ortho-Phosphate	mg/l	0.51	0.40	0.12	0.14	0.35	0.99	1.24	56		0
	Zinc Dissolved - as Zn	ug/l	7.23	7.50	5.00	5.00	5.00	9.40	11.50	41	5	24
	Copper Dissolved - as Cu	ug/l	3.75	1.20	2.47	2.50	3.50	5.74	6.36	55	2.5	5
	Copper - as Cu	ug/l	5.35	3.00	2.70	2.90	4.60	7.80	12.20	41	2.5	1
	Zinc - as Zn	ug/l	11.83	8.59	5.00	5.05	8.70	22.65	31.03	56	5	6
	DO % (Instrumental)	%	68.36	33.26	15.25	19.80	75.50	100.05	105.90	56		0
	DO conc. (Instrumental)	mg/l	8.09	4.72	1.37	2.24	7.61	13.12	15.38	33		0

Table A2.6. Water Quality statistics for the River Camel (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
82520705	pH - as pH units		7.32	0.34	6.86	6.93	7.42	7.64	7.66	4		0
	Temperature Water	ºC	9.20	1.67	7.06	7.36	9.36	10.90	11.10	4		0
	BOD ATU	mg/l	1.16	0.11	1.02	1.04	1.17	1.27	1.29	4	1	1
	Ammonia - as N	mg/l	0.03	0.00	0.03	0.03	0.03	0.03	0.03	4	0.03	4
	Nitrogen Total Oxidised - as N	mg/l	4.04	0.17	3.86	3.87	4.04	4.22	4.23	4		0
	Nitrate	mg/l	4.04	0.17	3.86	3.87	4.03	4.22	4.23	4		0
	Nitrite	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.01	4	0.004	3
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4	0.0001	4
	Solids Suspended @105C	mg/l	3.00	0.00	3.00	3.00	3.00	3.00	3.00	1	3	1
	Alkalinity pH 4.5	mg/l	34.50	0.00	34.50	34.50	34.50	34.50	34.50	1		0
	Ortho-Phosphate	mg/l	0.02	0.00	0.02	0.02	0.02	0.02	0.02	4	0.02	4
	Chlorophyll-A	ug/l	2.20	0.00	2.20	2.20	2.20	2.20	2.20	1		0
	Nitrogen Total Inorganic (Calculated)	mg/l	4.07	0.17	3.89	3.90	4.07	4.25	4.26	4		0
	DO % (Instrumental)	%	94.25	2.49	92.00	92.00	93.50	97.10	97.55	4		0
	DO conc. (Instrumental)	mg/l	10.88	0.73	10.15	10.19	10.70	11.70	11.85	4		0
82522505	pH - as pH units		7.22	0.29	6.86	6.94	7.15	7.57	7.64	67		0
	Temperature Water	ºC	11.38	2.71	6.81	7.75	11.20	15.02	15.48	66		0
	BOD ATU	mg/l	1.16	0.44	1.00	1.00	1.00	1.40	1.67	67	1	35
	Ammonia - as N	mg/l	0.04	0.03	0.03	0.03	0.03	0.07	0.11	67	0.03	44
	Nitrogen Total Oxidised - as N	mg/l	2.12	0.43	1.47	1.65	2.07	2.76	3.04	67		0
	Nitrate	mg/l	2.12	0.43	1.47	1.63	2.06	2.75	3.03	67		0
	Nitrite	mg/l	0.01	0.00	0.00	0.00	0.01	0.01	0.01	67	0.004	31
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66	0.0002	48
	Hardness Total	mg/l	31.45	3.87	27.25	28.22	30.90	36.10	39.97	15		0
	Alkalinity pH 4.5	mg/l	17.53	3.59	11.05	12.46	18.00	21.90	22.00	42	10	10
	Hardness Calcium	mg/l	32.25	0.00	32.25	32.25	32.25	32.25	32.25	1		0

	Hardness Magnesium	mg/l	9.80	0.00	9.80	9.80	9.80	9.80	9.80	1		0
	Ortho-Phosphate	mg/l	0.02	0.01	0.01	0.01	0.02	0.03	0.04	67	0.01	42
	Nitrogen Total Inorganic (Calculated)	mg/l	2.16	0.44	1.50	1.68	2.10	2.81	3.09	67		0
	Copper Dissolved - as Cu	ug/l	2.58	0.29	2.50	2.50	2.50	2.56	2.90	19	2.5	17
	Zinc - as Zn	ug/l	5.84	1.29	5.00	5.00	5.10	7.06	7.59	19	5	8
	DO % (Instrumental)	%	95.60	2.99	91.00	92.00	95.90	99.64	100.00	67		0
	DO conc. (Instrumental)	mg/l	10.47	0.73	9.42	9.57	10.45	11.50	11.60	66		0
82528026	pH - as pH units		7.40	0.28	7.02	7.25	7.35	7.57	7.75	13		0
	Temperature Water	ºC	10.60	2.75	6.27	7.03	10.70	14.24	14.27	13		0
	BOD ATU	mg/l	1.12	0.21	1.00	1.00	1.00	1.49	1.56	13	1	8
	Ammonia - as N	mg/l	0.04	0.01	0.03	0.03	0.03	0.05	0.05	13	0.03	7
	Nitrogen Total Oxidised - as N	mg/l	2.78	0.20	2.50	2.54	2.82	3.02	3.07	13		0
	Nitrate	mg/l	2.77	0.20	2.49	2.53	2.82	3.02	3.06	13		0
	Nitrite	mg/l	0.01	0.01	0.00	0.00	0.01	0.02	0.02	13	0.004	2
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13	0.00014	7
	Ortho-Phosphate	mg/l	0.13	0.09	0.02	0.02	0.11	0.29	0.30	13	0.02	2
	Nitrogen Total Inorganic (Calculated)	mg/l	2.82	0.20	2.54	2.57	2.85	3.05	3.10	13		0
	Copper Dissolved - as Cu	ug/l	1.43	0.31	1.06	1.12	1.60	1.68	1.69	3	1	1
	Zinc - as Zn	ug/l	17.53	16.17	5.94	5.98	6.30	33.58	36.99	3		0
	DO % (Instrumental)	%	95.60	3.67	89.48	89.84	96.00	99.80	100.00	13		0
	DO conc. (Instrumental)	mg/l	10.68	0.99	9.34	9.53	10.80	11.76	12.00	13		0
82528082	pH - as pH units		7.31	0.27	6.82	6.95	7.31	7.61	7.68	67		0
	Temperature Water	ºC	11.05	2.97	6.07	7.85	10.88	14.85	16.06	66		0
	BOD ATU	mg/l	1.21	0.34	1.00	1.00	1.02	1.64	1.87	67	1	29
	Ammonia - as N	mg/l	0.04	0.03	0.03	0.03	0.03	0.07	0.12	67	0.03	45
	Nitrogen Total Oxidised - as N	mg/l	2.23	0.29	1.67	1.94	2.24	2.52	2.62	67		0
	Nitrate	mg/l	2.23	0.29	1.65	1.94	2.23	2.52	2.61	67		0
	Nitrite	mg/l	0.01	0.00	0.00	0.00	0.01	0.01	0.02	67	0.004	30
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66	0.0002	45
	Hardness Total	mg/l	31.93	2.95	25.00	27.28	33.00	34.48	34.60	15		0
	Alkalinity pH 4.5	mg/l	17.22	3.98	10.00	12.02	17.00	22.09	22.97	42	10	11

	Hardness Calcium	mg/l	24.25	0.00	24.25	24.25	24.25	24.25	24.25	1		0
	Hardness Magnesium	mg/l	10.37	0.00	10.37	10.37	10.37	10.37	10.37	1		0
	Ortho-Phosphate	mg/l	0.05	0.03	0.02	0.02	0.04	0.09	0.11	67	0.02	8
	Nitrogen Total Inorganic (Calculated)	mg/l	2.28	0.28	1.80	1.97	2.27	2.57	2.65	67		0
	Copper Dissolved - as Cu	ug/l	2.59	0.38	2.50	2.50	2.50	2.50	2.67	19	2.5	18
	Zinc - as Zn	ug/l	6.84	3.18	5.00	5.00	5.00	10.70	14.80	19	5	10
	DO % (Instrumental)	%	95.47	3.71	90.66	91.12	95.50	99.00	99.88	67		0
	DO conc. (Instrumental)	mg/l	10.53	0.88	9.29	9.35	10.55	11.55	11.80	66		0
82528120	pH - as pH units		7.19	0.31	6.70	6.81	7.17	7.57	7.65	67		0
	Temperature Water	ºC	11.28	2.57	7.11	7.95	11.28	14.64	15.47	66		0
	BOD ATU	mg/l	1.55	1.21	1.00	1.00	1.20	2.08	2.81	67	1	19
	Ammonia - as N	mg/l	0.10	0.16	0.03	0.03	0.04	0.17	0.45	67	0.03	20
	Nitrogen Total Oxidised - as N	mg/l	3.08	0.42	2.48	2.59	3.12	3.55	3.70	67		0
	Nitrate	mg/l	3.06	0.41	2.47	2.57	3.11	3.53	3.68	67		0
	Nitrite	mg/l	0.02	0.04	0.00	0.01	0.01	0.03	0.05	67	0.004	9
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66	0.0001	22
	Hardness Total	mg/l	40.65	2.00	37.96	39.63	40.60	42.73	43.28	14		0
	Alkalinity pH 4.5	mg/l	22.60	3.31	17.03	19.00	22.00	27.00	27.00	42	20	1
	Hardness Calcium	mg/l	32.50	0.00	32.50	32.50	32.50	32.50	32.50	1		0
	Hardness Magnesium	mg/l	10.54	0.00	10.54	10.54	10.54	10.54	10.54	1		0
	Ortho-Phosphate	mg/l	0.13	0.13	0.03	0.03	0.08	0.29	0.45	67	0.02	2
	Nitrogen Total Inorganic (Calculated)	mg/l	3.19	0.43	2.53	2.67	3.24	3.65	3.85	67		0
	Copper Dissolved - as Cu	ug/l	2.41	0.57	1.40	1.50	2.50	2.50	2.50	21	2.5	17
	Zinc - as Zn	ug/l	7.16	1.68	5.00	5.30	6.70	9.40	9.80	21	5	2
	DO % (Instrumental)	%	94.23	3.55	89.45	90.00	94.60	98.40	99.61	67		0
	DO conc. (Instrumental)	mg/l	10.33	0.75	9.22	9.41	10.50	11.35	11.48	66		0
82528154	pH - as pH units		7.21	0.29	6.78	6.87	7.17	7.57	7.64	67		0
	Temperature Water	ºC	11.14	2.58	6.90	7.83	11.16	14.40	15.20	66		0
	BOD ATU	mg/l	1.31	0.61	1.00	1.00	1.10	1.60	2.26	67	1	26
	Ammonia - as N	mg/l	0.04	0.03	0.03	0.03	0.03	0.07	0.12	67	0.03	47
	Nitrogen Total Oxidised - as N	mg/l	2.90	0.39	2.25	2.30	2.86	3.46	3.52	67		0

	Nitrate	mg/l	2.89	0.40	2.24	2.30	2.86	3.45	3.51	67		0
	Nitrite	mg/l	0.01	0.00	0.00	0.00	0.01	0.01	0.02	67	0.004	28
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66	0.0002	48
	Hardness Total	mg/l	44.56	2.07	42.08	42.86	44.85	46.41	46.90	44		0
	Alkalinity pH 4.5	mg/l	24.31	4.24	17.39	19.20	24.50	29.00	29.00	42		0
	Hardness Calcium	mg/l	35.06	2.41	31.71	32.43	36.00	36.95	37.10	4		0
	Hardness Magnesium	mg/l	11.13	0.30	10.75	10.80	11.15	11.45	11.48	4		0
	Ortho-Phosphate	mg/l	0.02	0.01	0.01	0.02	0.02	0.04	0.05	67	0.01	36
	Nitrogen Total Inorganic (Calculated)	mg/l	2.94	0.39	2.28	2.33	2.90	3.49	3.62	67		0
	Copper Dissolved - as Cu	ug/l	2.52	0.56	1.58	2.50	2.50	2.50	2.80	57	2.5	51
	Zinc - as Zn	ug/l	8.04	3.92	5.00	5.00	6.40	15.04	16.62	57	5	22
	DO % (Instrumental)	%	95.50	3.10	90.33	92.00	96.00	99.04	100.00	67		0
	DO conc. (Instrumental)	mg/l	10.51	0.71	9.28	9.56	10.55	11.45	11.60	66		0
	pH - as pH units		7.16	0.33	6.64	6.70	7.17	7.55	7.69	67		0
	Temperature Water	ºC	10.90	2.52	6.85	7.91	11.02	13.78	14.63	66		0
	BOD ATU	mg/l	1.20	0.40	1.00	1.00	1.00	1.58	1.96	67	1	27
	Ammonia - as N	mg/l	0.05	0.05	0.03	0.03	0.03	0.08	0.13	67	0.03	34
	Nitrogen Total Oxidised - as N	mg/l	2.80	0.35	2.27	2.39	2.77	3.21	3.43	67		0
	Nitrate	mg/l	2.79	0.35	2.26	2.36	2.76	3.20	3.42	67		0
	Nitrite	mg/l	0.01	0.01	0.00	0.00	0.01	0.02	0.02	67	0.004	28
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66	0.0002	40
82528159	Hardness Total	mg/l	42.08	1.68	40.14	40.54	41.80	44.04	44.77	15		0
	Alkalinity pH 4.5	mg/l	21.81	3.01	18.00	18.00	22.00	25.99	26.95	42	20	1
	Hardness Calcium	mg/l	35.00	0.00	35.00	35.00	35.00	35.00	35.00	1		0
	Hardness Magnesium	mg/l	11.11	0.00	11.11	11.11	11.11	11.11	11.11	1		0
	Ortho-Phosphate	mg/l	0.03	0.02	0.01	0.02	0.02	0.04	0.07	67	0.01	32
	Nitrogen Total Inorganic (Calculated)	mg/l	2.85	0.34	2.30	2.42	2.81	3.31	3.50	67		0
	Copper Dissolved - as Cu	ug/l	2.58	0.32	2.50	2.50	2.50	2.50	2.71	18	2.5	17
	Zinc - as Zn	ug/l	6.75	3.18	5.00	5.00	5.40	10.19	12.12	18	5	6
	DO % (Instrumental)	%	94.19	3.44	90.00	90.92	94.00	98.40	100.00	67		0
	DO conc. (Instrumental)	mg/l	10.42	0.72	9.49	9.56	10.40	11.45	11.58	66		0

82530133	pH - as pH units		7.01	0.38	6.31	6.55	7.06	7.41	7.47	57		0
	Temperature Water	ºC	11.00	3.08	6.88	7.20	10.60	15.10	16.09	57		0
	BOD ATU	mg/l	1.09	0.15	1.00	1.00	1.00	1.30	1.42	57	1	30
	Ammonia - as N	mg/l	0.03	0.00	0.03	0.03	0.03	0.03	0.03	57	0.03	55
	Nitrogen Total Oxidised - as N	mg/l	0.52	0.23	0.27	0.30	0.47	0.88	1.00	57		0
	Nitrate	mg/l	0.52	0.23	0.26	0.30	0.47	0.88	0.99	57		0
	Nitrite	mg/l	0.01	0.00	0.00	0.00	0.00	0.01	0.01	57	0.004	50
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	57	0.0001	57
	Hardness Total	mg/l	9.97	2.36	6.76	7.20	9.35	13.60	14.28	45		0
	Alkalinity pH 4.5	mg/l	13.08	4.57	10.00	10.00	10.00	20.00	20.00	43	10	42
	Hardness Calcium	mg/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	4		0
	Hardness Magnesium	mg/l	4.23	0.26	3.93	3.96	4.22	4.52	4.56	4		0
	Ortho-Phosphate	mg/l	0.02	0.00	0.01	0.01	0.02	0.02	0.02	57	0.01	54
	Nitrogen Total Inorganic (Calculated)	mg/l	0.55	0.23	0.30	0.33	0.50	0.91	1.03	57		0
	Copper Dissolved - as Cu	ug/l	2.47	0.54	2.20	2.50	2.50	2.50	2.50	57	2.5	54
	Zinc - as Zn	ug/l	5.18	0.52	5.00	5.00	5.00	5.56	6.22	57	5	47
	DO % (Instrumental)	%	96.77	2.53	93.08	94.00	97.00	100.00	101.00	57		0
	DO conc. (Instrumental)	mg/l	10.69	0.87	9.36	9.59	10.75	11.85	12.23	56		0
82540170	pH - as pH units		7.40	0.21	7.11	7.17	7.37	7.65	7.70	13		0
	Temperature Water	ºC	11.59	2.22	8.42	8.83	11.21	14.70	14.91	13		0
	BOD ATU	mg/l	1.11	0.22	1.00	1.00	1.00	1.34	1.51	13	1	9
	Ammonia - as N	mg/l	0.05	0.02	0.03	0.03	0.03	0.08	0.09	13	0.03	8
	Nitrogen Total Oxidised - as N	mg/l	3.91	0.38	3.33	3.40	3.92	4.38	4.48	13		0
	Nitrate	mg/l	3.91	0.38	3.32	3.39	3.91	4.37	4.47	13		0
	Nitrite	mg/l	0.01	0.00	0.00	0.00	0.01	0.01	0.01	13	0.004	4
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13	0.00013	8
	Ortho-Phosphate	mg/l	0.07	0.02	0.04	0.04	0.06	0.11	0.11	13		0
	Phosphorus Total - as P	mg/l	0.07	0.03	0.04	0.05	0.06	0.11	0.11	13		0
	Nitrogen Total Inorganic (Calculated)	mg/l	3.96	0.37	3.40	3.45	3.95	4.41	4.51	13		0
	Copper Dissolved - as Cu	ug/l	1.33	0.26	1.11	1.12	1.20	1.60	1.65	3		0

Zinc - as Zn	ug/l	55.27	0.74	54.63	54.66	54.90	56.02	56.16	3	0
OrthoPhosphate Filtered - as P	mg/l	0.07	0.03	0.03	0.04	0.06	0.11	0.12	13	0
DO % (Instrumental)	%	94.35	3.51	88.92	90.00	94.10	98.40	98.82	13	0
DO conc. (Instrumental)	mg/l	10.27	0.60	9.55	9.64	10.30	11.02	11.30	13	0

Table A2.7. Water Quality statistics for the River Coquet (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb sample < DL
42300040	pH - as pH units		7.93	0.49	7.20	7.29	7.90	8.62	8.80	40		0
	Temperature Water	ºC	8.77	4.90	1.70	2.81	8.10	15.29	16.85	40		0
	BOD ATU	mg/l	1.68	0.52	1.00	1.07	1.65	2.30	2.36	38	1	4
	Ammonia - as N	mg/l	0.04	0.02	0.03	0.03	0.03	0.05	0.09	39	0.03	32
	Nitrogen Total Oxidised - as N	mg/l	0.26	0.12	0.20	0.20	0.20	0.37	0.45	39	0.2	21
	Nitrate	mg/l	0.25	0.12	0.19	0.19	0.20	0.37	0.44	39	0.196	13
	Nitrite	mg/l	0.01	0.00	0.00	0.00	0.01	0.01	0.02	39	0.005	31
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39	0.0003	32
	Solids Suspended @105C	mg/l	3.81	5.10	1.00	1.00	2.00	7.00	11.10	39	2	6
	Hardness Total	mg/l	53.25	20.09	24.92	27.74	52.40	79.08	83.22	17		0
	Alkalinity pH 4.5	mg/l	48.59	24.08	11.52	18.20	43.70	79.26	84.20	17	10	1
	Ortho-Phosphate	mg/l	0.03	0.04	0.02	0.02	0.02	0.04	0.05	36	0.02	23
	Ortho Phosphate Dissolved	mg/l	0.02	0.00	0.02	0.02	0.02	0.02	0.02	1	0.02	1
	Phosphorus Total - as P	mg/l	0.02	0.02	0.01	0.01	0.02	0.05	0.05	9		0
	Copper Dissolved - as Cu	ug/l	1.75	1.09	0.58	0.71	1.35	3.46	3.93	39	0.5	2
	Zinc - as Zn	ug/l	8.34	5.59	5.00	5.00	5.25	15.26	17.57	39	5	19
	Orthophosphate Filtered - as P	mg/l	0.00	0.00	0.00	0.00	0.00	0.01	0.01	9	0.001	1
	DO % (Instrumental)	%	100.55	4.92	92.95	96.00	100.50	105.20	108.00	40		0
	DO conc. (Instrumental)	mg/l	11.82	1.47	9.56	9.88	11.90	13.82	14.00	39		0
42300041	pH - as pH units		7.68	0.38	7.16	7.20	7.60	8.20	8.31	57		0
	Temperature Water	ºC	9.62	4.75	1.74	2.96	9.80	15.64	16.16	57		0
	BOD ATU	mg/l	1.59	0.63	0.77	1.00	1.60	2.26	2.83	55	1	16
	Ammonia - as N	mg/l	0.04	0.05	0.03	0.03	0.03	0.05	0.07	56	0.03	46
	Nitrogen Total Oxidised - as N	mg/l	0.40	0.22	0.20	0.20	0.30	0.72	0.84	56	0.2	14
	Nitrate	mg/l	0.40	0.22	0.19	0.20	0.30	0.70	0.84	56	0.195	7
	Nitrite	mg/l	0.01	0.00	0.00	0.00	0.01	0.01	0.02	56	0.005	33

	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56	0.0004	47
	Solids Suspended @105C	mg/l	4.79	5.33	1.00	1.00	3.25	9.75	15.38	56	1	17
	Hardness Total	mg/l	71.04	22.81	37.64	40.66	71.50	102.40	103.70	47		0
	Alkalinity pH 4.5	mg/l	62.78	26.78	24.34	29.24	62.40	99.32	104.50	47		0
	Ortho-Phosphate	mg/l	0.11	0.59	0.02	0.02	0.02	0.04	0.05	53	0.02	40
	Ortho Phosphate Dissolved	mg/l	0.02	0.00	0.02	0.02	0.02	0.02	0.02	1		0
	Copper Dissolved - as Cu	ug/l	1.45	0.83	0.59	0.69	1.24	2.65	3.16	56	0.5	2
	Zinc - as Zn	ug/l	7.04	3.37	5.00	5.00	5.10	11.25	14.43	56	5	28
	DO % (Instrumental)	%	98.89	5.81	91.60	93.00	98.00	106.40	108.20	57		0
	DO conc. (Instrumental)	mg/l	11.36	1.33	9.58	9.88	11.20	13.25	13.80	56		0
42300064	pH - as pH units		8.04	0.45	7.33	7.50	8.10	8.50	8.70	62		0
	Temperature Water	ºC	235.63	58.22	134.90	167.80	256.00	281.10	287.05	8		0
	Temperature Water	CEL	10.00	4.52	2.93	3.90	9.40	16.18	17.10	59		0
	Conductivity @25C	uS/cm	255.88	56.08	164.00	180.60	269.00	332.00	336.00	33		0
	BOD ATU	mg/l	1.80	0.75	1.00	1.10	1.60	2.68	3.34	63	1	11
	Ammonia - as N	mg/l	0.04	0.03	0.03	0.03	0.03	0.07	0.09	64	0.03	38
	Nitrogen Total Oxidised - as N	mg/l	0.95	0.46	0.32	0.40	0.92	1.55	1.78	64	0.2	2
	Nitrate	mg/l	0.94	0.46	0.32	0.40	0.91	1.55	1.77	64	0.195	1
	Nitrite	mg/l	0.01	0.01	0.00	0.00	0.01	0.02	0.04	64	0.005	25
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	59	0.0001	37
	Solids Suspended @105C	mg/l	12.27	29.10	1.00	1.30	4.25	20.70	34.75	64	2	9
	Hardness Total	mg/l	115.34	28.63	66.82	73.38	121.00	147.40	150.40	47		0
	Alkalinity pH 4.5	mg/l	101.26	35.10	42.52	49.88	104.50	128.70	134.85	64		0
	Chloride Ion - as Cl	mg/l	16.41	3.85	11.40	12.50	16.30	19.60	22.20	41		0
	Ortho-Phosphate	mg/l	0.04	0.05	0.02	0.02	0.02	0.05	0.08	61	0.02	30
	Ortho Phosphate Dissolved	mg/l	0.04	0.00	0.04	0.04	0.04	0.04	0.04	1		0
	Phosphorus Total - as P	mg/l	0.03	0.02	0.02	0.02	0.03	0.05	0.06	6		0
	Copper Dissolved - as Cu	ug/l	1.35	0.70	0.57	0.65	1.16	2.44	2.82	64		0
	Zinc - as Zn	ug/l	6.41	3.55	5.00	5.00	5.00	8.33	11.03	64	5	41
	Orthophosphate Filtered - as P	mg/l	0.01	0.01	0.00	0.00	0.02	0.02	0.02	6		0
	DO % (Instrumental)	%	94.77	12.16	72.70	81.70	98.50	105.00	105.05	60		0

	DO conc. (Instrumental)	mg/l	10.75	1.76	6.99	8.89	10.90	12.70	13.21	59		0
42300073	pH - as pH units		7.93	0.62	7.03	7.26	7.80	8.74	9.17	47		0
	Temperature Water	ºC	9.74	4.77	2.34	3.38	9.10	15.86	16.65	47		0
	BOD ATU	mg/l	1.59	0.49	1.00	1.04	1.60	2.12	2.48	45	3	10
	Ammonia - as N	mg/l	0.05	0.04	0.03	0.03	0.03	0.09	0.10	47	0.03	37
	Nitrogen Total Oxidised - as N	mg/l	0.66	0.41	0.20	0.20	0.60	1.24	1.36	47	0.2	7
	Nitrate	mg/l	0.66	0.41	0.20	0.20	0.60	1.24	1.35	47	0.195	4
	Nitrite	mg/l	0.01	0.00	0.00	0.00	0.01	0.01	0.01	47	0.005	38
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47	0.0001	37
	Solids Suspended @105C	mg/l	2.98	3.61	1.00	1.00	2.00	6.40	7.00	47	2	15
	Hardness Total	mg/l	49.92	10.35	35.02	35.86	47.30	64.24	67.00	25		0
	Alkalinity pH 4.5	mg/l	43.28	16.04	19.88	23.80	40.90	64.66	66.98	25		0
	Ortho-Phosphate	mg/l	0.02	0.01	0.02	0.02	0.02	0.02	0.03	47	0.02	36
	Phosphorus Total - as P	mg/l	0.02	0.01	0.01	0.01	0.02	0.04	0.05	9		0
	Copper Dissolved - as Cu	ug/l	2.68	11.68	0.50	0.50	0.80	1.72	1.96	47	0.5	6
	Zinc - as Zn	ug/l	5.58	3.37	5.00	5.00	5.00	5.00	5.94	47	5	43
	Orthophosphate Filtered - as P	mg/l	0.01	0.01	0.00	0.00	0.01	0.02	0.02	9		0
	DO % (Instrumental)	%	101.36	5.19	95.00	96.00	100.00	110.00	110.00	47		0
	DO conc. (Instrumental)	mg/l	11.60	1.29	9.93	10.00	11.60	13.28	13.87	47		0
42300181	pH - as pH units		7.90	0.62	6.90	7.07	8.00	8.80	8.80	48		0
	Temperature Water	ºC	9.55	5.08	1.54	3.07	8.90	16.30	16.73	48		0
	BOD ATU	mg/l	1.58	0.46	1.00	1.00	1.60	2.15	2.20	46	2	7
	Ammonia - as N	mg/l	0.05	0.04	0.03	0.03	0.03	0.06	0.10	47	0.03	38
	Nitrogen Total Oxidised - as N	mg/l	0.24	0.06	0.20	0.20	0.20	0.34	0.36	47	0.2	30
	Nitrate	mg/l	0.23	0.06	0.19	0.19	0.20	0.33	0.35	47	0.195	20
	Nitrite	mg/l	0.01	0.00	0.00	0.00	0.01	0.01	0.01	47	0.005	39
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47	0.0001	38
	Solids Suspended @105C	mg/l	3.46	4.65	1.00	1.00	2.00	6.40	7.70	47	2	11
	Hardness Total	mg/l	61.01	21.99	29.88	31.36	60.30	93.16	95.80	25		0
	Alkalinity pH 4.5	mg/l	60.03	27.92	22.26	24.66	55.50	97.68	102.36	25		0

Ortho-Phosphate	mg/l	0.02	0.01	0.02	0.02	0.02	0.03	0.05	47	0.02	35
Copper Dissolved - as Cu	ug/l	1.06	0.50	0.50	0.51	1.03	1.74	1.98	47	0.5	5
Zinc - as Zn	ug/l	6.20	5.67	5.00	5.00	5.00	6.09	7.84	47	5	39
DO % (Instrumental)	%	102.79	5.72	95.70	97.00	101.50	110.00	111.30	48		0
DO conc. (Instrumental)	mg/l	11.84	1.47	9.82	10.12	11.70	13.94	14.38	47		0

Table A2.8. Water Quality statistics for the River Derwent (Yorkshire) (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
49600134	pH - as pH units		7.96	0.27	7.50	7.61	8.00	8.20	8.30	69		0
	Temperature Water	ºC	10.82	4.59	3.96	5.06	10.60	17.38	18.12	69		0
	Conductivity @25C	uS/cm	625.00	0.00	625.00	625.00	625.00	625.00	625.00	1		0
	BOD ATU	mg/l	1.53	0.50	1.00	1.00	1.40	2.04	2.10	67	1	19
	Ammonia - as N	mg/l	0.08	0.05	0.03	0.03	0.06	0.12	0.16	68	0.03	7
	Nitrogen Total Oxidised - as N	mg/l	5.05	0.79	3.77	4.20	4.98	6.11	6.29	69		0
	Nitrate	mg/l	5.01	0.79	3.71	4.16	4.96	6.09	6.26	69		0
	Nitrite	mg/l	0.04	0.02	0.01	0.02	0.04	0.05	0.06	69		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	68	0.0011	7
	Solids Suspended @105C	mg/l	16.59	19.68	2.00	2.65	11.50	30.55	43.25	34	1	2
	Hardness Total	mg/l	255.46	42.74	164.90	191.80	267.00	295.80	305.90	48		0
	Alkalinity pH 4.5	mg/l	159.90	27.55	101.17	114.90	170.00	186.30	189.30	48		0
	Chloride Ion - as Cl	mg/l	39.80	0.00	39.80	39.80	39.80	39.80	39.80	1		0
	Ortho-Phosphate	mg/l	0.11	0.06	0.02	0.05	0.10	0.19	0.22	68	0.02	3
	Copper Dissolved - as Cu	ug/l	1.31	0.46	0.77	0.84	1.16	1.93	2.24	68	0.5	1
	Zinc - as Zn	ug/l	9.23	8.25	5.00	5.00	5.77	17.65	20.63	68	5	29
	DO % (Instrumental)	%	92.16	9.02	79.40	82.00	93.00	102.40	105.60	69		0
	DO conc. (Instrumental)	mg/l	10.28	1.43	8.54	8.76	10.30	12.12	12.66	69		0

Table A2.9. Water Quality statistics for the River Derwent and Tributaries (Cumbria) (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
88005567	pH - as pH units		7.15	0.46	6.60	6.60	7.11	7.60	7.70	51		0
	Conductivity @20C	uS/cm	93.02	23.70	63.70	69.50	88.20	128.00	129.00	21		0
	Temperature Water	ºC	9.17	4.02	3.82	4.29	8.50	14.21	16.83	50		0
	Conductivity @25C	uS/cm	89.34	20.40	59.93	61.55	89.65	111.40	126.55	30		0
	BOD ATU	mg/l	1.24	0.25	1.00	1.00	1.27	1.47	1.54	51	1.43	31
	Ammonia - as N	mg/l	0.03	0.01	0.03	0.03	0.03	0.04	0.06	50	0.03	40
	Nitrogen Total Oxidised - as N	mg/l	0.62	0.28	0.20	0.25	0.60	1.00	1.09	50	0.2	5
	Nitrate	mg/l	0.65	0.24	0.28	0.38	0.60	0.99	1.09	50	0.5	15
	Nitrite	mg/l	0.01	0.01	0.00	0.00	0.00	0.01	0.01	50	0.004	27
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48	0.00002	42
	Solids Suspended @105C	mg/l	3.69	2.62	3.00	3.00	3.00	4.00	7.00	51	3	43
	Solids Non-Volatile @500C	mg/l	12.50	4.33	10.00	10.00	10.00	20.00	20.00	12	10	12
	Alkalinity pH 4.5	mg/l	24.31	10.23	12.15	13.14	22.50	38.68	43.38	43		0
	Chloride Ion - as Cl	mg/l	9.19	2.34	5.90	6.37	9.18	11.57	12.96	50		0
	Ortho-Phosphate	mg/l	0.01	0.02	0.00	0.00	0.00	0.01	0.03	51	0.001	11
	DO % (Instrumental)	%	99.36	9.93	85.00	88.80	98.50	112.50	118.10	50		0
	DO conc. (Instrumental)	mg/l	11.34	1.24	9.00	9.80	11.50	12.70	13.10	51		0
88005619	pH - as pH units		6.97	0.70	6.00	6.00	6.97	7.80	7.90	41		0
	Conductivity @20C	uS/cm	49.49	11.61	40.05	40.40	44.30	64.40	71.70	11		0
	Temperature Water	ºC	8.59	3.41	2.60	4.20	8.30	13.50	13.70	41		0
	Conductivity @25C	uS/cm	53.88	52.95	37.11	38.68	43.65	49.61	55.19	30		0
	BOD ATU	mg/l	1.44	0.63	1.00	1.00	1.43	1.68	2.13	41	1.43	24
	Ammonia - as N	mg/l	0.13	0.41	0.03	0.03	0.03	0.22	0.27	41	0.03	30
	Nitrogen Total Oxidised - as N	mg/l	0.21	0.04	0.20	0.20	0.20	0.23	0.26	41	0.2	31
	Nitrate	mg/l	0.38	0.15	0.19	0.20	0.50	0.50	0.50	41	0.5	30
	Nitrite	mg/l	0.01	0.00	0.00	0.00	0.00	0.01	0.01	41	0.004	30

	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.01	0.00	0.00	0.00	0.00	0.00	41	0.00003	30
	Solids Suspended @105C	mg/l	3.22	0.81	3.00	3.00	3.00	3.00	5.00	41	3	35
	Solids Non-Volatile @500C	mg/l	13.33	4.71	10.00	10.00	10.00	20.00	20.00	12	10	12
	Hardness Total	mg/l	11.43	8.99	7.02	7.46	9.49	11.80	14.80	41		0
	Alkalinity pH 4.5	mg/l	5.70	2.31	5.00	5.00	5.00	7.00	7.70	41	5	31
	Chloride Ion - as Cl	mg/l	6.64	1.60	5.00	5.12	6.39	7.40	9.77	41	5	3
	Ortho-Phosphate	mg/l	0.02	0.06	0.00	0.00	0.00	0.04	0.06	41	0.001	15
	Copper Dissolved - as Cu	ug/l	2.19	8.87	0.50	0.50	0.61	1.27	1.58	41	0.5	9
	Zinc - as Zn	ug/l	5.54	1.70	5.00	5.00	5.00	5.74	8.46	41	5	30
	DO % (Instrumental)	%	100.22	5.28	93.00	95.00	100.00	107.00	110.00	41		0
	DO conc. (Instrumental)	mg/l	11.68	1.19	10.10	10.10	11.70	13.20	13.50	41		0
8805652	pH - as pH units		7.09	0.53	6.40	6.50	7.10	7.79	8.00	62		0
	Conductivity @20C	uS/cm	64.02	4.62	57.12	59.33	63.00	69.65	71.34	32		0
	Temperature Water	ºC	8.96	3.01	3.18	5.42	8.60	12.95	13.58	62		0
	Conductivity @25C	uS/cm	72.88	10.62	64.21	65.80	71.80	77.11	80.25	30		0
	BOD ATU	mg/l	1.23	0.27	1.00	1.00	1.12	1.49	1.68	62	1.68	39
	Ammonia - as N	mg/l	0.03	0.01	0.03	0.03	0.03	0.04	0.05	62	0.03	54
	Nitrogen Total Oxidised - as N	mg/l	0.45	0.18	0.20	0.24	0.42	0.64	0.87	62	0.2	4
	Nitrate	mg/l	0.49	0.16	0.24	0.28	0.50	0.63	0.86	62	0.5	24
	Nitrite	mg/l	0.00	0.00	0.00	0.00	0.00	0.01	0.01	62	0.004	46
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62	0.00003	55
	Solids Suspended @105C	mg/l	4.23	3.93	3.00	3.00	3.00	5.90	10.00	62	3	50
	Solids Non-Volatile @500C	mg/l	14.17	4.93	10.00	10.00	10.00	20.00	20.00	12	10	11
	Alkalinity pH 4.5	mg/l	8.84	3.54	5.31	5.51	8.20	15.00	16.39	42	15	3
	Chloride Ion - as Cl	mg/l	10.49	2.74	8.35	8.59	9.83	12.09	15.05	62		0
	Ortho-Phosphate	mg/l	0.01	0.01	0.00	0.00	0.00	0.01	0.01	62	0.001	2
	DO % (Instrumental)	%	99.97	5.09	93.00	94.00	99.50	106.00	108.90	62		0
	DO conc. (Instrumental)	mg/l	11.55	1.13	10.11	10.40	11.55	13.37	13.60	62		0
88005723	Lead - as Pb	ug/l	0.40	0.00	0.40	0.40	0.40	0.40	0.40	1	0.4	1
	Lead Dissolved - as Pb	ug/l	0.40	0.00	0.40	0.40	0.40	0.40	0.40	1	0.4	1
	pH - as pH units		7.75	0.31	7.23	7.40	7.80	8.14	8.27	67		0

	Conductivity @20C	uS/cm	236.35	34.83	186.90	197.60	237.50	263.00	276.75	34		0
	Temperature Water	ºC	10.11	3.73	5.06	6.00	9.60	14.48	15.70	67		0
	Conductivity @25C	uS/cm	249.78	30.21	200.15	210.30	256.50	285.80	290.15	32		0
	BOD ATU	mg/l	1.47	0.66	1.00	1.00	1.29	2.01	2.67	66	1.43	18
	Cadmium Dissolved - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	1	0.1	1
	Cadmium - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	1	0.1	1
	Ammonia - as N	mg/l	0.07	0.06	0.03	0.03	0.06	0.10	0.15	67	0.03	10
	Nitrogen Total Oxidised - as N	mg/l	1.95	0.39	1.37	1.48	1.90	2.51	2.67	67		0
	Nitrate	mg/l	1.93	0.39	1.35	1.47	1.88	2.47	2.66	67		0
	Nitrite	mg/l	0.02	0.02	0.01	0.01	0.01	0.05	0.06	67	0.004	3
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66	0.0003	9
	Solids Suspended @105C	mg/l	6.67	8.51	3.00	3.00	4.00	11.40	14.70	67	3	17
	Solids Non-Volatile @500C	mg/l	16.83	9.55	10.00	10.00	10.00	33.50	35.90	12	10	10
	Alkalinity pH 4.5	mg/l	94.20	16.52	63.10	71.94	97.10	113.60	118.40	45		0
	Chloride Ion - as Cl	mg/l	16.52	8.52	12.60	13.00	14.60	18.45	24.33	66		0
	Ortho-Phosphate	mg/l	0.04	0.06	0.01	0.01	0.03	0.06	0.07	67	0.5	1
	Chromium - as Cr	ug/l	0.50	0.00	0.50	0.50	0.50	0.50	0.50	1	0.5	1
	Zinc Dissolved - as Zn	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	1	5	1
	Chromium Dissolved - as Cr	ug/l	0.50	0.00	0.50	0.50	0.50	0.50	0.50	1	0.5	1
	Nickel Dissolved - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	1	5	1
	Copper Dissolved - as Cu	ug/l	0.72	0.00	0.72	0.72	0.72	0.72	0.72	1		0
	Copper - as Cu	ug/l	0.88	0.00	0.88	0.88	0.88	0.88	0.88	1		0
	Zinc - as Zn	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	1	5	1
	Nickel - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	1	5	1
	DO % (Instrumental)	%	99.27	8.94	88.30	90.00	99.00	111.20	116.00	67		0
	DO conc. (Instrumental)	mg/l	11.08	1.15	9.43	9.70	11.00	12.44	12.94	67		0
88010390	Lead - as Pb	ug/l	1.26	0.00	1.26	1.26	1.26	1.26	1.26	1		0
	Lead Dissolved - as Pb	ug/l	0.97	0.00	0.97	0.97	0.97	0.97	0.97	1		0
	pH - as pH units		7.29	0.37	6.70	6.80	7.30	7.70	7.90	41		0
	Conductivity @20C	uS/cm	80.00	14.24	61.81	64.51	77.60	97.92	103.39	12		0
	Temperature Water	ºC	8.72	3.68	3.80	4.20	9.10	14.20	15.00	41		0

Conductivity @25C	uS/cm	83.18	14.73	60.46	70.94	81.50	102.00	103.20	29		0
BOD ATU	mg/l	1.38	0.38	1.00	1.00	1.39	1.92	2.11	41	1.43	20
Cadmium Dissolved - as Cd	ug/l	0.19	0.00	0.19	0.19	0.19	0.19	0.19	1		0
Cadmium - as Cd	ug/l	0.19	0.00	0.19	0.19	0.19	0.19	0.19	1		0
Ammonia - as N	mg/l	0.04	0.01	0.03	0.03	0.03	0.04	0.07	41	0.03	30
Nitrogen Total Oxidised - as N	mg/l	0.44	0.14	0.20	0.30	0.41	0.58	0.65	41	0.2	2
Nitrate	mg/l	0.50	0.11	0.37	0.38	0.50	0.58	0.64	41	0.5	16
Nitrite	mg/l	0.01	0.00	0.00	0.00	0.01	0.01	0.02	41	0.004	12
Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31	0	24
Solids Suspended @105C	mg/l	6.54	8.70	3.00	3.00	3.00	13.00	18.00	41	3	24
Solids Non-Volatile @500C	mg/l	14.36	11.01	10.00	10.00	10.00	20.00	34.00	11	10	9
Hardness Total	mg/l	28.70	0.00	28.70	28.70	28.70	28.70	28.70	1		0
Alkalinity pH 4.5	mg/l	18.50	5.61	10.53	11.04	18.25	25.42	27.58	38		0
Chloride Ion - as Cl	mg/l	9.71	3.29	6.25	6.46	8.51	14.90	16.50	41		0
Ortho-Phosphate	mg/l	0.01	0.00	0.00	0.00	0.01	0.01	0.02	40	0.001	1
Chromium - as Cr	ug/l	0.50	0.00	0.50	0.50	0.50	0.50	0.50	1	0.5	1
Zinc Dissolved - as Zn	ug/l	75.40	0.00	75.40	75.40	75.40	75.40	75.40	1		0
Chromium Dissolved - as Cr	ug/l	0.50	0.00	0.50	0.50	0.50	0.50	0.50	1	0.5	1
Nickel Dissolved - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	1	5	1
Copper Dissolved - as Cu	ug/l	0.78	0.00	0.78	0.78	0.78	0.78	0.78	1		0
Copper - as Cu	ug/l	0.79	0.00	0.79	0.79	0.79	0.79	0.79	1		0
Zinc - as Zn	ug/l	78.90	0.00	78.90	78.90	78.90	78.90	78.90	1		0
Nickel - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	1	5	1
DO % (Instrumental)	%	94.71	10.15	74.00	82.00	97.00	106.00	106.00	41		0
DO conc. (Instrumental)	mg/l	11.24	2.26	8.50	8.90	11.10	13.20	13.70	41		0

Table A2.10. Water Quality statistics for the River Eden and Tributaries (Cumbria) (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
88006181	Lead - as Pb	ug/l	0.40	0.00	0.40	0.40	0.40	0.40	0.40	9	0.4	9
	pH - as pH units		8.26	0.26	7.89	7.90	8.29	8.53	8.60	58		0
	Conductivity @20C	uS/cm	373.18	42.23	314.00	320.40	373.00	434.60	438.40	33		0
	Temperature Water	ºC	10.51	4.34	4.41	5.87	9.85	16.03	17.38	58		0
	Conductivity @25C	uS/cm	424.42	37.87	357.90	363.00	433.50	476.70	486.85	24		0
	BOD ATU	mg/l	1.62	0.80	1.00	1.00	1.43	2.40	4.15	57	1.43	20
	Cadmium - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	9	0.1	9
	Ammonia - as N	mg/l	0.07	0.08	0.03	0.03	0.03	0.13	0.17	57	0.03	32
	Nitrogen Total Oxidised - as N	mg/l	1.38	0.46	0.79	0.88	1.29	1.97	2.23	57	1	1
	Nitrate	mg/l	1.36	0.47	0.77	0.83	1.28	1.96	2.22	57	1.92	2
	Nitrite	mg/l	0.02	0.03	0.00	0.00	0.01	0.04	0.06	57	0.004	8
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.01	57	0.0004	32
	Solids Suspended @105C	mg/l	4.98	5.18	3.00	3.00	3.00	7.80	10.40	57	3	27
	Solids Non-Volatile @500C	mg/l	13.33	4.71	10.00	10.00	10.00	20.00	20.00	12	10	12
	Alkalinity PH 4.5	mg/l	199.22	23.69	162.00	164.20	204.00	226.20	235.40	37		0
	Chloride Ion - as Cl	mg/l	11.87	2.41	9.28	9.65	11.60	14.54	15.06	57		0
	Ortho-Phosphate	mg/l	0.05	0.07	0.01	0.01	0.02	0.11	0.17	58	0.001	1
	Chromium - as Cr	ug/l	0.59	0.26	0.50	0.50	0.50	0.67	1.00	9	0.5	8
	Copper - as Cu	ug/l	0.88	0.25	0.60	0.61	0.86	1.27	1.32	9		0
	Zinc - as Zn	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	9	5	9
	Nickel - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	9	5	9
	BOD 5 Day 0.5 ATU	mg/l	1.43	0.00	1.43	1.43	1.43	1.43	1.43	1	1.43	1
	DO % (Instrumental)	%	107.50	12.57	95.00	96.70	105.00	121.30	131.90	58		0
	DO conc. (Instrumental)	mg/l	11.99	1.16	10.07	10.61	11.95	13.43	14.10	58		0

88006185	Lead - as Pb	ug/l	27.55	33.12	8.55	8.85	12.75	61.05	81.03	6		0
	pH - as pH units		8.20	0.35	7.64	7.80	8.14	8.65	8.70	62		0
	Conductivity @20C	uS/cm	188.43	37.98	120.40	135.60	204.00	226.80	236.50	35		0
	Temperature Water	ºC	9.74	3.96	4.80	5.60	8.70	14.70	16.00	61		0
	Conductivity @25C	uS/cm	208.67	49.59	127.30	137.40	211.00	262.60	273.40	27		0
	BOD ATU	mg/l	1.31	0.30	1.00	1.00	1.35	1.68	1.92	61	1.58	37
	Cadmium - as Cd	ug/l	0.11	0.01	0.10	0.10	0.10	0.12	0.12	6	0.1	5
	Ammonia - as N	mg/l	0.05	0.08	0.03	0.03	0.03	0.06	0.12	62	0.03	40
	Nitrogen Total Oxidised - as N	mg/l	0.82	0.36	0.30	0.36	0.79	1.24	1.34	62	0.2	1
	Nitrate	mg/l	0.82	0.34	0.35	0.38	0.79	1.24	1.33	62	0.5	9
	Nitrite	mg/l	0.01	0.01	0.00	0.00	0.01	0.02	0.02	62	0.004	22
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	61	0.00042	39
	Solids Suspended @105C	mg/l	7.94	14.53	3.00	3.00	3.00	15.60	23.75	62	3	34
	Solids Non-Volatile @500C	mg/l	15.69	9.34	10.00	10.00	10.00	20.00	29.60	13	10	12
	Alkalinity PH 4.5	mg/l	82.91	22.16	43.47	45.96	87.30	107.00	109.50	39		0
	Chloride Ion - as Cl	mg/l	7.96	1.96	5.01	5.75	7.71	10.38	11.36	62	5	2
	Ortho-Phosphate	mg/l	0.01	0.01	0.00	0.00	0.01	0.02	0.02	62	0.001	2
	Chromium - as Cr	ug/l	0.56	0.14	0.50	0.50	0.50	0.68	0.77	6	0.5	5
	Copper - as Cu	ug/l	1.32	0.77	0.78	0.80	1.05	2.10	2.55	6		0
	Zinc - as Zn	ug/l	6.68	3.76	5.00	5.00	5.00	10.05	12.58	6	5	5
	Nickel - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	6	5	6
	DO % (Instrumental)	%	100.39	6.30	93.00	94.00	101.00	107.00	108.00	61		0
	DO conc. (Instrumental)	mg/l	11.46	1.27	9.60	10.10	11.30	13.10	13.30	61		0
88006187	Lead - as Pb	ug/l	0.40	0.00	0.40	0.40	0.40	0.40	0.40	8	0.4	8
	pH - as pH units		8.12	0.21	7.70	7.89	8.19	8.31	8.36	60		0
	Conductivity @20C	uS/cm	362.06	33.06	313.35	326.00	372.00	395.80	401.10	34		0
	Temperature Water	ºC	9.54	3.66	3.60	4.96	9.25	14.41	15.91	60		0
	Conductivity @25C	uS/cm	402.19	40.77	319.75	350.50	409.00	445.50	457.00	26		0
	BOD ATU	mg/l	1.49	1.27	1.00	1.00	1.28	1.62	2.24	60	1.43	33
	Cadmium - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	8	0.1	8
	Ammonia - as N	mg/l	0.03	0.01	0.03	0.03	0.03	0.05	0.06	60	0.03	43

	Nitrogen Total Oxidised - as N	mg/l	0.76	0.81	0.21	0.32	0.60	1.21	1.37	60	0.2	3
	Nitrate	mg/l	0.77	0.78	0.32	0.34	0.60	1.20	1.34	60	0.5	14
	Nitrite	mg/l	0.01	0.01	0.00	0.00	0.00	0.01	0.01	60	0.004	31
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60	0.00035	43
	Solids Suspended @105C	mg/l	5.47	8.96	3.00	3.00	3.00	8.00	10.10	60	3	36
	Solids Non-Volatile @500C	mg/l	13.33	4.71	10.00	10.00	10.00	20.00	20.00	12	10	12
	Alkalinity PH 4.5	mg/l	187.62	27.78	136.70	152.40	194.00	220.00	220.50	39		0
	Chloride Ion - as Cl	mg/l	11.06	7.99	7.09	7.50	10.10	12.44	13.19	60		0
	Ortho-Phosphate	mg/l	0.12	0.90	0.00	0.00	0.00	0.01	0.02	60	0.001	3
	Chromium - as Cr	ug/l	0.51	0.03	0.50	0.50	0.50	0.52	0.55	8	0.5	7
	Copper - as Cu	ug/l	0.85	0.22	0.63	0.63	0.80	1.16	1.22	8		0
	Zinc - as Zn	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	8	5	8
	Nickel - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	8	5	8
	DO % (Instrumental)	%	99.53	6.83	90.95	92.90	99.00	106.00	111.00	60		0
	DO conc. (Instrumental)	mg/l	11.40	1.26	9.60	9.79	11.35	13.10	13.51	60		0
88006196	pH - as pH units		8.06	0.22	7.70	7.70	8.08	8.30	8.40	61		0
	Conductivity @20C	uS/cm	301.71	156.07	130.40	149.00	290.50	409.60	434.20	34		0
	Temperature Water	ºC	9.08	4.06	2.80	4.30	8.40	14.80	15.50	61		0
	Conductivity @25C	uS/cm	304.52	99.75	162.00	177.80	292.00	437.20	464.20	27		0
	BOD ATU	mg/l	1.34	0.39	1.00	1.00	1.39	1.68	1.90	61	1.43	33
	Ammonia - as N	mg/l	0.04	0.04	0.03	0.03	0.03	0.03	0.08	60	0.03	50
	Nitrogen Total Oxidised - as N	mg/l	0.81	0.29	0.44	0.48	0.79	1.23	1.31	60	0.2	1
	Nitrate	mg/l	0.81	0.28	0.44	0.50	0.78	1.22	1.30	60	0.5	6
	Nitrite	mg/l	0.01	0.00	0.00	0.00	0.01	0.01	0.01	60	0.004	13
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60	0.00028	50
	Solids Suspended @105C	mg/l	5.80	7.76	3.00	3.00	3.00	9.00	20.00	61	3	38
	Solids Non-Volatile @500C	mg/l	13.85	4.87	10.00	10.00	10.00	20.00	20.00	13	10	13
	Alkalinity PH 4.5	mg/l	114.83	44.51	42.47	45.11	118.00	181.30	184.15	40		0
	Chloride Ion - as Cl	mg/l	17.67	10.32	10.66	10.98	15.60	22.29	27.81	60		0
	Ortho-Phosphate	mg/l	0.01	0.00	0.00	0.00	0.01	0.01	0.01	61	0.001	5
	Phosphorus Total - as P	mg/l	0.04	0.02	0.02	0.02	0.04	0.06	0.06	9	0.02	1

	Orthophosphate Filtered - as P	mg/l	0.01	0.01	0.00	0.00	0.00	0.01	0.02	9	0.001	2
	DO % (Instrumental)	%	104.30	7.38	95.00	96.00	104.00	113.00	117.00	61		0
	DO conc. (Instrumental)	mg/l	12.07	1.23	10.10	10.50	12.00	13.60	14.40	61		0
88006218	Lead - as Pb	ug/l	0.40	0.00	0.40	0.40	0.40	0.40	0.40	2	0.4	2
	pH - as pH units		7.54	0.35	7.09	7.15	7.50	7.90	8.00	46		0
	Conductivity @20C	uS/cm	73.67	12.99	58.40	60.40	77.50	87.10	87.30	21		0
	Temperature Water	ºC	9.66	3.24	3.88	5.80	9.50	14.10	14.68	46		0
	Conductivity @25C	uS/cm	77.36	11.82	59.00	62.12	77.60	91.92	95.88	25		0
	BOD ATU	mg/l	1.25	0.41	1.00	1.00	1.09	1.43	1.78	46	1.43	34
	Cadmium - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	2	0.1	2
	Ammonia - as N	mg/l	0.03	0.00	0.03	0.03	0.03	0.03	0.04	46	0.03	41
	Nitrogen Total Oxidised - as N	mg/l	0.26	0.07	0.20	0.20	0.23	0.37	0.41	46	0.2	17
	Nitrate	mg/l	0.35	0.13	0.20	0.20	0.34	0.50	0.50	45	0.5	21
	Nitrite	mg/l	0.01	0.01	0.00	0.00	0.00	0.01	0.01	45	0.004	33
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	46	0.00012	41
	Solids Suspended @105C	mg/l	4.24	5.50	3.00	3.00	3.00	4.50	5.00	46	3	37
	Solids Non-Volatile @500C	mg/l	14.50	5.42	10.00	10.00	10.00	20.00	21.80	12	10	11
	Alkalinity pH 4.5	mg/l	23.77	7.20	12.77	15.50	23.20	32.16	33.26	39		0
	Chloride Ion - as Cl	mg/l	6.12	3.21	4.67	4.71	5.49	6.96	7.78	46	5	3
	Ortho-Phosphate	mg/l	0.00	0.00	0.00	0.00	0.00	0.01	0.01	46	0.001	9
	Chromium - as Cr	ug/l	0.50	0.00	0.50	0.50	0.50	0.50	0.50	2	0.5	2
	Copper - as Cu	ug/l	0.50	0.00	0.50	0.50	0.50	0.50	0.50	2	0.5	2
	Zinc - as Zn	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	2	5	2
	Nickel - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	2	5	2
	DO % (Instrumental)	%	100.30	3.71	95.00	97.00	100.00	105.00	107.50	46		0
	DO conc. (Instrumental)	mg/l	11.37	0.94	9.93	10.25	11.40	12.60	13.00	46		0
88006238	Lead - as Pb	ug/l	0.48	0.00	0.48	0.48	0.48	0.48	0.48	1		0
	pH - as pH units		7.94	0.51	7.21	7.41	7.83	8.70	8.90	63		0
	Conductivity @20C	uS/cm	223.38	54.90	141.80	150.60	228.50	305.90	309.90	32		0
	Temperature Water	ºC	10.23	4.89	2.66	3.74	9.70	16.78	17.00	63		0
	Conductivity @25C	uS/cm	220.20	59.60	122.15	153.90	218.00	301.30	322.90	30		0

	BOD ATU	mg/l	1.92	0.84	1.00	1.17	1.68	2.89	4.03	61	1.43	17
	Cadmium - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	1	0.1	1
	Ammonia - as N	mg/l	0.04	0.03	0.03	0.03	0.03	0.07	0.09	62	0.03	33
	Nitrogen Total Oxidised - as N	mg/l	1.40	0.53	0.67	0.80	1.36	2.12	2.28	62		0
	Nitrate	mg/l	1.39	0.52	0.64	0.79	1.34	2.11	2.27	62	0.5	2
	Nitrite	mg/l	0.01	0.01	0.01	0.01	0.01	0.02	0.03	62	0.004	1
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62	0.00013	33
	Solids Suspended @105C	mg/l	6.19	6.65	3.00	3.00	3.50	9.00	15.95	62	3	26
	Solids Non-Volatile @500C	mg/l	14.83	5.00	10.00	10.00	13.00	20.00	20.90	12	10	10
	Alkalinity PH 4.5	mg/l	84.87	33.56	38.35	43.97	79.85	132.00	141.95	42		0
	Chloride Ion - as Cl	mg/l	14.31	4.05	9.41	9.71	14.00	19.77	20.97	62		0
	Ortho-Phosphate	mg/l	0.04	0.02	0.02	0.02	0.03	0.07	0.08	63		0
	Chromium - as Cr	ug/l	0.50	0.00	0.50	0.50	0.50	0.50	0.50	1	0.5	1
	Copper - as Cu	ug/l	1.63	0.00	1.63	1.63	1.63	1.63	1.63	1		0
	Zinc - as Zn	ug/l	9.02	0.00	9.02	9.02	9.02	9.02	9.02	1		0
	Nickel - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	1	5	1
	DO % (Instrumental)	%	104.27	7.97	94.00	96.90	102.00	113.70	120.00	60		0
	DO conc. (Instrumental)	mg/l	11.72	1.31	9.99	10.29	11.70	13.21	13.91	60		0
	pH - as pH units		7.68	0.67	6.76	6.97	7.70	8.60	8.70	62		0
	Conductivity @20C	uS/cm	51.74	14.36	27.23	31.17	53.85	69.44	71.32	34		0
	Temperature Water	ºC	10.45	5.56	2.92	4.21	9.80	18.72	19.98	62		0
	Conductivity @25C	uS/cm	59.09	12.55	41.40	43.85	61.60	74.70	80.05	26		0
	BOD ATU	mg/l	1.24	0.24	1.00	1.00	1.21	1.46	1.68	60	1.68	38
	Ammonia - as N	mg/l	0.03	0.00	0.03	0.03	0.03	0.03	0.04	60	0.03	51
88006241	Nitrogen Total Oxidised - as N	mg/l	0.22	0.04	0.20	0.20	0.20	0.25	0.26	60	0.2	46
	Nitrate	mg/l	0.31	0.14	0.19	0.20	0.20	0.50	0.50	59	0.5	43
	Nitrite	mg/l	0.01	0.00	0.00	0.00	0.00	0.01	0.01	59	0.004	42
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60	0.00028	51
	Solids Suspended @105C	mg/l	3.27	0.95	3.00	3.00	3.00	4.00	4.05	60	3	51
	Solids Non-Volatile @500C	mg/l	14.17	4.93	10.00	10.00	10.00	20.00	20.00	12	10	12
	Alkalinity PH 4.5	mg/l	17.63	8.02	5.49	6.50	16.90	29.16	32.33	39	5	1

	Chloride Ion - as Cl	mg/l	5.19	1.65	3.15	3.42	5.00	6.89	8.29	59	5	7
	Ortho-Phosphate	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60	0.001	21
	DO % (Instrumental)	%	102.15	5.68	95.00	95.00	102.00	109.00	113.85	62		0
	DO conc. (Instrumental)	mg/l	11.46	1.67	9.00	9.21	11.55	13.30	13.89	62		0
88006244	Lead - as Pb	ug/l	1.61	1.21	0.52	0.64	1.61	2.58	2.70	2	0.4	1
	pH - as pH units		7.40	0.44	6.80	6.90	7.32	7.90	8.10	61		0
	Conductivity @20C	uS/cm	64.81	14.83	51.91	53.65	60.35	76.11	90.34	34		0
	Temperature Water	ºC	10.04	4.41	4.40	4.70	10.30	16.80	17.10	61		0
	Conductivity @25C	uS/cm	119.55	166.73	60.23	62.45	85.95	115.50	116.75	26		0
	BOD ATU	mg/l	1.37	0.31	1.00	1.00	1.37	1.69	2.09	60	1.43	21
	Cadmium - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	2	0.1	2
	Ammonia - as N	mg/l	0.04	0.02	0.03	0.03	0.03	0.05	0.07	60	0.03	33
	Nitrogen Total Oxidised - as N	mg/l	0.66	0.26	0.32	0.39	0.60	1.02	1.09	60		0
	Nitrate	mg/l	0.65	0.24	0.38	0.39	0.57	0.97	1.09	59	0.5	6
	Nitrite	mg/l	0.02	0.03	0.00	0.00	0.01	0.03	0.03	59	0.004	9
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60	0.00005	33
	Solids Suspended @105C	mg/l	3.52	2.18	3.00	3.00	3.00	4.00	6.05	60	3	47
	Solids Non-Volatile @500C	mg/l	14.17	4.93	10.00	10.00	10.00	20.00	20.00	12	10	12
	Alkalinity PH 4.5	mg/l	20.88	8.48	11.40	12.76	18.00	34.84	36.93	39		0
	Chloride Ion - as Cl	mg/l	7.03	3.27	5.05	5.23	6.29	8.53	13.00	60		0
	Ortho-Phosphate	mg/l	0.02	0.02	0.00	0.00	0.02	0.04	0.06	60	0.001	2
	Chromium - as Cr	ug/l	6.30	5.80	1.08	1.66	6.30	10.94	11.52	2	0.5	1
	Copper - as Cu	ug/l	9.03	7.77	2.04	2.81	9.03	15.25	16.02	2		0
	Zinc - as Zn	ug/l	15.80	10.80	6.08	7.16	15.80	24.44	25.52	2	5	1
	Nickel - as Ni	ug/l	6.20	1.20	5.12	5.24	6.20	7.15	7.27	2	5	1
	DO % (Instrumental)	%	99.90	7.39	90.00	90.00	100.00	112.00	113.00	61		0
	DO conc. (Instrumental)	mg/l	11.31	1.30	9.20	9.50	11.40	12.90	13.10	61		0
88006266	Lead - as Pb	ug/l	0.97	0.30	0.64	0.66	0.88	1.32	1.47	10		0
	pH - as pH units		7.80	0.23	7.40	7.47	7.80	8.03	8.19	64		0
	Conductivity @20C	uS/cm	286.59	28.98	240.55	247.20	288.50	315.40	317.75	34		0
	Temperature Water	ºC	9.39	2.68	4.88	6.32	9.65	12.47	13.60	64		0

	Conductivity @25C	uS/cm	300.14	43.83	204.00	239.00	305.00	351.00	351.00	29		0
	BOD ATU	mg/l	1.52	0.59	1.00	1.00	1.39	2.05	2.57	63	1.43	27
	Cadmium - as Cd	ug/l	0.11	0.03	0.10	0.10	0.10	0.11	0.15	10	0.1	9
	Ammonia - as N	mg/l	0.06	0.05	0.03	0.03	0.04	0.10	0.15	64	0.03	22
	Nitrogen Total Oxidised - as N	mg/l	5.87	1.23	4.20	4.62	5.87	6.72	6.92	64		0
	Nitrate	mg/l	5.85	1.23	4.18	4.60	5.85	6.70	6.89	64		0
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.04	0.04	64		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64	0.00026	22
	Solids Suspended @105C	mg/l	10.08	18.43	3.00	3.00	5.00	17.00	32.60	63	3	15
	Solids Non-Volatile @500C	mg/l	13.33	4.71	10.00	10.00	10.00	20.00	20.00	12	10	11
	Alkalinity PH 4.5	mg/l	96.21	20.37	56.19	68.32	99.50	117.90	121.80	42		0
	Chloride Ion - as Cl	mg/l	14.89	1.82	12.70	13.16	14.90	16.57	17.17	64		0
	Ortho-Phosphate	mg/l	0.08	0.09	0.04	0.05	0.07	0.10	0.10	64	0.001	1
	Chromium - as Cr	ug/l	0.58	0.15	0.50	0.50	0.50	0.69	0.85	10	0.5	6
	Copper - as Cu	ug/l	1.03	0.49	0.63	0.66	0.84	1.51	1.90	10		0
	Zinc - as Zn	ug/l	6.53	3.25	5.00	5.00	5.00	10.69	12.90	10	5	8
	Nickel - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	10	5	10
	DO % (Instrumental)	%	95.31	5.65	88.00	89.00	95.00	102.70	107.85	64		0
	DO conc. (Instrumental)	mg/l	10.71	1.39	9.72	10.00	10.85	11.70	11.89	64		0
88006278	Lead - as Pb	ug/l	0.96	0.40	0.65	0.67	0.85	1.25	1.66	10		0
	pH - as pH units		7.98	0.25	7.60	7.65	8.00	8.30	8.30	65		0
	Conductivity @20C	uS/cm	292.91	25.89	246.50	255.80	296.00	318.60	321.90	35		0
	Temperature Water	ºC	9.73	3.04	5.42	5.96	9.70	13.82	14.20	65		0
	Conductivity @25C	uS/cm	312.93	36.97	246.95	262.00	316.00	361.00	361.00	30		0
	BOD ATU	mg/l	1.64	0.87	1.00	1.00	1.43	2.21	2.76	65	1.43	21
	Cadmium - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	10	0.1	10
	Ammonia - as N	mg/l	0.06	0.07	0.03	0.03	0.03	0.10	0.14	65	0.03	31
	Nitrogen Total Oxidised - as N	mg/l	6.10	1.14	4.37	4.92	6.11	6.89	7.00	65		0
	Nitrate	mg/l	6.08	1.14	4.32	4.89	6.09	6.87	6.99	65		0
	Nitrite	mg/l	0.03	0.02	0.01	0.01	0.02	0.04	0.04	65		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	65	0.0004	31

	Solids Suspended @105C	mg/l	9.58	16.05	3.00	3.00	6.00	13.20	23.00	65	3	11
	Solids Non-Volatile @500C	mg/l	13.33	4.71	10.00	10.00	10.00	20.00	20.00	12	10	12
	Alkalinity PH 4.5	mg/l	100.19	17.93	69.62	78.78	104.00	118.80	121.90	43		0
	Chloride Ion - as Cl	mg/l	15.43	1.93	13.12	13.62	15.10	17.56	18.40	65		0
	Ortho-Phosphate	mg/l	0.07	0.02	0.04	0.05	0.07	0.09	0.10	65		0
	Chromium - as Cr	ug/l	0.62	0.17	0.50	0.50	0.50	0.85	0.92	10	0.5	6
	Copper - as Cu	ug/l	1.00	0.54	0.55	0.59	0.84	1.64	2.02	10	0.5	1
	Zinc - as Zn	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	10	5	10
	Nickel - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	10	5	10
	DO % (Instrumental)	%	100.22	9.62	92.00	93.00	98.00	110.70	114.70	64		0
	DO conc. (Instrumental)	mg/l	11.40	0.87	10.12	10.53	11.25	12.47	12.69	64		0
88006427	pH - as pH units		7.92	0.29	7.42	7.50	8.00	8.20	8.20	24		0
	Conductivity @20C	uS/cm	239.61	46.00	177.30	189.60	234.00	301.80	311.20	23		0
	Temperature Water	ºC	10.20	5.11	2.40	3.15	10.20	17.23	18.18	24		0
	Conductivity @25C	uS/cm	300.00	0.00	300.00	300.00	300.00	300.00	300.00	1		0
	BOD ATU	mg/l	1.72	0.53	1.00	1.05	1.62	2.42	2.62	24	1	3
	Ammonia - as N	mg/l	0.07	0.04	0.03	0.03	0.06	0.13	0.14	24	0.03	4
	Nitrogen Total Oxidised - as N	mg/l	2.00	0.83	1.05	1.17	1.95	3.33	3.68	24		0
	Nitrate	mg/l	1.99	0.83	1.04	1.16	1.92	3.32	3.67	24		0
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.01	0.03	0.04	24	0.004	1
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24	0.00059	4
	Solids Suspended @105C	mg/l	9.42	10.41	3.00	3.00	7.50	11.00	25.45	24	3	5
	Alkalinity PH 4.5	mg/l	102.66	19.93	71.18	74.03	109.00	123.70	124.70	14		0
	Chloride Ion - as Cl	mg/l	12.89	2.44	9.58	10.24	12.60	14.50	18.58	24		0
	Ortho-Phosphate	mg/l	0.04	0.01	0.02	0.02	0.04	0.05	0.06	24		0
	Chlorophyll	ug/l	6.95	4.77	1.64	2.43	5.49	13.70	16.51	24		0
	DO % (Instrumental)	%	105.42	29.59	90.00	90.30	96.50	124.50	136.20	24		0
	DO conc. (Instrumental)	mg/l	11.81	2.47	10.00	10.03	11.60	12.87	13.41	24		0
88009739	pH - as pH units		7.32	0.46	6.70	6.76	7.36	7.86	7.98	65		0
	Conductivity @20C	uS/cm	57.42	9.46	41.32	44.24	57.50	71.34	72.28	33		0
	Temperature Water	ºC	9.95	4.29	3.34	4.52	9.30	15.82	16.48	65		0

Conductivity @25C	uS/cm	60.70	10.25	45.39	47.97	60.30	73.25	75.04	30		0
BOD ATU	mg/l	1.23	0.23	1.00	1.00	1.14	1.51	1.59	63	1.43	38
Ammonia - as N	mg/l	0.03	0.01	0.03	0.03	0.03	0.05	0.05	63	0.03	49
Nitrogen Total Oxidised - as N	mg/l	0.35	0.12	0.20	0.20	0.33	0.52	0.56	63	0.2	10
Nitrate	mg/l	0.41	0.12	0.20	0.23	0.45	0.51	0.56	63	0.5	26
Nitrite	mg/l	0.00	0.00	0.00	0.00	0.00	0.01	0.01	63	0.004	48
Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	49	0	39
Solids Suspended @105C	mg/l	3.06	0.39	3.00	3.00	3.00	3.00	3.00	63	3	58
Solids Non-Volatile @500C	mg/l	13.57	4.79	10.00	10.00	10.00	20.00	20.00	14	10	14
Hardness Total	mg/l	18.59	4.32	12.52	13.91	17.95	24.99	25.70	42		0
Alkalinity PH 4.5	mg/l	14.07	5.33	7.32	7.78	12.80	20.70	23.57	43		0
Chloride Ion - as Cl	mg/l	5.97	1.49	4.14	4.51	5.62	7.81	9.19	63	5	4
Ortho-Phosphate	mg/l	0.00	0.00	0.00	0.00	0.00	0.01	0.01	64	0.001	11
Phosphorus Total - as P	mg/l	0.03	0.01	0.02	0.02	0.03	0.05	0.05	13	0.02	5
Copper Dissolved - as Cu	ug/l	0.61	0.44	0.50	0.50	0.50	0.70	0.96	63	0.5	44
Zinc - as Zn	ug/l	5.45	1.87	5.00	5.00	5.00	5.15	6.17	62	5	54
Orthophosphate Filtered - as P	mg/l	0.01	0.01	0.00	0.00	0.00	0.02	0.02	13	0.001	6
DO % (Instrumental)	%	102.16	6.43	96.00	96.00	101.00	110.00	110.95	62		0
DO conc. (Instrumental)	mg/l	11.55	1.32	9.60	10.20	11.55	13.08	13.30	62		0

Table A2.11. Water Quality statistics for the River Ehen (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
88005134	Lead Dissolved - as Pb	ug/l	0.40	0.00	0.40	0.40	0.40	0.40	0.40	1	0.4	1
	pH - as pH units		7.06	0.45	6.40	6.40	7.10	7.70	7.70	41		0
	Conductivity @20C	uS/cm	40.19	1.98	38.47	38.62	39.20	42.66	43.69	12		0
	Temperature Water	ºC	9.82	4.45	2.60	4.70	9.20	16.20	16.30	41		0
	Conductivity @25C	uS/cm	46.31	3.15	42.82	43.00	45.50	51.00	51.60	29		0
	BOD ATU	mg/l	1.26	0.27	1.00	1.00	1.15	1.49	1.78	41	1.43	25
	Cadmium Dissolved - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	1	0.1	1
	Ammonia - as N	mg/l	0.04	0.02	0.03	0.03	0.03	0.04	0.06	41	0.03	32
	Nitrogen Total Oxidised - as N	mg/l	0.32	0.09	0.20	0.20	0.34	0.43	0.44	41	0.2	8
	Nitrate	mg/l	0.44	0.09	0.26	0.31	0.50	0.50	0.50	41	0.5	23
	Nitrite	mg/l	0.00	0.00	0.00	0.00	0.00	0.01	0.01	41	0.004	24
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	41	0.00002	35
	Solids Suspended @105C	mg/l	3.90	3.16	3.00	3.00	3.00	4.00	10.00	41	3	35
	Solids Non-Volatile @500C	mg/l	13.33	4.71	10.00	10.00	10.00	20.00	20.00	12	10	12
	Hardness Total	mg/l	8.99	1.96	7.85	8.15	8.59	9.68	9.92	41		0
	Alkalinity pH 4.5	mg/l	5.50	1.89	5.00	5.00	5.00	5.40	7.70	41	5	37
	Chloride Ion - as Cl	mg/l	7.33	2.29	5.93	5.98	6.75	8.68	9.50	41		0
	Ortho-Phosphate	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40	0.001	25
	Zinc Dissolved - as Zn	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	1	5	1
	Chromium Dissolved - as Cr	ug/l	0.50	0.00	0.50	0.50	0.50	0.50	0.50	1	0.5	1
	Nickel Dissolved - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	1	5	1
	Copper Dissolved - as Cu	ug/l	0.59	0.29	0.50	0.50	0.50	0.80	0.85	40	0.5	32
	Zinc - as Zn	ug/l	5.45	1.54	5.00	5.00	5.00	5.41	8.04	41	5	35
	DO % (Instrumental)	%	100.02	7.33	90.00	92.00	101.00	106.00	114.00	41		0
	DO conc. (Instrumental)	mg/l	11.39	1.72	9.10	9.20	11.40	13.20	14.30	41		0

Table A2.12. Water Quality statistics for the River Frome (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
50550130	pH - as pH units		8.11	0.25	7.77	7.86	8.06	8.43	8.53	24		0
	Temperature Water	ºC	11.38	3.46	7.03	7.71	10.94	16.22	16.44	24		0
	BOD ATU	mg/l	1.75	0.78	1.00	1.01	1.64	2.67	3.14	24	1	3
	Ammonia - as N	mg/l	0.06	0.04	0.03	0.03	0.05	0.11	0.15	24	0.03	7
	Nitrogen Total Oxidised - as N	mg/l	6.92	1.15	5.40	5.42	6.89	8.61	9.06	24		0
	Nitrate	mg/l	6.89	1.14	5.36	5.38	6.87	8.57	9.00	24		0
	Nitrite	mg/l	0.03	0.01	0.02	0.02	0.03	0.05	0.05	24		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24	0.00082	7
	Hardness Total	mg/l	210.00	0.00	210.00	210.00	210.00	210.00	210.00	1		0
	Alkalinity pH 4.5	mg/l	187.40	30.67	150.40	150.80	202.00	218.20	221.60	5		0
	Ortho-Phosphate	mg/l	0.16	0.06	0.08	0.10	0.15	0.23	0.28	24		0
	Nitrogen Total Inorganic (Calculated)	mg/l	6.98	1.13	5.49	5.54	6.97	8.67	9.13	24		0
	Copper Dissolved - as Cu	ug/l	2.62	0.30	2.28	2.35	2.55	2.95	3.08	6	2.5	2
	Zinc - as Zn	ug/l	9.44	5.98	5.00	5.00	7.10	16.24	18.62	5	5	2
	DO % (Instrumental)	%	111.45	17.21	92.69	93.41	106.20	137.82	138.17	24		0
	DO conc. (Instrumental)	mg/l	12.14	1.54	9.51	10.45	12.00	14.11	14.54	24		0
50570188	pH - as pH units		7.91	0.19	7.65	7.72	7.88	8.14	8.20	17		0
	Temperature Water	ºC	11.78	2.86	7.98	8.49	11.99	15.35	15.40	18		0
	BOD ATU	mg/l	1.38	0.36	1.00	1.00	1.30	1.80	2.14	17	1	3
	Ammonia - as N	mg/l	0.04	0.04	0.03	0.03	0.03	0.04	0.08	17	0.03	11
	Nitrogen Total Oxidised - as N	mg/l	6.20	0.65	5.18	5.43	6.20	7.06	7.36	17		0
	Nitrate	mg/l	6.17	0.66	5.15	5.41	6.17	7.04	7.35	17		0
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.03	0.03	17		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17	0.00082	11
	Hardness Total	mg/l	276.80	8.80	263.40	266.80	280.00	283.80	284.40	5		0
	Alkalinity pH 4.5	mg/l	216.80	12.35	199.20	202.40	221.00	228.60	230.80	5		0

	Ortho-Phosphate	mg/l	0.09	0.03	0.05	0.05	0.09	0.13	0.13	17		0
	Nitrogen Total Inorganic (Calculated)	mg/l	6.24	0.64	5.33	5.52	6.25	7.09	7.39	17		0
	Copper Dissolved - as Cu	ug/l	2.31	0.47	1.24	1.54	2.50	2.50	2.54	17	2.5	14
	Zinc - as Zn	ug/l	8.35	7.36	5.00	5.00	5.00	10.70	16.34	17	5	9
	DO % (Instrumental)	%	99.31	15.42	83.54	84.30	94.40	123.64	126.40	17		0
	DO conc. (Instrumental)	mg/l	10.78	1.70	8.75	8.87	10.30	12.90	13.18	17		0
50590110	pH - as pH units		7.96	0.21	7.58	7.60	7.94	8.22	8.28	20		0
	Temperature Water	ºC	13.07	3.76	8.06	9.51	12.86	17.90	18.15	20		0
	BOD ATU	mg/l	1.31	0.44	1.00	1.00	1.12	1.66	2.23	22	1	9
	Ammonia - as N	mg/l	0.04	0.02	0.03	0.03	0.03	0.05	0.07	20	0.03	10
	Nitrogen Total Oxidised - as N	mg/l	5.08	0.78	3.81	4.42	4.77	6.11	6.38	20		0
	Nitrate	mg/l	5.05	0.78	3.77	4.41	4.75	6.07	6.36	20		0
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.04	0.04	20		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20	0.00086	10
	Ortho-Phosphate	mg/l	0.10	0.03	0.05	0.06	0.10	0.14	0.14	20		0
	Nitrogen Total Inorganic (Calculated)	mg/l	5.12	0.77	3.86	4.46	4.82	6.14	6.41	20		0
	Copper Dissolved - as Cu	ug/l	1.94	0.66	1.00	1.00	2.50	2.50	2.50	9	2.5	7
	Zinc - as Zn	ug/l	13.96	10.50	5.34	5.38	9.10	25.30	32.10	9		0
	DO % (Instrumental)	%	88.08	7.84	75.91	76.27	90.75	96.81	97.12	20		0
	DO conc. (Instrumental)	mg/l	9.33	1.38	7.37	7.51	9.27	10.95	11.43	20		0
50590188	pH - as pH units		7.98	0.19	7.74	7.76	7.98	8.20	8.20	6		0
	Temperature Water	ºC	10.11	1.52	8.53	8.59	9.63	12.11	12.38	6		0
	BOD ATU	mg/l	1.62	0.34	1.15	1.20	1.65	2.00	2.05	6		0
	Ammonia - as N	mg/l	0.07	0.03	0.03	0.04	0.07	0.10	0.11	6	0.03	1
	Nitrogen Total Oxidised - as N	mg/l	6.60	0.64	5.85	5.94	6.47	7.40	7.47	6		0
	Nitrate	mg/l	6.57	0.65	5.80	5.90	6.43	7.37	7.44	6		0
	Nitrite	mg/l	0.04	0.02	0.02	0.02	0.04	0.06	0.06	6		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6	0.00049	1
	Hardness Total	mg/l	259.50	1.50	258.15	258.30	259.50	260.70	260.85	2		0
	Alkalinity pH 4.5	mg/l	191.67	22.69	164.30	168.60	203.00	210.20	211.10	3		0
	Ortho-Phosphate	mg/l	0.12	0.06	0.06	0.06	0.11	0.20	0.22	6		0

	Nitrogen Total Inorganic (Calculated)	mg/l	6.67	0.62	5.93	6.04	6.52	7.45	7.53	6		0
	Copper Dissolved - as Cu	ug/l	2.50	0.00	2.50	2.50	2.50	2.50	2.50	3	2.5	3
	Zinc - as Zn	ug/l	22.13	5.93	16.35	16.80	20.40	28.16	29.13	3		0
	DO % (Instrumental)	%	98.25	10.03	88.25	88.30	95.65	110.80	113.65	6		0
	DO conc. (Instrumental)	mg/l	11.08	1.43	9.65	9.73	10.60	12.90	13.25	6		0
50590203	pH - as pH units		7.97	0.29	7.50	7.64	8.00	8.30	8.36	27		0
	Temperature Water	ºC	11.46	3.57	6.83	8.03	11.26	16.87	18.29	29		0
	BOD ATU	mg/l	1.37	0.34	1.00	1.00	1.30	1.80	1.85	27	1	5
	Ammonia - as N	mg/l	0.05	0.04	0.03	0.03	0.03	0.08	0.11	27	0.03	13
	Nitrogen Total Oxidised - as N	mg/l	5.91	0.77	4.95	5.00	5.86	6.89	7.40	27		0
	Nitrate	mg/l	5.87	0.77	4.91	4.97	5.82	6.86	7.37	27		0
	Nitrite	mg/l	0.03	0.01	0.02	0.02	0.03	0.05	0.05	27		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27	0.00052	13
	Hardness Total	mg/l	263.33	4.11	258.60	259.20	264.00	267.20	267.60	3		0
	Alkalinity pH 4.5	mg/l	197.75	21.55	167.45	173.90	208.00	213.40	213.70	4		0
	Ortho-Phosphate	mg/l	0.11	0.04	0.06	0.07	0.11	0.15	0.17	27		0
	Nitrogen Total Inorganic (Calculated)	mg/l	5.96	0.76	4.99	5.09	5.89	6.93	7.46	27		0
	Copper Dissolved - as Cu	ug/l	1.97	0.73	1.00	1.00	2.50	2.50	2.80	11	2.5	7
	Zinc - as Zn	ug/l	17.15	5.74	10.10	10.50	16.80	23.30	26.30	11		0
	DO % (Instrumental)	%	99.60	13.60	82.51	83.60	97.60	117.78	126.87	27		0
	DO conc. (Instrumental)	mg/l	10.84	1.59	8.67	9.08	10.80	13.28	14.12	27		0
C0508000	pH - as pH units		7.99	0.26	7.55	7.73	7.95	8.33	8.44	70		0
	Temperature Water	ºC	11.58	3.03	7.10	7.86	12.08	15.41	15.74	69		0
	BOD ATU	mg/l	1.63	0.73	1.00	1.00	1.40	2.40	3.42	69	1	10
	Ammonia - as N	mg/l	0.05	0.05	0.03	0.03	0.03	0.10	0.17	70	0.03	41
	Nitrogen Total Oxidised - as N	mg/l	5.34	0.74	3.88	4.65	5.46	6.00	6.15	69		0
	Nitrate	mg/l	5.32	0.75	3.84	4.61	5.44	5.96	6.13	69		0
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.04	0.04	69		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	69	0.0005	40
	Hardness Total	mg/l	254.07	26.10	213.75	222.50	261.00	280.50	283.75	46		0
	Alkalinity pH 4.5	mg/l	207.79	24.30	153.80	177.40	212.00	228.00	230.90	43		0

	Hardness Calcium	mg/l	246.29	10.27	232.69	234.88	245.25	258.75	259.38	6		0
	Hardness Magnesium	mg/l	9.08	0.35	8.67	8.69	9.08	9.47	9.53	6		0
	Ortho-Phosphate	mg/l	0.11	0.05	0.06	0.07	0.10	0.15	0.17	69		0
	Nitrogen Total Inorganic (Calculated)	mg/l	5.40	0.71	4.13	4.70	5.50	6.03	6.20	69		0
	Copper Dissolved - as Cu	ug/l	2.45	1.42	1.00	1.00	2.50	2.50	2.50	69	2.5	62
	Zinc - as Zn	ug/l	10.92	15.14	5.00	5.00	5.70	17.50	24.66	69	5	32
	DO % (Instrumental)	%	100.62	18.19	84.80	86.90	98.00	124.76	130.00	69		0
	DO conc. (Instrumental)	mg/l	10.93	1.96	8.93	9.13	11.25	12.80	13.45	68		0
C0527000	pH - as pH units		8.01	0.25	7.62	7.72	7.99	8.34	8.45	70		0
	Temperature Water	ºC	11.84	3.28	7.18	7.72	12.32	15.98	16.31	69		0
	BOD ATU	mg/l	1.64	0.70	1.00	1.00	1.50	2.48	3.06	69	1	13
	Ammonia - as N	mg/l	0.05	0.04	0.03	0.03	0.03	0.09	0.14	70	0.03	47
	Nitrogen Total Oxidised - as N	mg/l	5.33	0.69	4.39	4.61	5.34	6.19	6.30	69		0
	Nitrate	mg/l	5.31	0.70	4.35	4.58	5.33	6.17	6.28	69		0
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.04	0.04	69		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	69	0.0007	46
	Hardness Total	mg/l	261.43	18.90	225.50	236.00	267.00	280.50	283.75	46		0
	Alkalinity pH 4.5	mg/l	213.40	17.27	184.80	195.80	217.00	230.40	232.00	43		0
	Hardness Calcium	mg/l	256.38	8.09	246.81	247.88	256.25	265.00	266.25	6		0
	Hardness Magnesium	mg/l	9.05	0.12	8.88	8.90	9.06	9.18	9.20	6		0
	Ortho-Phosphate	mg/l	0.10	0.04	0.05	0.06	0.09	0.15	0.18	69		0
	Nitrogen Total Inorganic (Calculated)	mg/l	5.38	0.67	4.48	4.66	5.38	6.22	6.33	69		0
	Copper Dissolved - as Cu	ug/l	2.20	0.59	1.00	1.00	2.50	2.50	2.50	69	2.5	64
	Zinc - as Zn	ug/l	8.33	5.86	5.00	5.00	5.00	16.20	19.80	69	5	33
	DO % (Instrumental)	%	103.63	14.41	88.04	90.06	99.00	125.12	137.34	69		0
	DO conc. (Instrumental)	mg/l	11.19	1.39	9.20	9.41	11.30	12.72	13.54	69		0

Table A2.13. Water Quality statistics for the River Hull Headwaters (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
49200071	pH - as pH units		7.86	0.35	7.32	7.44	7.90	8.20	8.20	45		0
	Conductivity @20C	uS/cm	466.33	51.08	418.40	425.80	459.00	500.60	527.60	33		0
	Temperature Water	ºC	12.40	3.51	6.03	6.90	13.20	16.65	17.08	46		0
	BOD ATU	mg/l	1.49	0.49	0.81	1.00	1.40	2.20	2.30	42	0.8	1
	Ammonia - as N	mg/l	0.07	0.04	0.03	0.04	0.06	0.10	0.14	45	0.03	2
	Nitrogen Total Oxidised - as N	mg/l	9.63	0.89	8.43	8.64	9.51	10.82	11.08	45		0
	Nitrate	mg/l	9.53	0.94	8.28	8.48	9.39	10.82	11.08	45		0
	Nitrite	mg/l	0.10	0.07	0.01	0.02	0.10	0.21	0.23	45		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45	0.00019	2
	Hardness Total	mg/l	260.00	0.00	260.00	260.00	260.00	260.00	260.00	1		0
	Alkalinity pH 4.5	mg/l	179.00	0.00	179.00	179.00	179.00	179.00	179.00	1		0
	Ortho-Phosphate	mg/l	0.03	0.02	0.02	0.02	0.02	0.05	0.06	45	0.02	24
	Copper Dissolved - as Cu	ug/l	1.08	0.58	0.62	0.67	0.83	1.70	1.84	45	0.5	1
	Zinc - as Zn	ug/l	5.44	1.49	5.00	5.00	5.00	5.96	7.23	45	5	39
	DO % (Instrumental)	%	96.33	14.69	72.00	79.00	94.50	116.50	121.00	46		0
	DO conc. (Instrumental)	mg/l	10.18	1.42	7.83	8.56	10.20	12.00	12.08	45		0

Table A2.14. Water Quality statistics for the River Ise and Meadows (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb sample < DL
RISE150B	pH - as pH units		7.81	0.27	7.29	7.37	7.80	8.10	8.20	68		0
	Conductivity @20C	uS/cm	752.06	142.29	527.70	588.00	747.00	947.80	969.10	35		0
	Temperature Water	ºC	10.96	3.84	5.40	6.00	10.22	16.30	16.85	71		0
	Conductivity @25C	uS/cm	817.48	153.83	576.00	643.00	810.30	1020.00	1032.50	36		0
	DO % (Lab)	%	103.69	13.17	87.24	88.08	104.00	124.00	128.80	13		0
	DO conc. (lab)	mg/l	11.81	1.34	9.78	10.10	12.10	13.36	13.43	15		0
	BOD ATU	mg/l	1.63	1.40	1.00	1.00	1.26	2.40	2.91	71	1	21
	Ammonia - as N	mg/l	0.07	0.14	0.03	0.03	0.03	0.10	0.17	71	0.03	36
	Nitrogen Total Oxidised - as N	mg/l	6.46	2.80	2.94	3.49	6.18	9.80	11.55	71		0
	Nitrate	mg/l	6.14	3.02	2.64	2.88	5.64	10.35	12.49	35		0
	Nitrite	mg/l	0.03	0.02	0.01	0.01	0.02	0.06	0.08	35		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	68	0.001	34
	Alkalinity pH 4.5	mg/l	241.86	38.14	171.60	193.50	238.50	278.70	287.75	14		0
	Chloride Ion - as Cl	mg/l	47.16	13.22	29.05	30.10	46.60	64.60	72.75	71		0
	Ortho-Phosphate	mg/l	0.14	0.08	0.04	0.06	0.13	0.24	0.29	71		0
	Phosphorus Total - as P	mg/l	7.50	1.46	5.48	6.07	7.46	9.12	9.55	7		0
	DO % (Instrumental)	%	92.81	13.63	71.78	78.80	92.55	109.45	119.63	56		0
	DO conc. (Instrumental)	mg/l	10.31	1.89	7.85	8.05	9.88	12.70	13.37	35		0
RISE180G	pH - as pH units		8.00	0.29	7.47	7.70	8.10	8.25	8.30	46		0
	Conductivity @20C	uS/cm	865.50	128.60	666.50	757.00	845.50	1008.30	1019.00	12		0
	Temperature Water	ºC	11.05	3.83	5.94	6.00	10.30	16.29	16.99	48		0
	Conductivity @25C	uS/cm	847.82	162.66	590.00	636.50	848.00	1050.00	1052.50	36		0
	DO % (Lab)	%	106.47	16.24	84.10	87.32	107.00	125.40	131.40	13		0
	DO conc. (lab)	mg/l	12.19	1.47	10.05	10.28	12.50	14.32	14.43	15		0
	BOD ATU	mg/l	1.38	0.60	1.00	1.00	1.10	2.39	2.83	48	1	16
	Ammonia - as N	mg/l	0.05	0.05	0.03	0.03	0.03	0.12	0.16	48	0.03	31

Nitrogen Total Oxidised - as N	mg/l	7.16	2.41	4.40	4.63	6.99	9.31	10.44	48		0
Nitrate	mg/l	5.96	2.15	4.22	4.34	4.73	8.88	10.00	12		0
Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.04	0.04	12	0.008	1
Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	46	0.001	29
Alkalinity pH 4.5	mg/l	265.08	36.02	215.25	240.20	258.50	309.50	314.60	12		0
Chloride Ion - as Cl	mg/l	46.14	12.25	29.02	30.70	44.55	64.82	66.21	48		0
Ortho-Phosphate	mg/l	0.12	0.08	0.03	0.04	0.10	0.22	0.27	48	0.02	1
Phosphorus Total - as P	mg/l	8.38	1.24	6.91	6.92	8.52	9.71	10.25	7		0
DO % (Instrumental)	%	101.35	19.83	73.24	79.64	97.70	122.62	139.48	33		0
DO conc. (Instrumental)	mg/l	10.40	2.37	7.73	8.04	9.84	12.87	14.49	12		0

Table A2.15. Water Quality statistics for the River Itchen (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
G0003793	pH - as pH units		8.03	0.19	7.74	7.79	8.05	8.25	8.29	56		0
	Conductivity @20C	uS/cm	524.50	12.04	507.95	512.90	523.00	537.40	543.70	10		0
	Temperature Water	ºC	11.24	2.89	7.54	8.24	10.61	15.12	15.51	57		0
	BOD ATU	mg/l	1.28	0.29	1.00	1.00	1.20	1.64	1.80	57	1	12
	Ammonia - as N	mg/l	0.04	0.02	0.03	0.03	0.03	0.05	0.05	57	0.03	35
	Nitrogen Total Oxidised - as N	mg/l	6.24	0.63	5.23	5.40	6.21	7.04	7.15	57		0
	Nitrate	mg/l	6.21	0.63	5.22	5.39	6.18	7.02	7.13	57		0
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.03	0.04	57		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56	0.0005	34
	Solids Suspended @105C	mg/l	12.11	19.64	3.00	3.09	8.30	14.21	18.39	20	3	2
	Hardness Total	mg/l	301.49	12.22	285.60	291.80	303.00	314.00	314.00	35		0
	Alkalinity pH 4.5	mg/l	243.71	11.69	227.70	231.40	247.00	254.00	255.00	35		0
	Chloride Ion - as Cl	mg/l	20.28	0.82	19.34	19.47	20.10	21.20	21.65	10		0
	Ortho-Phosphate	mg/l	0.09	0.03	0.05	0.06	0.09	0.12	0.14	57		0
	Zinc Dissolved - as Zn	ug/l	5.46	1.88	5.00	5.00	5.00	5.00	7.26	33	5	29
	Copper Dissolved - as Cu	ug/l	2.52	0.14	2.50	2.50	2.50	2.50	2.50	43	2.5	42
	Copper - as Cu	ug/l	4.31	7.20	2.50	2.50	2.50	5.78	9.28	33	2.5	27
	Zinc - as Zn	ug/l	6.88	5.15	5.00	5.00	5.20	8.54	11.02	43	5	19
	DO % (Instrumental)	%	104.53	7.30	93.43	95.90	105.20	113.35	116.70	56		0
	DO conc. (Instrumental)	mg/l	11.50	0.74	10.38	10.58	11.40	12.56	12.70	35		0
G0003806	pH - as pH units		7.79	0.25	7.35	7.48	7.79	8.04	8.09	56		0
	Conductivity @20C	uS/cm	515.60	8.33	507.45	507.90	514.00	525.80	529.40	10		0
	Temperature Water	ºC	11.40	2.91	6.70	7.40	11.66	14.99	15.79	55		0
	BOD 5 Day ATU Filtrate - as O	mg/l	1.01	0.03	1.00	1.00	1.00	1.00	1.04	14	1	13
	BOD ATU	mg/l	1.34	0.29	1.00	1.00	1.30	1.73	1.92	56	1	8
	Ammonia - as N	mg/l	0.06	0.02	0.03	0.03	0.06	0.09	0.10	56	0.03	8

	Nitrogen Total Oxidised - as N	mg/l	6.21	0.60	5.19	5.52	6.16	7.08	7.27	56		0
	Nitrate	mg/l	6.17	0.62	5.13	5.45	6.12	7.06	7.25	56		0
	Nitrite	mg/l	0.04	0.02	0.01	0.02	0.04	0.06	0.07	56		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	55	0.0006	8
	Solids Suspended @105C	mg/l	6.00	3.59	3.00	3.00	4.60	10.94	11.90	24	3	7
	Solids Non-Volatile @500C	mg/l	20.00	0.00	20.00	20.00	20.00	20.00	20.00	15	20	15
	Hardness Total	mg/l	300.09	8.72	287.00	289.30	302.00	310.00	312.35	34		0
	Alkalinity pH 4.5	mg/l	247.06	10.66	224.10	230.00	250.00	257.60	259.60	35		0
	Chloride Ion - as Cl	mg/l	17.12	0.50	16.40	16.40	17.00	17.71	17.76	10		0
	Ortho-Phosphate	mg/l	0.06	0.02	0.03	0.04	0.05	0.07	0.08	56		0
	Phosphorus Total - as P	mg/l	0.08	0.02	0.05	0.06	0.08	0.10	0.10	14		0
	Zinc Dissolved - as Zn	ug/l	5.64	2.18	5.00	5.00	5.00	6.48	8.86	33	5	23
	Copper Dissolved - as Cu	ug/l	2.52	0.37	2.50	2.50	2.50	2.50	2.68	43	2.5	40
	Copper - as Cu	ug/l	3.15	1.71	2.50	2.50	2.50	4.88	6.56	32	2.5	24
	Zinc - as Zn	ug/l	6.28	2.16	5.00	5.00	5.00	9.51	10.86	42	5	22
	DO % (Instrumental)	%	103.75	13.99	85.25	86.65	102.70	122.70	126.83	56		0
	DO conc. (Instrumental)	mg/l	11.44	1.03	10.06	10.54	11.10	12.90	13.02	33		0
G0003810	pH - as pH units		7.73	0.25	7.27	7.47	7.75	7.93	8.03	56		0
	Conductivity @20C	uS/cm	511.60	7.76	502.90	503.80	509.50	521.60	524.30	10		0
	Temperature Water	ºC	11.11	2.56	6.97	7.54	11.49	14.17	14.77	55		0
	BOD ATU	mg/l	1.29	0.35	1.00	1.00	1.20	1.70	1.87	56	1	18
	Ammonia - as N	mg/l	0.04	0.01	0.03	0.03	0.03	0.05	0.06	56	0.03	25
	Nitrogen Total Oxidised - as N	mg/l	6.17	0.70	4.98	5.26	6.13	7.26	7.40	56		0
	Nitrate	mg/l	6.14	0.71	4.95	5.23	6.09	7.25	7.39	56		0
	Nitrite	mg/l	0.03	0.01	0.01	0.01	0.03	0.04	0.05	56		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	55	0.0004	24
	Hardness Total	mg/l	296.43	10.37	283.20	290.00	298.00	306.20	307.00	35		0
	Alkalinity pH 4.5	mg/l	243.77	12.18	216.00	222.40	248.00	255.20	257.00	35		0
	Chloride Ion - as Cl	mg/l	16.83	0.67	16.04	16.17	16.55	17.82	17.91	10		0
	Ortho-Phosphate	mg/l	0.05	0.02	0.03	0.03	0.05	0.07	0.08	56		0
	Phosphorus Total - as P	mg/l	0.05	0.03	0.02	0.02	0.05	0.09	0.10	18		0

	Zinc Dissolved - as Zn	ug/l	8.31	18.69	5.00	5.00	5.00	5.54	5.92	33	5	25
	Copper Dissolved - as Cu	ug/l	2.49	0.29	2.50	2.50	2.50	2.50	2.50	43	2.5	42
	Copper - as Cu	ug/l	2.57	0.57	2.50	2.50	2.50	2.50	3.00	33	2.5	30
	Zinc - as Zn	ug/l	5.51	1.05	5.00	5.00	5.00	6.98	8.01	43	5	27
	OrthoPhosphate Filtered - as P	mg/l	0.05	0.03	0.01	0.02	0.04	0.08	0.12	18		0
	DO % (Instrumental)	%	100.23	11.20	85.95	88.25	99.40	117.90	121.88	56		0
	DO conc. (Instrumental)	mg/l	10.97	1.07	9.31	9.81	10.90	12.78	13.04	33		0
G0003812	pH - as pH units		7.68	0.36	7.06	7.17	7.72	8.04	8.08	56		0
	Conductivity @20C	uS/cm	518.60	9.67	502.85	508.70	519.50	526.10	531.05	10		0
	Temperature Water	ºC	11.02	2.19	7.46	8.80	11.00	13.49	14.33	55		0
	BOD 5 Day ATU Filtrate - as O	mg/l	1.00	0.00	1.00	1.00	1.00	1.00	1.00	12	1	12
	BOD ATU	mg/l	1.18	0.31	1.00	1.00	1.00	1.66	1.93	56	1	27
	Ammonia - as N	mg/l	0.03	0.01	0.03	0.03	0.03	0.03	0.04	56	0.03	48
	Nitrogen Total Oxidised - as N	mg/l	6.40	0.63	5.26	5.68	6.48	7.01	7.20	56		0
	Nitrate	mg/l	6.39	0.63	5.25	5.67	6.48	7.01	7.19	56		0
	Nitrite	mg/l	0.01	0.01	0.00	0.00	0.01	0.02	0.02	56	0.004	11
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	55	0.0003	48
	Solids Suspended @105C	mg/l	3.99	1.35	3.00	3.00	3.00	5.78	6.24	13	3	8
	Solids Non-Volatile @500C	mg/l	20.00	0.00	20.00	20.00	20.00	20.00	20.00	13	20	13
	Hardness Total	mg/l	296.29	20.13	272.80	287.80	300.00	309.20	313.30	35		0
	Alkalinity pH 4.5	mg/l	242.66	17.44	216.30	231.40	246.00	254.00	255.90	35		0
	Chloride Ion - as Cl	mg/l	18.09	1.12	16.85	16.89	18.00	19.36	19.63	10		0
	Ortho-Phosphate	mg/l	0.03	0.01	0.02	0.02	0.02	0.04	0.05	56	0.02	26
	Phosphorus Total - as P	mg/l	0.03	0.01	0.01	0.01	0.03	0.04	0.04	20	0.02	1
	Zinc Dissolved - as Zn	ug/l	6.12	3.04	5.00	5.00	5.00	7.18	13.40	33	5	21
	Copper Dissolved - as Cu	ug/l	2.52	0.16	2.50	2.50	2.50	2.50	2.50	43	2.5	40
	Copper - as Cu	ug/l	2.72	0.70	2.50	2.50	2.50	3.30	4.32	33	2.5	28
	Zinc - as Zn	ug/l	6.70	4.84	5.00	5.00	5.00	9.02	12.96	43	5	28
	OrthoPhosphate Filtered - as P	mg/l	0.02	0.01	0.01	0.01	0.02	0.03	0.03	8		0
	DO % (Instrumental)	%	97.70	14.25	79.85	83.00	96.30	117.30	119.93	56		0
	DO conc. (Instrumental)	mg/l	11.01	1.31	9.14	9.59	10.90	13.04	13.32	33		0

G0003814	pH - as pH units		7.66	0.29	7.17	7.25	7.70	7.90	8.00	56		0
	Conductivity @20C	uS/cm	518.90	12.69	504.90	505.80	515.50	535.20	540.60	10		0
	Temperature Water	ºC	10.98	2.20	7.73	8.18	10.82	13.81	14.26	56		0
	BOD ATU	mg/l	1.33	0.50	1.00	1.00	1.20	1.60	1.98	56	1	9
	Ammonia - as N	mg/l	0.07	0.03	0.03	0.03	0.07	0.11	0.13	56	0.03	4
	Nitrogen Total Oxidised - as N	mg/l	6.31	0.55	5.33	5.63	6.31	7.06	7.35	56		0
	Nitrate	mg/l	6.30	0.56	5.31	5.61	6.29	7.05	7.34	56		0
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.02	0.03	56	0.008	2
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56	0.0004	4
	Hardness Total	mg/l	300.97	11.31	278.40	285.80	303.00	311.00	313.00	35		0
	Alkalinity pH 4.5	mg/l	246.77	11.75	223.30	228.60	249.00	258.60	261.00	35		0
	Chloride Ion - as Cl	mg/l	17.79	1.22	16.89	16.98	17.30	18.59	19.90	10		0
	Ortho-Phosphate	mg/l	0.04	0.03	0.02	0.02	0.03	0.04	0.05	56	0.02	10
	Zinc Dissolved - as Zn	ug/l	5.14	1.07	5.00	5.00	5.00	5.00	6.16	33	5	31
	Copper Dissolved - as Cu	ug/l	2.53	0.37	2.50	2.50	2.50	2.50	2.68	43	2.5	39
	Copper - as Cu	ug/l	5.46	13.51	2.50	2.50	2.50	5.80	7.94	33	2.5	23
	Zinc - as Zn	ug/l	8.79	13.31	5.00	5.00	5.00	13.02	13.39	43	5	26
	DO % (Instrumental)	%	92.15	9.82	80.45	80.60	89.30	106.38	109.29	55		0
	DO conc. (Instrumental)	mg/l	10.10	1.00	8.66	8.83	10.00	11.60	11.70	33		0
G0003857	pH - as pH units		7.73	0.29	7.16	7.39	7.77	7.92	8.04	42		0
	Conductivity @20C	uS/cm	514.07	21.94	472.45	505.30	519.50	532.50	536.95	42		0
	Temperature Water	ºC	11.12	2.78	6.64	6.98	11.59	14.71	14.79	41		0
	BOD ATU	mg/l	1.40	0.39	1.00	1.00	1.30	1.90	2.19	42	1	6
	Ammonia - as N	mg/l	0.06	0.06	0.03	0.03	0.04	0.10	0.11	42	0.03	8
	Nitrogen Total Oxidised - as N	mg/l	5.65	0.74	4.50	4.69	5.66	6.49	6.88	42		0
	Nitrate	mg/l	5.62	0.75	4.46	4.64	5.64	6.48	6.87	42		0
	Nitrite	mg/l	0.03	0.02	0.01	0.01	0.03	0.06	0.06	42		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	41	0.0004	7
	Solids Suspended @105C	mg/l	7.36	8.07	3.00	3.12	5.30	9.40	15.48	42	3	3
	Hardness Total	mg/l	303.35	11.35	278.30	287.90	307.00	314.10	315.70	34		0

Alkalinity pH 4.5	mg/l	255.71	13.31	229.90	236.10	259.00	265.00	266.00	34		0
Chloride Ion - as Cl	mg/l	17.02	0.62	16.21	16.41	17.05	17.70	17.99	42		0
Ortho-Phosphate	mg/l	0.08	0.04	0.04	0.05	0.08	0.12	0.15	42		0
Phosphate	mg/l	0.10	0.03	0.05	0.06	0.10	0.13	0.16	21		0
Phosphorus Total - as P	mg/l	0.10	0.02	0.06	0.07	0.11	0.12	0.12	5		0
Copper Dissolved - as Cu	ug/l	2.56	0.25	2.50	2.50	2.50	2.50	2.88	42	2.5	39
Zinc - as Zn	ug/l	16.91	10.82	5.00	5.00	15.85	32.19	33.26	42	5	7
OrthoPhosphate Filtered - as P	mg/l	0.07	0.02	0.05	0.05	0.06	0.10	0.10	4		0
DO % (Instrumental)	%	97.04	8.59	83.22	84.09	96.35	107.79	109.99	42		0

Table A2.16. Water Quality statistics for the Rivers Kennet and Lambourn (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
PKER0038	Lead - as Pb	ug/l	1.44	0.82	0.52	0.68	1.40	1.68	2.62	13	0.4	1
	pH - as pH units		8.20	0.11	8.00	8.01	8.20	8.30	8.30	12		0
	Temperature Water	ºC	11.28	3.31	6.31	7.09	10.97	15.03	16.10	13		0
	BOD ATU	mg/l	1.06	0.12	1.00	1.00	1.00	1.19	1.29	12	1	7
	Cadmium - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	13	0.1	13
	Ammonia - as N	mg/l	0.04	0.01	0.03	0.03	0.03	0.05	0.06	13	0.03	7
	Nitrogen Total Oxidised - as N	mg/l	5.09	0.69	4.33	4.49	4.85	5.84	6.24	12		0
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.02	0.03	13	0.004	1
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12	0.001	7
	Solids Suspended @105C	mg/l	12.92	9.13	7.02	7.28	10.50	15.34	27.48	12		0
	Hardness Total	mg/l	291.62	20.37	256.80	272.00	294.00	310.00	314.00	13		0
	Alkalinity pH 4.5	mg/l	247.00	24.17	205.80	231.90	254.00	266.80	267.45	12		0
	Chloride Ion - as Cl	mg/l	21.03	1.17	19.40	20.31	21.10	21.95	22.72	12		0
	Ortho-Phosphate	mg/l	0.19	0.07	0.09	0.11	0.18	0.25	0.30	12		0
	Chromium - as Cr	ug/l	0.75	0.39	0.50	0.50	0.50	1.00	1.36	13	1	8
	Copper Dissolved - as Cu	ug/l	2.34	0.97	0.96	1.02	2.30	3.68	3.84	13		0
	Copper - as Cu	ug/l	2.88	1.91	1.54	1.70	2.30	4.44	6.34	13		0
	Zinc - as Zn	ug/l	7.08	3.50	3.60	4.00	6.00	12.60	13.80	13		0
	Nickel - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	13	5	12
	DO % (Instrumental)	%	96.43	6.85	87.26	87.52	95.30	104.30	106.24	13		0
	DO conc. (Instrumental)	mg/l	10.56	1.18	8.98	9.10	10.63	12.22	12.34	13		0
PKER0043	pH - as pH units		8.16	0.10	8.00	8.02	8.20	8.30	8.30	13		0
	Temperature Water	ºC	11.08	3.14	6.34	7.07	11.00	14.74	15.81	13		0
	BOD ATU	mg/l	1.08	0.15	1.00	1.00	1.00	1.36	1.40	13	1	7
	Ammonia - as N	mg/l	0.04	0.03	0.03	0.03	0.03	0.04	0.08	13	0.03	10
	Nitrogen Total Oxidised - as N	mg/l	5.14	0.72	4.32	4.48	4.88	5.88	6.29	12		0
	Nitrite	mg/l	0.02	0.01	0.01	0.02	0.02	0.03	0.03	13		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13	0.001	8

Solids Suspended @105C	mg/l	15.20	10.09	8.56	9.36	11.20	22.80	32.36	13		0
Hardness Total	mg/l	294.31	15.94	269.20	281.60	292.00	310.00	314.00	13		0
Alkalinity pH 4.5	mg/l	246.17	30.08	183.95	193.20	253.50	274.80	276.35	12		0
Chloride Ion - as Cl	mg/l	19.43	1.07	17.67	18.33	19.60	20.48	20.73	12		0
Ortho-Phosphate	mg/l	0.09	0.04	0.04	0.05	0.08	0.13	0.16	12	0.02	1
Copper Dissolved - as Cu	ug/l	1.32	0.25	1.06	1.10	1.20	1.50	1.68	12		0
Copper - as Cu	ug/l	1.74	0.50	1.32	1.42	1.60	2.12	2.64	13		0
Zinc - as Zn	ug/l	5.85	2.44	3.00	3.00	5.00	9.00	9.80	13		0
DO % (Instrumental)	%	94.73	6.72	86.18	86.56	94.40	103.44	104.42	13		0
DO conc. (Instrumental)	mg/l	10.43	1.14	8.82	9.04	10.50	11.89	11.95	13		0

PKER0045

Lead - as Pb	ug/l	2.00	0.00	2.00	2.00	2.00	2.00	2.00	9	2	9
pH - as pH units		2.00	0.00	2.00	2.00	2.00	2.00	2.00	9	2	9
Temperature Water	ºC	8.06	0.15	7.79	7.90	8.08	8.26	8.29	32		0
Temperature Water	CEL	11.80	3.59	6.28	6.75	11.43	16.57	16.86	32		0
BOD ATU	mg/l	1.50	1.05	1.00	1.00	1.02	1.90	2.90	31	1	15
Cadmium Dissolved - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	9	0.1	9
Cadmium - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	9	0.1	9
Ammonia - as N	mg/l	0.04	0.01	0.03	0.03	0.03	0.06	0.07	32	0.03	14
Nitrogen Total Oxidised - as N	mg/l	5.44	0.61	4.51	4.76	5.44	6.19	6.28	32		0
Nitrate	mg/l	5.25	0.52	4.57	4.72	5.30	5.97	6.06	19		0
Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.03	0.03	19		0
Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32	0.001	18
Solids Suspended @105C	mg/l	6.02	3.56	3.00	3.00	4.00	11.00	12.00	9	3	2
Alkalinity pH 4.5	mg/l	263.62	13.26	244.80	248.00	264.00	275.80	285.40	13		0
Chloride Ion - as Cl	mg/l	18.81	1.78	16.06	18.20	19.10	19.98	20.16	13		0
Ortho-Phosphate	mg/l	0.07	0.03	0.02	0.03	0.07	0.11	0.12	32		0
Phosphorus Total - as P	mg/l	0.07	0.02	0.04	0.05	0.07	0.09	0.10	9		0
Chromium - as Cr	ug/l	0.53	0.09	0.50	0.50	0.50	0.56	0.68	9	0.5	8
Zinc Dissolved - as Zn	ug/l	8.62	10.25	5.00	5.00	5.00	11.52	24.56	9	5	8
Chromium Dissolved - as Cr	ug/l	0.52	0.06	0.50	0.50	0.50	0.54	0.62	9	0.5	8
Nickel Dissolved - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	9	5	9
Copper Dissolved - as Cu	ug/l	2.22	0.85	1.00	1.00	2.50	2.78	3.34	9	2.5	7
Copper - as Cu	ug/l	2.44	1.20	1.00	1.00	2.50	3.08	4.24	9	2.5	7

	Zinc - as Zn	ug/l	9.31	12.19	5.00	5.00	5.00	12.76	28.28	9	5	8
	Nickel - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	9	5	9
	DO % (Instrumental)	%	105.74	13.18	89.63	90.43	104.05	121.54	126.70	32		0
	DO conc. (Instrumental)	mg/l	11.43	1.26	9.33	9.81	11.43	13.07	13.44	32		0
PKER0046	pH - as pH units		7.83	0.12	7.60	7.66	7.83	7.97	7.99	27		0
	Temperature Water	ºC	11.02	2.51	7.99	8.02	10.36	14.55	14.97	27		0
	BOD ATU	mg/l	1.43	0.43	1.00	1.00	1.35	2.06	2.27	28	1	9
	Ammonia - as N	mg/l	0.09	0.05	0.04	0.04	0.08	0.16	0.19	28	0.03	1
	Nitrogen Total Oxidised - as N	mg/l	7.17	0.67	5.91	6.09	7.28	7.79	8.10	27		0
	Nitrate	mg/l	7.40	0.41	6.71	7.00	7.41	7.92	8.14	21		0
	Nitrite	mg/l	0.04	0.02	0.02	0.02	0.03	0.07	0.09	22		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26	0.001	7
	Solids Suspended @105C	mg/l	7.24	9.43	3.00	3.00	4.00	11.30	13.69	28	3	9
	Hardness Total	mg/l	316.25	8.14	309.45	309.90	313.00	325.20	327.60	4		0
	Alkalinity pH 4.5	mg/l	253.32	12.73	235.60	236.00	255.00	266.80	270.80	19		0
	Chloride Ion - as Cl	mg/l	22.02	3.14	18.08	19.16	21.20	25.14	27.12	10		0
	Ortho-Phosphate	mg/l	0.09	0.04	0.04	0.05	0.08	0.15	0.16	27		0
	Copper Dissolved - as Cu	ug/l	1.70	0.80	0.90	0.90	1.70	2.50	2.50	4	2.5	2
	Copper - as Cu	ug/l	1.75	0.75	1.00	1.00	1.75	2.50	2.50	4	2.5	2
	Zinc - as Zn	ug/l	4.93	3.55	2.00	2.00	3.50	8.99	9.85	4	2	3
	DO % (Instrumental)	%	98.77	15.19	79.56	80.88	98.60	114.13	114.72	28		0
	DO conc. (Instrumental)	mg/l	10.99	1.47	8.82	9.28	10.90	12.26	13.13	27		0
PKER0052	pH - as pH units		7.93	0.14	7.80	7.80	7.90	8.02	8.19	22		0
	Temperature Water	ºC	9.62	1.70	7.16	7.51	9.37	12.12	12.35	22		0
	BOD ATU	mg/l	1.01	0.04	1.00	1.00	1.00	1.00	1.01	20	1	17
	Ammonia - as N	mg/l	0.05	0.03	0.03	0.03	0.04	0.08	0.09	22	0.03	3
	Nitrogen Total Oxidised - as N	mg/l	6.50	0.69	5.01	6.01	6.55	7.24	7.30	22		0
	Nitrate	mg/l	6.46	0.72	4.89	5.91	6.53	7.20	7.30	22		0
	Nitrite	mg/l	0.05	0.04	0.01	0.01	0.02	0.10	0.10	16		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22	0.001	10
	Solids Suspended @105C	mg/l	13.10	14.13	3.60	4.00	7.00	21.12	35.88	13	3	1
	Hardness Total	mg/l	321.08	21.06	284.60	297.40	330.00	339.00	340.00	13		0
	Alkalinity pH 4.5	mg/l	260.14	21.79	229.35	237.30	264.50	277.80	280.85	22		0

	Chloride Ion - as Cl	mg/l	20.66	1.57	19.23	19.72	20.80	22.14	22.30	22		0
	Ortho-Phosphate	mg/l	0.11	0.10	0.02	0.03	0.09	0.16	0.16	22	0.02	1
	Copper Dissolved - as Cu	ug/l	2.05	0.72	1.40	1.42	1.80	2.72	3.32	13		0
	Copper - as Cu	ug/l	2.44	1.99	1.42	1.50	1.80	2.70	5.36	13		0
	Zinc - as Zn	ug/l	5.54	2.34	3.60	4.00	5.00	7.80	9.60	13		0
	DO % (Instrumental)	%	90.18	11.42	74.39	78.00	93.50	102.19	102.49	22		0
	DO conc. (Instrumental)	mg/l	10.22	1.43	7.94	8.54	10.39	11.82	12.03	22		0
PKER0053	Lead - as Pb	ug/l	1.32	0.81	0.70	0.72	1.00	1.98	2.78	13		0
	pH - as pH units		8.18	0.10	8.00	8.02	8.20	8.30	8.30	13		0
	Temperature Water	ºC	11.21	3.19	6.38	7.11	11.06	14.95	15.85	13		0
	BOD ATU	mg/l	1.07	0.14	1.00	1.00	1.00	1.20	1.32	13	1	9
	Cadmium - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	13	0.1	13
	Ammonia - as N	mg/l	0.04	0.02	0.03	0.03	0.03	0.05	0.07	13	0.03	8
	Nitrogen Total Oxidised - as N	mg/l	5.22	0.68	4.45	4.63	4.98	5.95	6.34	12		0
	Nitrite	mg/l	0.02	0.01	0.01	0.02	0.02	0.02	0.03	13		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13	0.001	9
	Solids Suspended @105C	mg/l	12.83	9.10	6.08	6.48	10.00	20.56	29.36	13		0
	Hardness Total	mg/l	291.92	16.09	269.20	286.00	290.00	309.00	310.00	13		0
	Alkalinity pH 4.5	mg/l	247.75	22.17	211.40	233.40	254.50	268.80	272.25	12		0
	Chloride Ion - as Cl	mg/l	20.70	1.01	19.14	19.92	20.90	21.95	22.05	12		0
	Ortho-Phosphate	mg/l	0.19	0.06	0.11	0.13	0.18	0.26	0.27	12		0
	Chromium - as Cr	ug/l	0.78	0.41	0.50	0.50	0.50	1.00	1.40	13	1	9
	Copper Dissolved - as Cu	ug/l	1.58	0.36	1.10	1.12	1.60	2.08	2.14	13		0
	Copper - as Cu	ug/l	2.04	0.74	1.42	1.54	1.90	2.48	3.32	13		0
	Zinc - as Zn	ug/l	6.00	2.96	4.00	4.00	5.00	8.60	11.40	13		0
	Nickel - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	13	5	12
	DO % (Instrumental)	%	94.18	6.25	87.10	87.30	93.80	100.84	102.12	13		0
	DO conc. (Instrumental)	mg/l	10.34	1.12	8.78	8.91	10.70	11.70	11.89	13		0
PKER0058	Lead - as Pb	ug/l	1.41	0.81	0.80	0.83	1.15	2.05	2.83	14		0
	pH - as pH units		0.40	0.00	0.40	0.40	0.40	0.40	0.40	14	0.4	14
	Temperature Water	ºC	8.04	0.21	7.73	7.80	8.10	8.27	8.34	14		0
	Temperature Water	CEL	10.25	2.71	6.20	7.05	9.60	13.78	14.38	15		0
	BOD ATU	mg/l	1.26	0.43	1.00	1.00	1.00	2.01	2.10	14	1	10

Mercury - as Hg	ug/l	0.01	0.00	0.01	0.01	0.01	0.01	0.01	13	0.01	12
Cadmium - as Cd	ug/l	0.85	2.46	0.10	0.10	0.10	0.44	3.72	14	0.1	9
Ammonia - as N	mg/l	0.04	0.02	0.03	0.03	0.03	0.06	0.08	14	0.03	8
Nitrogen Total Oxidised - as N	mg/l	5.95	1.53	3.32	4.67	6.24	7.32	7.50	14		0
Nitrate	mg/l	5.93	1.54	3.30	4.65	6.21	7.31	7.49	14		0
Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.02	0.03	14		0
Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13	0.001	6
Solids Suspended @105C	mg/l	8.27	2.87	4.12	4.52	8.40	11.36	12.58	14		0
Hardness Total	mg/l	291.93	15.60	273.05	279.30	290.00	310.00	315.95	14		0
Alkalinity pH 4.5	mg/l	240.79	18.11	213.95	224.40	241.00	256.10	266.45	14		0
Chloride Ion - as Cl	mg/l	20.65	3.92	15.80	17.63	20.05	24.98	27.22	14		0
Ortho-Phosphate	mg/l	0.11	0.04	0.04	0.06	0.11	0.15	0.16	14	0.02	1
Phosphate	mg/l	0.11	0.02	0.07	0.09	0.11	0.14	0.15	14		0
Chromium - as Cr	ug/l	1.06	1.05	0.50	0.50	0.70	1.65	2.78	14	1	7
Zinc Dissolved - as Zn	ug/l	8.00	4.14	2.65	3.30	6.50	13.00	14.05	14		0
Chromium Dissolved - as Cr	ug/l	1.00	0.83	0.50	0.50	0.65	1.51	2.34	14	1	9
Nickel Dissolved - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	14	5	12
Copper Dissolved - as Cu	ug/l	1.95	0.67	1.16	1.22	1.80	2.90	3.06	13		0
Copper - as Cu	ug/l	2.93	0.85	1.50	1.74	3.05	4.00	4.00	14		0
Zinc - as Zn	ug/l	10.07	3.59	5.95	7.00	9.50	14.10	16.40	14		0
Nickel - as Ni	ug/l	5.07	0.26	5.00	5.00	5.00	5.00	5.35	14	5	12
DO % (Instrumental)	%	94.45	5.04	88.41	90.64	92.80	100.66	102.55	15		0
DO conc. (Instrumental)	mg/l	10.60	0.89	9.10	9.36	10.76	11.70	11.72	15		0

PKER0059

Lead - as Pb	ug/l	0.89	0.32	0.47	0.50	0.80	1.36	1.40	15	0.4	1
Lead Dissolved - as Pb	ug/l	0.40	0.00	0.40	0.40	0.40	0.40	0.40	8	0.4	8
pH - as pH units		7.99	0.12	7.90	7.90	8.00	8.18	8.20	23		0
Temperature Water	ºC	505.29	15.69	485.30	487.20	500.50	525.90	531.15	14		0
Temperature Water	CEL	10.11	2.32	6.92	7.00	9.65	13.32	13.85	24		0
BOD ATU	mg/l	1.02	0.10	1.00	1.00	1.00	1.00	1.00	23	1	22
Mercury Dissolved - as Hg	ug/l	0.01	0.00	0.01	0.01	0.01	0.01	0.01	7	0.01	7
Mercury - as Hg	ug/l	0.01	0.00	0.01	0.01	0.01	0.01	0.01	14	0.01	14
Cadmium Dissolved - as Cd	ug/l	0.13	0.07	0.10	0.10	0.10	0.16	0.23	8	0.1	7
Cadmium - as Cd	ug/l	0.19	0.25	0.10	0.10	0.10	0.26	0.54	15	0.1	12

Ammonia - as N	mg/l	0.03	0.01	0.03	0.03	0.03	0.05	0.05	23	0.03	18
Nitrogen Total Oxidised - as N	mg/l	6.27	1.17	5.51	5.92	6.22	7.40	7.72	23		0
Nitrate	mg/l	6.31	1.47	4.38	5.94	6.26	7.62	7.80	14		0
Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.03	0.04	14		0
Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23	0.001	15
Solids Suspended @105C	mg/l	6.04	2.95	3.00	3.00	5.70	10.90	11.19	22	3	6
Hardness Total	mg/l	288.00	9.80	280.00	280.00	280.00	300.00	300.00	5		0
Alkalinity pH 4.5	mg/l	238.14	9.20	225.00	229.00	239.00	248.00	253.00	21		0
Chloride Ion - as Cl	mg/l	18.24	2.99	12.84	16.06	17.80	21.96	23.82	23		0
Ortho-Phosphate	mg/l	0.12	0.04	0.07	0.07	0.11	0.17	0.18	23		0
Phosphate	mg/l	0.14	0.02	0.11	0.11	0.14	0.16	0.17	8		0
Chromium - as Cr	ug/l	1.34	1.15	0.52	0.54	1.00	2.56	3.08	5	1	2
Zinc Dissolved - as Zn	ug/l	6.13	3.02	3.35	3.70	5.00	9.50	11.25	8		0
Nickel Dissolved - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	8	5	7
Copper Dissolved - as Cu	ug/l	1.39	0.24	1.10	1.10	1.40	1.66	1.73	8		0
Copper - as Cu	ug/l	2.06	0.52	1.50	1.50	2.00	2.46	2.80	15		0
Zinc - as Zn	ug/l	7.13	2.12	4.70	5.00	7.00	10.60	11.00	15		0
Nickel - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	15	5	13
DO % (Instrumental)	%	92.76	9.02	77.05	78.41	94.85	102.15	107.33	24		0
DO conc. (Instrumental)	mg/l	10.40	0.89	9.05	9.30	10.45	11.28	11.67	24		0

PKER0063

pH - as pH units		7.92	0.18	7.74	7.80	7.90	8.06	8.19	15		0
Temperature Water	ºC	10.44	1.47	8.34	8.57	10.00	12.39	12.59	15		0
BOD ATU	mg/l	1.00	0.00	1.00	1.00	1.00	1.00	1.00	15	1	15
Ammonia - as N	mg/l	0.03	0.00	0.03	0.03	0.03	0.03	0.04	15	0.03	13
Nitrogen Total Oxidised - as N	mg/l	6.35	1.60	4.43	6.08	6.63	7.43	7.70	15		0
Nitrite	mg/l	0.01	0.01	0.00	0.00	0.01	0.02	0.03	15	0.004	1
Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15	0.001	11
Solids Suspended @105C	mg/l	9.88	8.14	3.00	3.08	7.00	19.52	24.08	15	3	2
Hardness Total	mg/l	276.33	9.21	265.40	266.80	270.00	290.00	290.00	15		0
Alkalinity pH 4.5	mg/l	218.60	8.97	205.10	207.60	220.00	230.20	233.30	15		0
Chloride Ion - as Cl	mg/l	17.22	3.61	12.85	14.50	17.00	21.26	23.30	15		0
Ortho-Phosphate	mg/l	0.05	0.03	0.02	0.02	0.04	0.10	0.12	15	0.02	4
Copper Dissolved - as Cu	ug/l	1.91	0.83	0.94	1.04	1.70	2.72	3.22	15		0

	Copper - as Cu	ug/l	2.63	2.16	1.04	1.26	2.10	3.54	5.79	15		0
	Zinc - as Zn	ug/l	7.33	5.00	2.70	3.40	7.00	10.40	15.60	15	2	1
	DO % (Instrumental)	%	95.96	8.34	80.99	86.04	97.40	106.64	109.09	15		0
	DO conc. (Instrumental)	mg/l	10.68	0.90	9.28	9.95	10.60	11.61	11.82	15		0
PKER0066	pH - as pH units		7.89	0.37	7.60	7.60	7.80	8.16	8.47	15		0
	Temperature Water	ºC	10.79	0.96	9.48	9.78	10.70	12.04	12.30	15		0
	BOD ATU	mg/l	1.00	0.00	1.00	1.00	1.00	1.00	1.00	15	1	15
	Ammonia - as N	mg/l	0.03	0.00	0.03	0.03	0.03	0.04	0.04	15	0.03	12
	Nitrogen Total Oxidised - as N	mg/l	6.84	1.78	4.89	6.89	7.22	7.72	7.94	15		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15	0.001	11
	Alkalinity pH 4.5	mg/l	218.13	10.11	201.60	209.40	220.00	226.20	229.40	15		0
	Chloride Ion - as Cl	mg/l	19.91	2.56	16.73	17.98	19.60	23.92	24.06	15		0
	Ortho-Phosphate	mg/l	0.07	0.06	0.02	0.02	0.05	0.14	0.17	15	0.02	4
	DO % (Instrumental)	%	94.40	6.53	84.55	88.10	94.10	102.66	102.79	15		0
	DO conc. (Instrumental)	mg/l	10.46	0.73	9.50	9.96	10.50	11.37	11.62	15		0
PKER0160	Lead - as Pb	ug/l	2.00	0.00	2.00	2.00	2.00	2.00	2.00	3	2	3
	Lead Dissolved - as Pb	ug/l	2.00	0.00	2.00	2.00	2.00	2.00	2.00	6	2	6
	pH - as pH units		8.01	0.13	7.82	7.89	8.00	8.18	8.21	26		0
	Temperature Water	ºC	9.63	3.20	5.54	5.91	8.68	14.61	14.97	26		0
	BOD ATU	mg/l	1.91	1.40	1.00	1.00	1.50	3.09	4.63	25	1	7
	Cadmium Dissolved - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	6	0.1	6
	Cadmium - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	3	0.1	3
	Ammonia - as N	mg/l	0.30	0.25	0.06	0.07	0.27	0.55	0.75	26		0
	Nitrogen Total Oxidised - as N	mg/l	6.11	0.80	4.81	4.99	6.15	7.08	7.25	26		0
	Nitrate	mg/l	6.42	0.71	5.42	5.73	6.58	7.13	7.26	17		0
	Nitrite	mg/l	0.04	0.02	0.02	0.03	0.04	0.06	0.06	17		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.01	0.01	26		0
	Solids Suspended @105C	mg/l	8.75	9.06	3.62	3.78	5.40	14.00	24.26	13		0
	Alkalinity pH 4.5	mg/l	245.09	16.42	218.60	230.40	246.50	261.90	262.00	22		0
	Chloride Ion - as Cl	mg/l	20.44	2.34	17.74	17.98	20.00	22.72	24.36	9		0
	Ortho-Phosphate	mg/l	0.16	0.16	0.04	0.05	0.09	0.31	0.40	26	0.02	1
	Phosphorus Total - as P	mg/l	0.10	0.02	0.07	0.08	0.10	0.12	0.13	13		0
	Chromium - as Cr	ug/l	0.63	0.19	0.50	0.50	0.50	0.82	0.86	3	0.5	1

	Zinc Dissolved - as Zn	ug/l	5.37	0.73	5.00	5.00	5.00	6.10	6.55	6	5	4
	Chromium Dissolved - as Cr	ug/l	0.52	0.04	0.50	0.50	0.50	0.55	0.58	6	0.5	5
	Nickel Dissolved - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	6	5	6
	Copper Dissolved - as Cu	ug/l	2.50	0.00	2.50	2.50	2.50	2.50	2.50	6	2.5	6
	Copper - as Cu	ug/l	2.87	0.33	2.53	2.56	2.80	3.20	3.25	3	2.5	1
	Zinc - as Zn	ug/l	6.60	1.20	5.19	5.38	6.90	7.70	7.80	3	5	1
	Nickel - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	3	5	3
	DO % (Instrumental)	%	92.42	9.39	83.23	83.90	91.50	105.90	109.33	26		0
	DO conc. (Instrumental)	mg/l	10.57	1.43	8.61	8.84	10.45	12.30	12.30	26		0
PKER0162	pH - as pH units		8.06	0.12	7.96	8.00	8.00	8.18	8.28	13		0
	Temperature Water	ºC	9.53	2.10	6.62	6.93	9.25	12.75	13.05	13		0
	BOD ATU	mg/l	1.01	0.03	1.00	1.00	1.00	1.00	1.05	12	1	11
	Ammonia - as N	mg/l	0.04	0.01	0.03	0.03	0.04	0.05	0.06	13	0.03	4
	Nitrogen Total Oxidised - as N	mg/l	6.10	0.61	5.28	5.55	6.07	6.76	6.99	13		0
	Nitrite	mg/l	0.03	0.02	0.01	0.01	0.02	0.05	0.06	13		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13	0.001	5
	Solids Suspended @105C	mg/l	11.00	5.42	4.08	4.84	10.00	17.92	18.96	13	3	1
	Hardness Total	mg/l	320.15	16.10	291.20	295.60	330.00	335.00	335.80	13		0
	Alkalinity pH 4.5	mg/l	264.00	9.22	248.80	252.00	267.00	269.80	274.40	13		0
	Chloride Ion - as Cl	mg/l	19.95	1.59	17.46	19.26	20.20	21.32	21.70	13		0
	Ortho-Phosphate	mg/l	0.09	0.03	0.05	0.06	0.09	0.12	0.13	13		0
	Copper Dissolved - as Cu	ug/l	1.73	0.24	1.40	1.42	1.70	1.98	2.12	13		0
	Copper - as Cu	ug/l	1.96	0.47	1.48	1.60	1.70	2.68	2.78	13		0
	Zinc - as Zn	ug/l	5.54	2.13	3.00	3.20	5.00	8.00	8.80	13		0
	DO % (Instrumental)	%	91.94	8.02	78.24	80.40	94.90	99.10	100.20	13		0
	DO conc. (Instrumental)	mg/l	10.50	1.12	8.43	8.95	10.90	11.59	11.69	13		0
PKER0263	Lead - as Pb	ug/l	2.00	0.00	2.00	2.00	2.00	2.00	2.00	3	2	3
	Lead Dissolved - as Pb	ug/l	2.00	0.00	2.00	2.00	2.00	2.00	2.00	6	2	6
	pH - as pH units		7.98	0.10	7.84	7.86	7.96	8.12	8.13	26		0
	Temperature Water	ºC	9.51	2.98	5.25	5.66	8.84	14.24	14.36	26		0
	BOD ATU	mg/l	1.40	0.38	1.00	1.00	1.30	1.98	2.10	25	1	7
	Cadmium Dissolved - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	6	0.1	6
	Cadmium - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	3	0.1	3

Ammonia - as N	mg/l	0.07	0.03	0.03	0.03	0.06	0.11	0.12	26	0.03	3
Nitrogen Total Oxidised - as N	mg/l	5.64	0.47	4.96	5.09	5.54	6.29	6.57	26		0
Nitrate	mg/l	5.77	0.47	5.18	5.22	5.69	6.44	6.67	17		0
Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.04	0.04	17		0
Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26	0.001	5
Solids Suspended @105C	mg/l	6.95	2.69	3.92	4.18	6.70	9.02	11.50	13		0
Alkalinity pH 4.5	mg/l	249.45	9.83	230.15	233.90	251.50	258.00	260.85	22		0
Chloride Ion - as Cl	mg/l	18.33	0.61	17.44	17.48	18.50	18.92	19.16	9		0
Ortho-Phosphate	mg/l	0.07	0.05	0.03	0.03	0.04	0.16	0.17	26	0.02	1
Phosphorus Total - as P	mg/l	0.07	0.01	0.05	0.06	0.07	0.08	0.09	13		0
Chromium - as Cr	ug/l	0.67	0.24	0.50	0.50	0.50	0.90	0.95	3	0.5	2
Zinc Dissolved - as Zn	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	6	5	6
Chromium Dissolved - as Cr	ug/l	0.57	0.15	0.50	0.50	0.50	0.70	0.80	6	0.5	5
Nickel Dissolved - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	6	5	6
Copper Dissolved - as Cu	ug/l	2.50	0.00	2.50	2.50	2.50	2.50	2.50	6	2.5	6
Copper - as Cu	ug/l	2.50	0.00	2.50	2.50	2.50	2.50	2.50	3	2.5	3
Zinc - as Zn	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	3	5	3
Nickel - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	3	5	3
DO % (Instrumental)	%	92.22	10.25	80.75	82.10	90.95	106.35	108.33	26		0
DO conc. (Instrumental)	mg/l	10.58	1.61	8.56	8.68	10.65	12.56	12.80	26		0

Table A2.17. Water Quality statistics for the River Kent (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
88004369	pH - as pH units		7.69	0.36	7.13	7.22	7.70	8.15	8.28	66		0
	Conductivity @20C	uS/cm	154.34	21.95	124.10	125.00	155.00	186.80	192.50	35		0
	Temperature Water	ºC	10.22	4.08	3.90	5.35	9.85	15.10	16.00	66		0
	Conductivity @25C	uS/cm	172.44	45.00	123.55	127.20	165.50	212.60	223.95	32		0
	BOD ATU	mg/l	1.52	0.78	1.00	1.00	1.38	2.40	2.83	65	1.43	29
	Ammonia - as N	mg/l	0.04	0.05	0.03	0.03	0.03	0.06	0.11	66	0.03	48
	Nitrogen Total Oxidised - as N	mg/l	1.33	0.36	0.86	0.90	1.28	1.86	2.01	66		0
	Nitrate	mg/l	1.32	0.36	0.86	0.90	1.28	1.86	2.00	66	1.43	4
	Nitrite	mg/l	0.01	0.02	0.00	0.00	0.01	0.01	0.01	66	0.004	16
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66	0.00013	49
	Solids Suspended @105C	mg/l	5.24	6.82	3.00	3.00	3.00	10.00	12.75	66	3	40
	Solids Non-Volatile @500C	mg/l	12.67	4.27	10.00	10.00	10.00	20.00	20.00	12	10	11
	Alkalinity pH 4.5	mg/l	54.76	13.21	36.43	39.30	52.75	68.85	79.75	46		0
	Chloride Ion - as Cl	mg/l	11.78	7.61	7.23	7.47	10.30	15.65	17.60	66		0
	Ortho-Phosphate	mg/l	0.02	0.01	0.01	0.01	0.02	0.03	0.04	66		0
	DO % (Instrumental)	%	100.79	5.49	93.00	93.50	101.00	107.00	109.75	66		0
	DO conc. (Instrumental)	mg/l	11.37	1.15	9.58	10.00	11.30	13.05	13.38	66		0
88004390	pH - as pH units		7.66	0.50	6.92	7.10	7.70	8.17	8.30	68		0
	Conductivity @20C	uS/cm	208.29	40.32	124.65	154.90	213.00	256.40	260.50	34		0
	Temperature Water	ºC	10.34	4.11	4.48	5.64	9.60	15.60	16.83	68		0
	Conductivity @25C	uS/cm	222.67	107.32	103.53	132.90	205.00	285.70	313.20	34		0
	BOD ATU	mg/l	1.46	0.65	1.00	1.00	1.36	1.97	2.68	68	1.9	30
	Ammonia - as N	mg/l	0.05	0.04	0.03	0.03	0.03	0.07	0.08	68	0.03	37
	Nitrogen Total Oxidised - as N	mg/l	2.29	0.68	1.39	1.54	2.26	3.14	3.49	68	0.2	1
	Nitrate	mg/l	2.29	0.66	1.37	1.53	2.26	3.14	3.49	68	0.5	5
	Nitrite	mg/l	0.01	0.01	0.00	0.00	0.01	0.02	0.02	68	0.004	15

Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67	0.00018	36
Solids Suspended @105C	mg/l	6.74	10.41	3.00	3.00	3.00	13.30	19.65	68	3	42
Solids Non-Volatile @500C	mg/l	17.00	16.13	10.00	10.00	10.00	20.00	40.40	13	10	12
Hardness Total	mg/l	9.39	1.32	8.20	8.33	9.39	10.44	10.57	2		0
Alkalinity pH 4.5	mg/l	71.43	27.46	26.76	37.80	69.70	103.60	115.00	48	5	1
Chloride Ion - as Cl	mg/l	16.33	19.77	8.72	9.40	12.30	17.85	26.67	68		0
Ortho-Phosphate	mg/l	0.04	0.02	0.01	0.02	0.03	0.07	0.08	67		0
Phosphorus Total - as P	mg/l	0.09	0.06	0.04	0.04	0.05	0.19	0.19	9		0
Copper Dissolved - as Cu	ug/l	1.94	0.69	1.32	1.39	1.94	2.48	2.55	2		0
Zinc - as Zn	ug/l	32.70	2.90	30.09	30.38	32.70	35.02	35.31	2		0
Orthophosphate Filtered - as P	mg/l	0.04	0.02	0.02	0.02	0.04	0.06	0.08	9		0
DO % (Instrumental)	%	99.42	4.67	94.00	94.60	99.00	103.40	105.00	67		0
DO conc. (Instrumental)	mg/l	11.18	1.18	9.43	9.70	11.10	12.68	13.07	67		0
88004394											
Lead - as Pb	ug/l	1.27	2.23	0.40	0.40	0.47	1.67	4.80	10	0.4	4
Lead Dissolved - as Pb	ug/l	0.40	0.00	0.40	0.40	0.40	0.40	0.40	27	0.4	26
pH - as pH units		7.63	0.46	7.00	7.20	7.60	8.29	8.60	62		0
Conductivity @20C	uS/cm	149.07	31.88	82.46	99.36	157.50	176.70	184.00	34		0
Temperature Water	ºC	10.55	4.15	3.63	5.71	10.05	16.46	17.27	62		0
Conductivity @25C	uS/cm	149.69	41.46	90.70	101.82	151.50	194.30	211.60	28		0
BOD ATU	mg/l	1.53	1.04	1.00	1.00	1.38	1.96	2.49	62	1.43	27
Cadmium Dissolved - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	10	0.1	10
Cadmium - as Cd	ug/l	0.10	0.01	0.10	0.10	0.10	0.10	0.11	10	0.1	9
Ammonia - as N	mg/l	0.04	0.01	0.03	0.03	0.03	0.05	0.05	62	0.03	40
Nitrogen Total Oxidised - as N	mg/l	1.41	0.56	0.61	0.65	1.40	2.14	2.41	62		0
Nitrate	mg/l	1.41	0.56	0.60	0.64	1.40	2.13	2.40	62	0.5	5
Nitrite	mg/l	0.01	0.00	0.00	0.00	0.01	0.01	0.02	62	0.004	10
Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62	0.00025	41
Solids Suspended @105C	mg/l	9.18	23.34	3.00	3.00	3.00	8.90	14.00	62	3	41
Solids Non-Volatile @500C	mg/l	19.00	13.30	10.00	10.00	15.00	29.60	40.80	8	10	7
Hardness Total	mg/l	58.54	17.76	27.32	32.92	67.30	77.60	83.60	25		0

Alkalinity pH 4.5	mg/l	50.42	16.25	29.22	31.92	52.00	71.15	73.88	42		0
Chloride Ion - as Cl	mg/l	10.35	3.43	6.32	6.66	9.63	13.50	15.83	62		0
Ortho-Phosphate	mg/l	0.02	0.01	0.00	0.01	0.02	0.03	0.04	62	0.001	2
Phosphorus Total - as P	mg/l	0.81	5.91	0.02	0.02	0.04	0.10	0.18	62	0.02	5
Chromium - as Cr	ug/l	0.58	0.21	0.50	0.50	0.50	0.63	0.91	10	0.5	8
Zinc Dissolved - as Zn	ug/l	5.23	0.69	5.00	5.00	5.00	5.23	6.27	10	5	9
Chromium Dissolved - as Cr	ug/l	0.61	0.20	0.50	0.50	0.50	0.89	1.10	27	0.5	17
Nickel Dissolved - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	27	5	27
Copper Dissolved - as Cu	ug/l	1.01	0.33	0.67	0.71	0.92	1.41	1.60	27		0
Copper - as Cu	ug/l	1.41	1.08	0.73	0.74	1.01	2.48	3.44	10		0
Zinc - as Zn	ug/l	6.68	4.36	5.00	5.00	5.00	9.49	16.43	27	5	19
Nickel - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	10	5	10
DO % (Instrumental)	%	104.19	8.55	95.00	96.10	102.00	116.00	119.95	62		0
DO conc. (Instrumental)	mg/l	11.63	1.14	9.62	10.11	11.80	12.90	13.40	62		0

Table A2.18. Water Quality statistics for the Lymington River (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
G0004186	pH - as pH units		7.08	0.45	6.53	6.62	7.09	7.61	7.83	57		0
	Conductivity @20C	uS/cm	199.50	36.32	139.50	153.00	199.00	234.30	244.65	10		0
	Temperature Water	ºC	11.00	4.01	4.35	5.93	10.77	16.26	17.41	57		0
	BOD ATU	mg/l	1.65	0.76	1.00	1.00	1.40	2.28	2.71	57	1	7
	Ammonia - as N	mg/l	0.08	0.11	0.03	0.03	0.06	0.13	0.14	57	0.03	8
	Nitrogen Total Oxidised - as N	mg/l	1.72	1.66	0.31	0.35	1.29	3.24	5.48	57	0.2	1
	Nitrate	mg/l	1.70	1.64	0.30	0.34	1.28	3.19	5.43	57		0
	Nitrite	mg/l	0.02	0.02	0.00	0.01	0.01	0.05	0.07	57	0.008	6
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	57	0.0001	11
	Solids Suspended @105C	mg/l	10.66	17.69	3.70	3.77	4.55	19.59	35.31	18		0
	Hardness Total	mg/l	49.18	17.64	26.35	27.54	49.20	69.06	76.78	35		0
	Alkalinity pH 4.5	mg/l	28.83	12.36	15.60	16.80	25.00	44.70	53.30	35	20	7
	Chloride Ion - as Cl	mg/l	31.68	4.46	24.54	25.08	32.00	37.37	38.14	10		0
	Ortho-Phosphate	mg/l	0.33	0.36	0.03	0.04	0.22	0.76	1.17	57	0.02	1
	Zinc Dissolved - as Zn	ug/l	8.65	3.76	5.00	5.00	7.40	14.20	15.98	33	5	6
	Copper Dissolved - as Cu	ug/l	2.67	0.42	2.50	2.50	2.50	3.24	3.68	43	2.5	33
	Copper - as Cu	ug/l	3.06	1.17	2.50	2.50	2.50	4.76	5.00	33	2.5	23
	Zinc - as Zn	ug/l	9.32	4.51	5.00	5.00	7.80	15.40	17.79	43	5	7
	DO % (Instrumental)	%	81.31	11.81	61.94	66.84	81.30	92.48	93.08	57		0
	DO conc. (Instrumental)	mg/l	8.98	1.92	5.64	6.53	8.95	11.07	11.41	34		0
G0004188	pH - as pH units		6.91	0.39	6.22	6.47	6.91	7.44	7.60	55		0
	Conductivity @20C	uS/cm	152.10	5.70	142.50	147.00	154.50	156.30	157.65	10		0
	Temperature Water	ºC	11.12	4.31	3.99	5.62	10.72	16.61	17.89	55		0
	BOD ATU	mg/l	1.27	0.35	1.00	1.00	1.17	1.67	2.06	55	1	19
	Ammonia - as N	mg/l	0.04	0.01	0.03	0.03	0.03	0.05	0.06	55	0.03	24
	Nitrogen Total Oxidised - as N	mg/l	0.27	0.08	0.20	0.20	0.25	0.39	0.43	55	0.2	22

	Nitrate	mg/l	0.26	0.08	0.19	0.19	0.24	0.38	0.43	55	0.192	15
	Nitrite	mg/l	0.01	0.00	0.00	0.00	0.01	0.01	0.01	55	0.004	32
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	55	0.0001	36
	Solids Suspended @105C	mg/l	8.52	15.71	3.00	3.00	4.40	7.50	22.60	17	3	3
	Hardness Total	mg/l	37.15	6.47	25.74	27.74	38.00	44.08	46.54	33		0
	Alkalinity pH 4.5	mg/l	20.19	5.36	11.20	12.28	20.00	26.80	28.96	33	10	10
	Chloride Ion - as Cl	mg/l	26.14	1.75	23.40	23.89	26.20	28.57	28.89	10		0
	Ortho-Phosphate	mg/l	0.02	0.01	0.01	0.01	0.02	0.02	0.03	55	0.02	38
	Zinc Dissolved - as Zn	ug/l	7.17	2.79	5.00	5.00	5.80	11.50	12.50	45	5	16
	Copper Dissolved - as Cu	ug/l	2.24	0.54	1.07	1.24	2.50	2.50	2.50	55	2.5	42
	Copper - as Cu	ug/l	2.28	0.79	1.12	1.30	2.50	2.50	2.58	45	2.5	30
	Zinc - as Zn	ug/l	7.68	3.23	5.00	5.00	6.50	11.50	13.97	55	5	15
	DO % (Instrumental)	%	84.52	9.35	65.23	67.50	85.40	93.10	95.32	55		0
	DO conc. (Instrumental)	mg/l	9.26	1.68	6.18	6.66	9.46	11.16	11.60	33		0
G0004207	pH - as pH units		6.88	0.51	6.10	6.32	6.84	7.50	7.65	52		0
	Conductivity @20C	uS/cm	146.43	7.40	138.20	139.40	146.00	155.00	158.00	7		0
	Temperature Water	ºC	11.04	4.44	3.67	5.22	10.90	16.93	17.91	52		0
	BOD ATU	mg/l	1.28	0.37	1.00	1.00	1.10	1.80	2.05	52	1	22
	Ammonia - as N	mg/l	0.04	0.01	0.03	0.03	0.03	0.05	0.05	52	0.03	32
	Nitrogen Total Oxidised - as N	mg/l	0.27	0.10	0.20	0.20	0.20	0.39	0.47	52	0.2	26
	Nitrate	mg/l	0.26	0.10	0.19	0.19	0.20	0.39	0.46	52	0.192	18
	Nitrite	mg/l	0.01	0.00	0.00	0.00	0.01	0.01	0.01	52	0.004	32
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52	0.0001	38
	Solids Suspended @105C	mg/l	7.41	8.54	3.00	3.00	4.20	15.86	20.64	17	3	5
	Hardness Total	mg/l	30.53	6.60	20.79	22.07	29.65	38.53	41.61	30		0
	Alkalinity pH 4.5	mg/l	17.06	4.28	10.00	10.00	20.00	20.10	21.55	30	10	15
	Chloride Ion - as Cl	mg/l	26.46	1.06	25.46	25.52	26.30	27.66	28.23	7		0
	Ortho-Phosphate	mg/l	0.02	0.01	0.01	0.01	0.02	0.02	0.02	52	0.01	45
	Phosphorus Total - as P	mg/l	0.02	0.01	0.02	0.02	0.02	0.03	0.04	7		0
	Zinc Dissolved - as Zn	ug/l	6.77	2.21	5.00	5.00	5.60	9.40	10.35	31	5	12

Copper Dissolved - as Cu	ug/l	2.52	0.10	2.50	2.50	2.50	2.50	2.50	38	2.5	37
Copper - as Cu	ug/l	2.50	0.00	2.50	2.50	2.50	2.50	2.50	31	2.5	31
Zinc - as Zn	ug/l	6.88	2.36	5.00	5.00	5.50	10.12	11.72	38	5	13
OrthoPhosphate Filtered - as P	mg/l	0.03	0.07	0.01	0.01	0.01	0.07	0.14	8	0.005	4
DO % (Instrumental)	%	87.74	6.27	76.53	80.52	89.00	95.26	96.55	52		0
DO conc. (Instrumental)	mg/l	9.71	1.38	7.68	7.94	9.90	11.38	11.94	33		0

Table A2.19. Water Quality statistics for the River Mease (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
58472140	Lead - as Pb	ug/l	0.94	0.00	0.94	0.94	0.94	0.94	0.94	1		0
	pH - as pH units		7.89	0.23	7.55	7.70	7.90	8.10	8.35	71		0
	Conductivity @20C	uS/cm	820.27	103.07	655.40	682.60	809.00	964.40	977.00	45		0
	Temperature Water	ºC	10.88	4.31	4.00	5.00	11.20	17.00	17.82	70		0
	Conductivity @25C	uS/cm	2.01	0.65	1.28	1.39	1.92	2.75	2.90	70	1.43	6
	DO % (Lab)	%	0.10	0.00	0.10	0.10	0.10	0.10	0.10	1	0.1	1
	DO conc. (lab)	mg/l	0.10	0.08	0.03	0.03	0.07	0.24	0.28	70	0.03	9
	BOD ATU	mg/l	10.73	2.33	7.36	7.61	10.50	13.61	15.38	70		0
	Ammonia - as N	mg/l	10.29	2.40	7.26	7.31	9.95	13.10	15.05	39		0
	Nitrogen Total Oxidised - as N	mg/l	0.09	0.04	0.04	0.04	0.09	0.13	0.15	39		0
	Nitrate	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	69	0.0005	9
	Nitrite	mg/l	8.47	5.17	3.00	3.00	8.00	14.20	17.00	49	3	6
	Ammonia Non-Ionised (Calc.)	mg/l	330.48	40.04	257.50	298.50	337.00	371.00	381.75	46		0
	Alkalinity pH 4.5	mg/l	180.02	17.88	146.40	164.20	179.00	202.80	205.70	47		0
	Chloride Ion - as Cl	mg/l	81.90	21.09	50.48	57.96	77.90	111.30	121.10	70		0
	Ortho-Phosphate	mg/l	0.89	0.66	0.26	0.33	0.73	1.62	2.43	70		0
	Chlorophyll	ug/l	7.33	4.55	2.27	2.61	5.98	14.26	16.96	33		0
	Chromium - as Cr	ug/l	0.64	0.00	0.64	0.64	0.64	0.64	0.64	1		0
	Copper Dissolved - as Cu	ug/l	3.36	0.71	2.51	2.60	3.28	4.08	4.78	70		0
	Copper - as Cu	ug/l	5.11	0.00	5.11	5.11	5.11	5.11	5.11	1		0
	Zinc - as Zn	ug/l	17.24	10.03	8.98	9.60	14.35	27.83	29.98	70		0
	Nickel - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	1	5	1
	DO % (Instrumental)	%	85.15	15.75	63.45	68.90	84.00	105.10	117.30	70		0
	DO conc. (Instrumental)	mg/l	9.51	2.22	6.50	6.95	9.12	12.14	13.32	69		0

58472580	pH - as pH units		7.94	0.28	7.60	7.70	7.90	8.30	8.50	71		0
	Conductivity @20C	uS/cm	853.63	99.70	686.75	708.50	872.00	976.50	991.25	46		0
	Temperature Water	ºC	10.89	4.19	4.50	5.00	11.10	16.90	18.00	71		0
	BOD ATU	mg/l	1.93	0.66	1.29	1.39	1.81	2.69	2.90	71	1.68	10
	Ammonia - as N	mg/l	0.12	0.11	0.03	0.03	0.07	0.29	0.34	71	0.03	11
	Nitrogen Total Oxidised - as N	mg/l	11.08	2.01	7.81	8.58	10.90	13.70	14.45	71		0
	Nitrate	mg/l	10.72	2.10	7.55	8.36	10.50	13.52	13.82	40		0
	Nitrite	mg/l	0.08	0.04	0.03	0.04	0.08	0.13	0.16	40		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	71	0.0006	11
	Solids Suspended @105C	mg/l	7.02	3.88	3.00	3.00	6.00	11.10	13.55	50	3	6
	Hardness Total	mg/l	341.81	42.28	269.55	278.00	348.50	383.90	394.15	48		0
	Alkalinity pH 4.5	mg/l	184.04	22.07	141.80	161.00	184.00	212.30	217.30	48		0
	Chloride Ion - as Cl	mg/l	86.43	21.14	53.55	58.00	87.40	111.00	117.50	71		0
	Ortho-Phosphate	mg/l	0.83	0.77	0.18	0.22	0.50	1.83	2.72	71		0
	Chlorophyll	ug/l	6.50	4.17	2.40	3.00	5.27	11.05	12.85	34		0
	Copper Dissolved - as Cu	ug/l	3.45	0.69	2.52	2.70	3.41	4.38	4.56	71		0
	Zinc - as Zn	ug/l	17.94	8.25	8.55	9.60	15.60	30.30	34.80	71		0
	DO % (Instrumental)	%	90.96	20.86	65.50	72.00	88.00	117.00	130.00	71		0
	DO conc. (Instrumental)	mg/l	10.14	2.56	6.62	7.39	10.00	12.90	14.25	71		0
58473850	pH - as pH units		7.86	0.18	7.50	7.60	7.90	8.10	8.12	57		0
	Conductivity @20C	uS/cm	892.23	41.40	825.20	839.40	894.00	945.60	952.00	13		0
	Temperature Water	ºC	11.35	4.26	4.80	5.60	12.10	17.00	18.92	57		0
	BOD ATU	mg/l	2.21	0.71	1.38	1.43	2.10	3.29	3.59	57	1.43	7
	Ammonia - as N	mg/l	0.17	0.18	0.03	0.04	0.10	0.43	0.54	57	0.03	3
	Nitrogen Total Oxidised - as N	mg/l	11.48	2.02	8.75	9.01	11.30	14.34	14.72	57		0
	Nitrate	mg/l	11.21	2.37	8.01	8.62	10.60	14.25	14.75	26		0
	Nitrite	mg/l	0.12	0.08	0.04	0.04	0.09	0.24	0.26	26		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.01	0.01	57	0.00035	3
	Solids Suspended @105C	mg/l	6.65	2.66	3.00	3.60	6.00	10.00	10.40	17	3	2
	Hardness Total	mg/l	430.51	40.43	373.40	381.00	434.00	487.40	498.90	43		0
	Alkalinity pH 4.5	mg/l	236.50	29.60	185.15	200.10	244.00	262.40	263.85	44		0

	Chloride Ion - as Cl	mg/l	54.78	7.92	41.68	42.12	56.30	63.00	65.70	57		0
	Ortho-Phosphate	mg/l	1.82	1.11	0.41	0.44	1.85	3.27	3.43	57		0
	Chlorophyll	ug/l	5.16	3.17	2.26	2.28	3.39	8.80	10.25	7		0
	Copper Dissolved - as Cu	ug/l	3.39	0.55	2.72	2.79	3.34	4.00	4.23	57		0
	Zinc - as Zn	ug/l	11.73	6.17	5.31	6.06	10.20	19.20	22.28	56	5	2
	DO % (Instrumental)	%	83.74	18.89	46.60	57.80	86.00	108.20	112.20	57		0
	DO conc. (Instrumental)	mg/l	9.32	2.60	4.88	6.06	9.35	12.54	13.10	57		0
58807700	pH - as pH units		7.92	0.19	7.65	7.80	7.90	8.10	8.30	71		0
	Conductivity @20C	uS/cm	886.67	132.01	670.25	734.50	888.50	1060.00	1105.00	46		0
	Temperature Water	ºC	11.40	3.79	6.00	6.00	12.00	16.00	17.50	71		0
	BOD ATU	mg/l	2.46	1.00	1.39	1.39	2.36	3.17	3.30	70	1.39	6
	Ammonia - as N	mg/l	0.20	0.20	0.03	0.04	0.12	0.42	0.51	71	0.03	3
	Nitrogen Total Oxidised - as N	mg/l	12.09	2.58	7.17	9.09	12.00	15.30	16.45	71		0
	Nitrate	mg/l	12.04	2.63	7.11	8.64	12.10	15.24	16.22	37		0
	Nitrite	mg/l	0.12	0.09	0.02	0.03	0.09	0.26	0.30	37		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.01	0.01	71	0.0006	3
	Solids Suspended @105C	mg/l	8.14	4.37	3.00	4.00	7.00	15.00	16.00	50	3	3
	Hardness Total	mg/l	306.56	33.54	234.40	266.30	307.50	339.30	348.95	48		0
	Alkalinity pH 4.5	mg/l	165.46	19.63	140.05	144.10	163.00	195.90	199.65	48		0
	Chloride Ion - as Cl	mg/l	107.01	28.53	68.95	72.50	104.00	140.00	163.00	71		0
	Ortho-Phosphate	mg/l	0.87	1.04	0.10	0.12	0.21	2.32	3.20	71		0
	Chlorophyll	ug/l	10.40	20.49	1.76	1.87	5.18	19.02	22.94	34		0
	Copper Dissolved - as Cu	ug/l	3.39	1.08	1.99	2.35	3.29	4.64	5.53	71		0
	Zinc - as Zn	ug/l	22.11	11.96	9.97	10.50	18.10	40.90	44.55	71		0
	DO % (Instrumental)	%	90.68	9.30	76.50	82.00	90.00	103.00	104.50	71		0
	DO conc. (Instrumental)	mg/l	9.96	1.43	7.91	8.06	9.89	11.90	12.55	71		0

Table A2.20. Water Quality statistics for the Moors River (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
50360406	pH - as pH units		7.58	0.28	7.16	7.27	7.64	7.90	7.93	70		0
	Temperature Water	ºC	11.75	3.57	5.92	7.44	11.90	16.69	17.11	71		0
	BOD ATU	mg/l	1.60	0.61	1.00	1.00	1.48	2.38	2.70	67	1	12
	Ammonia - as N	mg/l	0.05	0.12	0.03	0.03	0.03	0.06	0.07	69	0.03	35
	Nitrogen Total Oxidised - as N	mg/l	5.15	1.61	2.74	3.12	4.94	7.40	7.98	68		0
	Nitrate	mg/l	5.13	1.61	2.72	3.11	4.89	7.38	7.96	68		0
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.04	0.04	68		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	68	0.0002	36
	Hardness Total	mg/l	185.28	30.74	128.00	145.00	193.50	221.50	227.00	46		0
	Alkalinity pH 4.5	mg/l	137.81	27.55	85.10	105.40	143.00	168.00	174.60	43		0
	Hardness Calcium	mg/l	191.80	43.67	124.70	142.65	212.25	222.90	225.20	5		0
	Hardness Magnesium	mg/l	10.21	0.83	8.94	9.27	10.54	10.82	10.82	5		0
	Ortho-Phosphate	mg/l	0.05	0.03	0.02	0.02	0.04	0.07	0.08	68	0.02	6
	Chlorophyll-A	ug/l	6.18	6.05	1.47	1.50	4.30	12.42	14.99	35		0
	Nitrogen Total Inorganic (Calculated)	mg/l	5.21	1.61	2.79	3.16	5.04	7.43	8.01	68		0
	Copper Dissolved - as Cu	ug/l	2.46	0.47	1.53	2.50	2.50	2.50	2.50	58	2.5	54
	Zinc - as Zn	ug/l	14.59	7.45	5.00	5.37	13.40	24.59	29.12	58	5	5
	DO % (Instrumental)	%	84.50	13.75	62.04	65.58	86.60	101.22	104.00	70		0
	DO conc. (Instrumental)	mg/l	9.26	1.89	6.20	6.73	9.57	11.60	11.91	70		0
50360477	pH - as pH units		7.72	0.34	7.05	7.29	7.80	8.05	8.09	68		0
	Temperature Water	ºC	11.38	3.00	6.36	7.54	11.80	15.10	15.71	69		0
	BOD ATU	mg/l	1.63	1.04	1.00	1.00	1.40	2.23	3.25	68	1	8
	Ammonia - as N	mg/l	0.06	0.07	0.03	0.03	0.04	0.10	0.14	68	0.03	23
	Nitrogen Total Oxidised - as N	mg/l	7.53	1.65	4.87	5.54	7.54	9.74	10.10	68		0
	Nitrate	mg/l	7.51	1.65	4.84	5.53	7.51	9.72	10.10	68		0
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.03	0.04	68		0

Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	68	0.0005	26
Hardness Total	mg/l	237.06	34.22	168.65	187.00	249.50	267.10	272.15	18		0
Alkalinity pH 4.5	mg/l	179.26	35.36	122.50	138.40	189.00	204.00	207.90	43	20	1
Hardness Calcium	mg/l	256.25	6.25	250.63	251.25	256.25	261.25	261.88	2		0
Hardness Magnesium	mg/l	10.41	0.20	10.23	10.25	10.41	10.58	10.60	2		0
Ortho-Phosphate	mg/l	0.14	0.17	0.03	0.04	0.10	0.24	0.25	68		0
Chlorophyll-A	ug/l	4.15	2.17	1.33	1.56	3.65	6.49	8.30	34		0
Nitrogen Total Inorganic (Calculated)	mg/l	7.59	1.64	4.99	5.60	7.60	9.78	10.10	68		0
Copper Dissolved - as Cu	ug/l	2.33	0.53	1.14	1.30	2.50	2.50	2.74	25	2.5	20
Zinc - as Zn	ug/l	12.66	4.77	7.86	8.14	11.90	18.58	21.50	25		0
DO % (Instrumental)	%	90.98	7.13	79.87	81.02	90.20	100.00	101.33	68		0
DO conc. (Instrumental)	mg/l	10.00	1.25	8.42	8.55	9.87	11.90	12.07	68		0

Table A2.21. Water Quality statistics for the River Nar (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
58M02	pH - as pH units		7.80	0.24	7.41	7.60	7.80	8.11	8.20	63		0
	Conductivity @20C	uS/cm	637.21	46.97	616.65	618.90	644.00	664.60	675.75	34		0
	Temperature Water	ºC	10.18	3.75	3.90	5.00	10.55	15.00	15.40	66		0
	Conductivity @25C	uS/cm	707.49	40.27	628.00	687.00	723.00	733.00	738.30	35		0
	DO % (Lab)	%	78.36	18.54	51.30	61.95	79.50	102.40	104.40	14		0
	DO conc. (lab)	mg/l	9.15	2.69	5.17	6.05	9.25	12.62	13.08	14		0
	BOD ATU	mg/l	1.35	0.43	1.00	1.00	1.20	1.92	2.06	69	1	23
	Ammonia - as N	mg/l	0.06	0.06	0.03	0.03	0.04	0.07	0.12	69	0.03	14
	Nitrogen Total Oxidised - as N	mg/l	6.32	1.86	3.83	4.14	6.06	8.62	10.30	69		0
	Nitrate	mg/l	6.44	2.05	3.75	4.08	6.20	8.81	10.94	34		0
	Nitrite	mg/l	0.03	0.02	0.02	0.02	0.02	0.05	0.06	34		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63	0.001	14
	Alkalinity pH 4.5	mg/l	279.67	31.44	218.70	238.30	282.00	311.20	313.80	12		0
	Chloride Ion - as Cl	mg/l	40.60	45.78	29.78	30.38	34.40	39.24	43.64	69		0
	Ortho-Phosphate	mg/l	0.11	0.05	0.06	0.06	0.10	0.16	0.21	69		0
	Nitrogen Total Inorganic (Calc.)	mg/l	5.65	1.32	4.10	4.19	5.76	7.08	7.27	7		0
	DO % (Instrumental)	%	79.50	12.78	64.15	65.50	76.80	99.60	101.10	51		0
	DO conc. (Instrumental)	mg/l	8.96	1.83	6.46	6.94	8.73	11.95	12.51	30		0
58M03	pH - as pH units		7.83	0.20	7.57	7.60	7.80	8.09	8.10	54		0
	Conductivity @20C	uS/cm	742.75	76.66	672.10	686.40	727.50	833.90	914.75	24		0
	Temperature Water	ºC	10.20	3.80	4.54	4.96	10.00	15.00	15.92	57		0
	Conductivity @25C	uS/cm	787.36	64.01	676.25	728.47	798.00	843.50	849.25	36		0
	DO % (Lab)	%	82.99	13.12	64.08	68.18	81.30	94.31	101.96	14		0
	DO conc. (lab)	mg/l	9.59	2.03	7.08	7.69	9.45	11.82	12.70	14		0
	BOD ATU	mg/l	1.48	0.50	1.00	1.00	1.30	2.01	2.51	60	1	13
	Ammonia - as N	mg/l	0.10	0.05	0.05	0.05	0.08	0.17	0.19	60	0.03	2
	Nitrogen Total Oxidised - as N	mg/l	8.36	2.01	5.26	5.77	8.72	10.81	11.32	60		0
	Nitrate	mg/l	8.24	2.41	4.90	5.34	8.62	11.51	12.03	24		0

	Nitrite	mg/l	0.06	0.03	0.03	0.03	0.05	0.08	0.09	24		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54	0.0003	2
	Alkalinity pH 4.5	mg/l	281.00	22.24	241.10	244.80	286.00	310.20	313.35	12		0
	Chloride Ion - as Cl	mg/l	50.71	11.59	37.18	39.57	48.50	66.02	76.55	60		0
	Ortho-Phosphate	mg/l	0.14	0.17	0.06	0.07	0.10	0.16	0.28	60		0
	Phosphorus Total - as P	mg/l	0.08	0.01	0.08	0.08	0.08	0.09	0.09	2		0
	Nitrogen Total Inorganic (Calc.)	mg/l	9.54	0.96	8.39	8.61	9.11	10.86	10.98	7		0
	Phosphorus Total	ug/l	157.31	73.23	81.55	87.40	136.50	255.90	333.80	58		0
	DO % (Instrumental)	%	79.19	12.14	61.00	63.21	80.05	93.68	100.26	42		0
	DO conc. (Instrumental)	mg/l	8.90	1.95	6.74	6.93	8.39	10.74	12.93	20		0
58M04	pH - as pH units		7.98	0.24	7.60	7.70	8.00	8.20	8.30	51		0
	Conductivity @20C	uS/cm	664.67	30.64	618.00	626.00	665.00	699.00	710.00	21		0
	Temperature Water	ºC	10.74	4.40	4.27	4.72	9.90	16.00	17.39	54		0
	Conductivity @25C	uS/cm	749.32	33.32	686.20	712.60	754.00	779.20	794.30	35		0
	DO % (Lab)	%	89.38	9.75	73.40	76.99	90.75	101.27	104.70	14		0
	DO conc. (lab)	mg/l	10.30	1.76	7.48	8.17	10.60	12.41	12.98	14		0
	BOD ATU	mg/l	1.46	0.48	1.00	1.00	1.30	2.10	2.32	57	1	19
	Ammonia - as N	mg/l	0.05	0.03	0.03	0.03	0.04	0.09	0.11	56	0.03	17
	Nitrogen Total Oxidised - as N	mg/l	6.45	2.54	2.58	2.73	6.74	9.73	10.00	56		0
	Nitrate	mg/l	5.65	2.81	2.55	2.55	4.07	9.73	10.30	21		0
	Nitrite	mg/l	0.04	0.03	0.01	0.01	0.03	0.07	0.12	21		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50	0.001	17
	Alkalinity pH 4.5	mg/l	267.08	11.76	249.50	254.20	268.50	277.70	282.95	12		0
	Chloride Ion - as Cl	mg/l	42.47	4.49	38.25	38.70	41.50	46.30	50.23	56		0
	Ortho-Phosphate	mg/l	0.10	0.24	0.03	0.04	0.07	0.11	0.12	56		0
	Phosphorus Total - as P	mg/l	0.05	0.01	0.03	0.03	0.05	0.06	0.06	4		0
	Nitrogen Total Inorganic (Calc.)	mg/l	7.17	1.58	5.24	5.34	6.90	8.95	9.04	7		0
	Phosphorus Total	ug/l	0.03	0.01	0.02	0.02	0.03	0.04	0.04	5		0
	DO % (Instrumental)	%	87.27	10.30	72.54	75.68	86.80	98.44	100.51	39		0
	DO conc. (Instrumental)	mg/l	9.67	1.74	7.26	7.35	10.20	11.66	12.34	17		0
58M05	pH - as pH units		7.84	0.21	7.52	7.60	7.90	8.10	8.13	64		0
	Conductivity @20C	uS/cm	656.61	11.01	642.00	644.40	655.00	672.00	672.40	33		0

	Temperature Water	ºC	10.75	3.28	5.44	6.58	10.70	14.98	16.00	67		0
	Conductivity @25C	uS/cm	722.58	21.78	676.75	696.00	725.00	745.00	750.50	36		0
	DO % (Lab)	%	98.31	10.87	82.24	84.31	99.45	112.90	115.00	14		0
	DO conc. (lab)	mg/l	11.21	1.08	9.65	10.09	11.10	12.58	12.74	14		0
	BOD ATU	mg/l	1.23	0.30	1.00	1.00	1.10	1.70	1.86	69	1	30
	Ammonia - as N	mg/l	0.03	0.01	0.03	0.03	0.03	0.04	0.05	69	0.03	53
	Nitrogen Total Oxidised - as N	mg/l	9.21	0.86	8.06	8.25	9.37	10.30	10.40	69		0
	Nitrate	mg/l	9.36	0.80	8.19	8.37	9.43	10.38	10.44	33		0
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.02	0.03	33		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64	0.001	51
	Alkalinity pH 4.5	mg/l	261.08	6.85	252.40	256.00	259.50	272.40	273.00	12		0
	Chloride Ion - as Cl	mg/l	37.96	4.37	34.64	35.46	37.20	40.52	42.76	69		0
	Ortho-Phosphate	mg/l	0.06	0.02	0.03	0.03	0.06	0.10	0.11	69		0
	Phosphorus Total - as P	mg/l	0.05	0.02	0.02	0.03	0.05	0.06	0.07	16		0
	Nitrogen Total Inorganic (Calc.)	mg/l	8.91	0.60	8.22	8.24	8.88	9.66	9.69	7		0
	Phosphorus Total	ug/l	81.24	33.35	48.25	51.40	71.50	115.60	173.45	58		0
	Ortho-Phosphate filtered – as P	mg/l	0.04	0.01	0.02	0.02	0.04	0.05	0.06	16		0
	DO % (Instrumental)	%	99.25	16.34	78.63	82.71	99.50	115.31	118.94	52		0
	DO conc. (Instrumental)	mg/l	11.02	1.75	8.74	9.18	11.50	12.16	12.81	30		0
	pH - as pH units		8.12	0.22	7.71	7.80	8.20	8.30	8.39	63		0
	Conductivity @20C	uS/cm	580.64	28.30	547.40	550.40	579.00	614.80	624.80	33		0
	Temperature Water	ºC	11.70	4.62	5.03	5.70	11.19	17.95	18.88	66		0
	Conductivity @25C	uS/cm	656.18	28.13	616.10	623.60	656.00	690.00	703.10	35		0
	DO % (Lab)	%	99.44	11.15	83.05	87.56	99.00	113.10	115.75	14		0
	DO conc. (lab)	mg/l	11.30	1.62	8.90	9.16	11.65	13.17	13.52	14		0
58M09	BOD ATU	mg/l	1.34	0.34	1.00	1.00	1.20	1.83	2.00	68	1	16
	Ammonia - as N	mg/l	0.04	0.01	0.03	0.03	0.03	0.06	0.07	68	0.03	39
	Nitrogen Total Oxidised - as N	mg/l	8.36	1.10	6.69	6.98	8.26	9.62	10.18	68		0
	Nitrate	mg/l	8.25	1.11	6.58	6.97	8.09	9.38	10.34	33		0
	Nitrite	mg/l	0.04	0.01	0.02	0.02	0.03	0.05	0.06	33		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62	0.001	37
	Alkalinity pH 4.5	mg/l	224.08	14.80	200.10	210.20	226.50	239.60	241.80	12		0

Chloride Ion - as Cl	mg/l	34.15	2.97	30.94	31.17	33.80	37.03	39.20	68		0
Ortho-Phosphate	mg/l	0.05	0.02	0.02	0.02	0.04	0.07	0.09	68	0.02	6
Phosphorus Total - as P	mg/l	0.06	0.03	0.02	0.03	0.05	0.07	0.10	15		0
Nitrogen Total Inorganic (Calc.)	mg/l	8.01	0.65	7.14	7.26	8.15	8.80	8.87	7		0
Ortho-Phosphate filtered – as P	mg/l	0.04	0.01	0.02	0.02	0.04	0.05	0.06	17		0
DO % (Instrumental)	%	98.52	16.49	73.16	79.28	95.50	119.10	128.89	52		0
DO conc. (Instrumental)	mg/l	10.89	1.64	7.95	8.80	11.05	12.70	12.76	30		0

Table A2.22. Water Quality statistics for the River Test (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
G0003900	Lead - as Pb	ug/l	2.00	0.00	2.00	2.00	2.00	2.00	2.00	15	2	14
	Lead Dissolved - as Pb	ug/l	2.00	0.00	2.00	2.00	2.00	2.00	2.00	15	2	15
	pH - as pH units		7.87	0.13	7.72	7.73	7.84	8.07	8.10	27		0
	Conductivity @20C	uS/cm	508.04	17.24	497.00	497.60	509.00	525.40	527.40	27		0
	Temperature Water	ºC	11.41	3.60	5.91	7.06	11.10	16.33	16.53	27		0
	BOD ATU	mg/l	1.10	0.15	1.00	1.00	1.00	1.26	1.37	27	1	13
	Mercury Dissolved - as Hg	ug/l	0.04	0.06	0.01	0.01	0.01	0.12	0.17	14	0.01	10
	Mercury - as Hg	ug/l	0.03	0.07	0.01	0.01	0.01	0.05	0.12	15	0.01	11
	Cadmium Dissolved - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	15	0.1	15
	Cadmium - as Cd	ug/l	0.10	0.00	0.10	0.10	0.10	0.10	0.10	15	0.1	15
	Ammonia - as N	mg/l	0.04	0.01	0.03	0.03	0.03	0.05	0.06	27	0.03	12
	Nitrogen Kjeldahl - as N	mg/l	0.59	0.16	0.50	0.50	0.50	0.84	0.97	15	0.5	10
	Nitrogen Total Oxidised - as N	mg/l	7.13	0.66	6.04	6.20	7.29	7.88	8.09	27		0
	Nitrate	mg/l	7.11	0.66	6.02	6.18	7.27	7.86	8.07	27		0
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.02	0.03	27		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27	0.0005	12
	Solids Suspended @105C	mg/l	9.06	5.72	3.00	3.00	7.20	16.42	17.94	27	3	5
	Hardness Total	mg/l	288.92	10.86	273.90	282.00	288.00	303.00	303.00	12		0
	Alkalinity pH 4.5	mg/l	228.92	9.30	211.65	214.00	232.50	236.80	239.70	12		0
	Chloride Ion - as Cl	mg/l	21.16	0.84	19.93	20.06	21.00	22.26	22.57	27		0
	Ortho-Phosphate	mg/l	0.06	0.02	0.03	0.04	0.06	0.09	0.09	27		0
	Phosphate	mg/l	0.07	0.02	0.04	0.04	0.07	0.10	0.11	27		0
	Chlorophyll	ug/l	3.21	0.64	2.58	2.63	3.04	3.86	3.96	3		0
	Phaeophytin B	ug/l	0.60	0.15	0.50	0.50	0.50	0.75	0.78	3		0
	Chromium - as Cr	ug/l	0.81	0.63	0.50	0.50	0.50	1.62	2.14	15	0.5	10
	Zinc Dissolved - as Zn	ug/l	6.47	4.21	5.00	5.00	5.00	10.16	13.38	27	5	22

	Chromium Dissolved - as Cr	ug/l	1.79	3.51	0.50	0.50	0.50	1.86	5.77	15	0.5	8
	Nickel Dissolved - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	15	5	15
	Chlorophyll B	ug/l	0.50	0.00	0.50	0.50	0.50	0.50	0.50	3	0.5	3
	Copper Dissolved - as Cu	ug/l	2.11	0.90	1.00	1.00	2.50	2.50	2.78	27	2.5	20
	Copper - as Cu	ug/l	2.30	0.84	1.03	1.22	2.50	2.78	3.95	27	2.5	16
	Zinc - as Zn	ug/l	8.98	9.86	5.00	5.00	5.00	21.56	22.36	27	5	18
	Nickel - as Ni	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	15	5	15
	DO % (Instrumental)	%	91.21	7.25	80.60	81.62	91.30	101.40	103.99	27		0
	DO conc. (Instrumental)	mg/l	10.07	1.10	8.40	8.71	10.40	11.36	11.54	12		0
G0003902	pH - as pH units		7.90	0.22	7.59	7.63	7.89	8.18	8.19	46		0
	Conductivity @20C	uS/cm	497.90	37.18	435.55	480.10	509.50	521.60	524.30	10		0
	Temperature Water	ºC	11.65	3.17	6.72	7.17	11.02	15.74	16.31	46		0
	BOD ATU	mg/l	1.24	0.28	1.00	1.00	1.20	1.60	1.78	46	1	13
	Ammonia - as N	mg/l	0.03	0.01	0.03	0.03	0.03	0.05	0.05	46	0.03	36
	Nitrogen Total Oxidised - as N	mg/l	7.20	0.63	6.47	6.49	7.16	8.08	8.38	46		0
	Nitrate	mg/l	7.18	0.63	6.45	6.47	7.14	8.06	8.37	46		0
	Nitrite	mg/l	0.02	0.00	0.01	0.01	0.02	0.03	0.03	46		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	46	0.0004	36
	Hardness Total	mg/l	289.17	14.32	276.70	282.00	292.00	299.60	300.60	35		0
	Alkalinity pH 4.5	mg/l	229.97	13.67	213.80	217.80	232.00	240.60	241.90	35		0
	Chloride Ion - as Cl	mg/l	19.58	1.25	17.41	17.81	19.95	20.81	20.86	10		0
	Ortho-Phosphate	mg/l	0.06	0.02	0.04	0.04	0.06	0.09	0.10	46		0
	Zinc Dissolved - as Zn	ug/l	5.07	0.39	5.00	5.00	5.00	5.00	5.00	36	5	35
	Copper Dissolved - as Cu	ug/l	2.41	0.35	1.53	2.50	2.50	2.50	2.50	46	2.5	45
	Copper - as Cu	ug/l	2.48	0.44	2.25	2.50	2.50	2.50	2.50	36	2.5	34
	Zinc - as Zn	ug/l	6.23	6.87	5.00	5.00	5.00	5.00	5.30	46	5	42
	DO % (Instrumental)	%	98.25	13.22	82.45	84.15	96.60	114.50	120.93	46		0
	DO conc. (Instrumental)	mg/l	10.78	1.10	9.37	9.39	10.80	11.50	13.21	23		0
G0003929	pH - as pH units		7.94	0.18	7.67	7.72	7.90	8.18	8.25	55		0
	Conductivity @20C	uS/cm	510.70	9.74	495.20	502.40	513.50	521.00	521.00	10		0
	Temperature Water	ºC	10.88	2.55	6.74	7.10	11.14	14.41	14.67	57		0

	BOD 5 Day ATU Filtrate - as O	mg/l	1.00	0.00	1.00	1.00	1.00	1.00	1.00	15	1	15
	BOD ATU	mg/l	1.24	0.28	1.00	1.00	1.15	1.54	1.90	57	1	9
	Ammonia - as N	mg/l	0.03	0.00	0.03	0.03	0.03	0.03	0.04	57	0.03	48
	Nitrogen Total Oxidised - as N	mg/l	6.96	0.45	6.26	6.39	6.98	7.51	7.63	57		0
	Nitrate	mg/l	6.94	0.45	6.23	6.37	6.96	7.49	7.62	57		0
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.01	0.02	0.02	57		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	55	0.0005	46
	Hardness Total	mg/l	286.26	7.40	274.20	279.30	289.00	294.00	294.00	34		0
	Alkalinity pH 4.5	mg/l	238.54	5.86	229.80	233.00	238.00	245.60	246.90	35		0
	Chloride Ion - as Cl	mg/l	20.68	1.59	18.14	18.68	20.70	22.22	22.76	10		0
	Ortho-Phosphate	mg/l	0.07	0.02	0.04	0.04	0.07	0.10	0.11	57		0
	Zinc Dissolved - as Zn	ug/l	5.00	0.00	5.00	5.00	5.00	5.00	5.00	32	5	32
	Copper Dissolved - as Cu	ug/l	2.46	0.23	2.50	2.50	2.50	2.50	2.50	42	2.5	42
	Copper - as Cu	ug/l	2.64	0.89	2.50	2.50	2.50	2.50	3.09	32	2.5	30
	Zinc - as Zn	ug/l	5.11	0.63	5.00	5.00	5.00	5.00	5.00	42	5	39
	DO % (Instrumental)	%	106.67	15.31	88.30	89.68	105.50	123.70	131.32	57		0
	DO conc. (Instrumental)	mg/l	11.95	1.52	9.98	10.34	11.80	13.54	14.55	35		0
G0003935	pH - as pH units		7.75	0.16	7.52	7.56	7.76	7.93	7.98	56		0
	Conductivity @20C	uS/cm	534.70	13.75	512.75	528.50	536.00	548.10	548.55	10		0
	Temperature Water	ºC	11.14	2.27	7.32	7.77	11.43	14.04	14.51	58		0
	BOD 5 Day ATU Filtrate - as O	mg/l	1.00	0.00	1.00	1.00	1.00	1.00	1.00	18	1	18
	BOD ATU	mg/l	1.25	0.30	1.00	1.00	1.20	1.53	1.66	58	1	15
	Ammonia - as N	mg/l	0.04	0.01	0.03	0.03	0.03	0.05	0.06	58	0.03	32
	Nitrogen Total Oxidised - as N	mg/l	6.71	0.61	5.69	5.82	6.76	7.64	7.72	58		0
	Nitrate	mg/l	6.69	0.61	5.67	5.80	6.73	7.63	7.71	58		0
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.03	0.04	58		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56	0.0003	32
	Hardness Total	mg/l	289.14	6.05	279.80	282.40	290.00	295.00	297.30	35		0
	Alkalinity pH 4.5	mg/l	244.33	8.55	230.75	234.50	246.00	254.50	257.00	36		0
	Chloride Ion - as Cl	mg/l	23.96	3.16	19.78	21.35	22.85	28.19	28.60	10		0
	Ortho-Phosphate	mg/l	0.10	0.04	0.04	0.05	0.09	0.15	0.17	58		0

	Zinc Dissolved - as Zn	ug/l	5.26	0.73	5.00	5.00	5.00	5.98	7.04	47	5	40
	Copper Dissolved - as Cu	ug/l	2.27	0.45	1.18	1.56	2.50	2.50	2.50	57	2.5	42
	Copper - as Cu	ug/l	2.38	0.58	1.36	1.56	2.50	2.50	2.50	47	2.5	30
	Zinc - as Zn	ug/l	5.58	2.10	5.00	5.00	5.00	5.00	11.72	57	5	51
	DO % (Instrumental)	%	100.24	12.73	82.69	84.00	98.90	118.39	120.93	58		0
	DO conc. (Instrumental)	mg/l	11.10	1.28	9.19	9.54	11.10	12.60	13.22	35		0
G0003943	pH - as pH units		7.62	0.17	7.31	7.40	7.64	7.85	7.86	56		0
	Conductivity @20C	uS/cm	578.00	33.29	529.65	546.30	571.50	610.10	624.05	10		0
	Temperature Water	ºC	11.97	2.09	8.53	9.11	12.42	14.65	15.15	58		0
	BOD 5 Day ATU Filtrate - as O	mg/l	1.00	0.00	1.00	1.00	1.00	1.00	1.00	18	1	18
	BOD ATU	mg/l	1.36	0.33	1.00	1.00	1.30	1.82	1.95	58	1	5
	Ammonia - as N	mg/l	0.10	0.06	0.03	0.03	0.09	0.18	0.21	58	0.03	6
	Nitrogen Total Oxidised - as N	mg/l	5.97	1.05	4.21	4.46	6.10	7.27	7.55	58		0
	Nitrate	mg/l	5.94	1.06	4.17	4.42	6.07	7.22	7.53	58		0
	Nitrite	mg/l	0.04	0.02	0.01	0.01	0.03	0.06	0.07	58		0
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56	0.0003	6
	Solids Suspended @105C	mg/l	4.20	1.22	3.00	3.00	4.00	6.12	6.40	17	3	4
	Hardness Total	mg/l	293.69	7.98	273.80	285.40	295.00	300.00	301.20	35		0
	Alkalinity pH 4.5	mg/l	261.72	16.16	240.00	242.50	260.00	282.50	285.50	36		0
	Chloride Ion - as Cl	mg/l	31.87	8.67	21.37	23.44	27.60	41.45	44.83	10		0
	Ortho-Phosphate	mg/l	0.19	0.10	0.07	0.08	0.17	0.32	0.36	58		0
	Zinc Dissolved - as Zn	ug/l	5.57	1.59	5.00	5.00	5.00	6.60	9.16	47	5	37
	Copper Dissolved - as Cu	ug/l	2.58	0.45	1.96	2.42	2.50	3.24	3.60	57	2.5	38
	Copper - as Cu	ug/l	3.12	1.73	2.12	2.50	2.50	4.40	4.68	47	2.5	23
	Zinc - as Zn	ug/l	6.30	3.59	5.00	5.00	5.00	10.42	13.76	57	5	42
	DO % (Instrumental)	%	91.74	10.58	77.33	79.74	89.05	107.90	110.82	58		0
	DO conc. (Instrumental)	mg/l	9.77	1.04	8.33	8.61	9.57	11.02	11.55	35		0
G0003947	pH - as pH units		7.23	0.26	6.69	7.02	7.25	7.48	7.57	55		0
	Conductivity @20C	uS/cm	526.70	6.10	519.00	519.00	527.00	531.90	535.95	10		0
	Temperature Water	ºC	10.43	2.04	8.09	8.33	10.72	12.39	13.42	57		0
	BOD 5 Day ATU Filtrate - as O	mg/l	1.00	0.00	1.00	1.00	1.00	1.00	1.00	18	1	18

	BOD ATU	mg/l	1.09	0.23	1.00	1.00	1.00	1.24	1.40	57	1	40
	Ammonia - as N	mg/l	0.03	0.00	0.03	0.03	0.03	0.03	0.04	57	0.03	51
	Nitrogen Total Oxidised - as N	mg/l	7.64	0.50	6.97	7.04	7.59	8.20	8.74	57		0
	Nitrate	mg/l	7.63	0.50	6.96	7.03	7.57	8.19	8.72	57		0
	Nitrite	mg/l	0.01	0.01	0.00	0.00	0.01	0.02	0.02	57	0.004	25
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	55	0.0002	52
	Hardness Total	mg/l	290.79	49.98	274.50	284.00	302.00	307.00	308.60	35		0
	Alkalinity pH 4.5	mg/l	243.72	8.72	226.00	229.00	246.00	254.00	255.00	36		0
	Chloride Ion - as Cl	mg/l	18.80	1.01	17.47	17.74	18.95	19.40	20.30	10		0
	Ortho-Phosphate	mg/l	0.03	0.01	0.02	0.02	0.03	0.04	0.04	57	0.02	16
	Phosphorus Total - as P	mg/l	0.04	0.07	0.01	0.01	0.02	0.03	0.08	18		0
	Zinc Dissolved - as Zn	ug/l	5.31	1.47	5.00	5.00	5.00	5.00	5.00	46	5	43
	Copper Dissolved - as Cu	ug/l	2.17	0.61	1.00	1.00	2.50	2.50	2.50	56	2.5	53
	Copper - as Cu	ug/l	2.25	1.13	1.00	1.00	2.50	2.50	2.50	46	2.5	40
	Zinc - as Zn	ug/l	5.44	1.53	5.00	5.00	5.00	5.00	8.63	56	5	50
	OrthoPhosphate Filtered - as P	mg/l	0.02	0.01	0.01	0.01	0.02	0.03	0.03	18	0.004	1
	DO % (Instrumental)	%	88.98	13.19	73.92	76.84	86.30	103.00	110.36	57		0
	DO conc. (Instrumental)	mg/l	9.86	1.40	8.30	8.34	9.60	11.51	12.26	34		0
G0003976	pH - as pH units		7.48	0.21	7.11	7.21	7.49	7.70	7.74	56		0
	Conductivity @20C	uS/cm	524.38	62.07	505.25	508.00	517.50	527.30	530.15	58		0
	Temperature Water	ºC	10.57	1.79	7.71	7.96	10.80	12.79	12.98	58		0
	BOD ATU	mg/l	1.10	0.24	1.00	1.00	1.00	1.33	1.64	58	1	37
	Ammonia - as N	mg/l	0.03	0.03	0.03	0.03	0.03	0.03	0.04	58	0.03	48
	Nitrogen Total Oxidised - as N	mg/l	7.48	0.63	6.73	6.86	7.49	8.20	8.49	58		0
	Nitrate	mg/l	7.47	0.64	6.73	6.86	7.48	8.19	8.48	58		0
	Nitrite	mg/l	0.01	0.01	0.00	0.00	0.01	0.01	0.02	58	0.004	18
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56	0.0002	50
	Hardness Total	mg/l	295.46	6.85	284.00	284.80	297.00	304.00	304.30	35		0
	Alkalinity pH 4.5	mg/l	242.42	17.67	223.50	227.00	242.00	249.50	252.25	36		0
	Chloride Ion - as Cl	mg/l	19.87	15.15	17.00	17.20	17.65	18.66	19.52	58		0
	Ortho-Phosphate	mg/l	0.04	0.13	0.02	0.02	0.02	0.04	0.04	58	0.02	17

	Copper Dissolved - as Cu	ug/l	2.19	0.68	1.00	1.00	2.50	2.50	2.50	57	2.5	52
	Zinc - as Zn	ug/l	5.78	3.50	5.00	5.00	5.00	5.00	8.54	57	5	51
	DO % (Instrumental)	%	93.86	11.53	76.49	80.77	92.70	108.65	112.41	58		0
G0004098	pH - as pH units		7.47	0.22	7.21	7.23	7.49	7.71	7.77	44		0
	Conductivity @20C	uS/cm	545.40	4.43	539.45	539.90	545.50	548.70	551.85	10		0
	Temperature Water	ºC	10.23	2.53	7.02	7.37	9.64	13.87	14.31	44		0
	BOD ATU	mg/l	1.08	0.13	1.00	1.00	1.00	1.28	1.39	43	1	19
	Ammonia - as N	mg/l	0.05	0.03	0.03	0.03	0.05	0.08	0.10	43	0.03	13
	Nitrogen Total Oxidised - as N	mg/l	7.57	0.44	6.92	7.10	7.65	8.00	8.14	43		0
	Nitrate	mg/l	7.55	0.45	6.89	7.07	7.64	7.99	8.12	43		0
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.01	0.03	0.04	43	0.004	4
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43	0.0003	13
	Solids Suspended @105C	mg/l	3.99	1.32	3.00	3.00	3.40	5.98	6.80	17	3	6
	Hardness Total	mg/l	314.34	9.78	294.10	297.00	318.00	324.20	325.00	35		0
	Alkalinity pH 4.5	mg/l	252.80	23.06	237.30	245.60	257.00	264.60	265.30	35		0
	Chloride Ion - as Cl	mg/l	19.65	0.60	18.94	19.07	19.55	20.27	20.59	10		0
	Ortho-Phosphate	mg/l	0.05	0.02	0.03	0.03	0.04	0.06	0.06	43		0
	Phosphorus Total - as P	mg/l	0.05	0.01	0.03	0.03	0.05	0.06	0.06	6		0
	Zinc Dissolved - as Zn	ug/l	5.18	0.64	5.00	5.00	5.00	5.16	6.20	33	5	29
	Copper Dissolved - as Cu	ug/l	2.50	0.00	2.50	2.50	2.50	2.50	2.50	43	2.5	43
	Copper - as Cu	ug/l	2.50	0.00	2.50	2.50	2.50	2.50	2.50	33	2.5	33
	Zinc - as Zn	ug/l	5.65	2.86	5.00	5.00	5.00	5.16	6.22	43	5	38
	OrthoPhosphate Filtered - as P	mg/l	0.03	0.01	0.01	0.02	0.04	0.04	0.05	6		0
	DO % (Instrumental)	%	89.82	7.79	78.03	80.24	89.30	101.10	102.79	43		0
	DO conc. (Instrumental)	mg/l	9.81	0.96	8.24	8.59	9.53	11.00	11.02	20		0

Table A2.23. Water Quality statistics for the River Tweed (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
41000033	pH - as pH units		7.87	0.46	7.13	7.35	7.80	8.45	8.78	66		0
	Temperature Water	ºC	10.50	5.06	2.82	3.79	9.55	17.64	18.07	64		0
	BOD ATU	mg/l	1.67	0.56	1.00	1.10	1.60	2.10	2.40	64	1	14
	Ammonia - as N	mg/l	0.06	0.19	0.03	0.03	0.03	0.05	0.08	67	0.03	38
	Nitrogen Total Oxidised - as N	mg/l	1.86	0.69	0.83	1.11	1.79	2.82	2.98	67		0
	Nitrate	mg/l	1.85	0.69	0.82	1.10	1.79	2.81	2.97	67		0
	Nitrite	mg/l	0.01	0.01	0.00	0.00	0.01	0.02	0.02	67	0.005	15
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64	0.0002	37
	Solids Suspended @105C	mg/l	7.69	13.05	1.00	1.00	3.50	16.20	26.10	67	1	11
	Hardness Total	mg/l	92.88	16.62	66.83	71.50	91.70	113.00	116.75	46		0
	Alkalinity pH 4.5	mg/l	75.61	16.97	49.16	50.80	77.00	94.46	97.92	45		0
	Ortho-Phosphate	mg/l	0.04	0.03	0.02	0.02	0.03	0.07	0.09	65	0.02	20
	Copper Dissolved - as Cu	ug/l	1.55	0.51	0.90	1.03	1.44	2.20	2.53	67		0
	Zinc - as Zn	ug/l	6.40	3.99	5.00	5.00	5.00	10.38	14.21	67	5	53
	DO % (Instrumental)	%	96.81	6.06	88.30	90.30	96.00	104.00	105.85	64		0
	DO conc. (Instrumental)	mg/l	10.92	1.48	8.48	8.77	10.90	12.94	13.20	64		0
41000035	pH - as pH units		7.73	0.34	7.20	7.30	7.70	8.19	8.33	68		0
	Temperature Water	ºC	10.00	4.65	2.65	4.21	9.75	16.22	17.17	68		0
	BOD ATU	mg/l	1.59	0.55	1.00	1.00	1.50	2.20	2.68	66	1	16
	Ammonia - as N	mg/l	0.05	0.03	0.03	0.03	0.04	0.06	0.11	68	0.03	34
	Nitrogen Total Oxidised - as N	mg/l	2.56	0.48	1.94	2.00	2.52	3.26	3.35	68		0
	Nitrate	mg/l	2.55	0.48	1.92	2.00	2.51	3.26	3.34	68		0
	Nitrite	mg/l	0.01	0.01	0.00	0.00	0.01	0.02	0.02	68	0.005	15
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	68	0.0003	34
	Solids Suspended @105C	mg/l	10.35	11.33	1.00	2.00	6.50	23.60	35.60	68	1	4
	Hardness Total	mg/l	119.59	25.12	75.18	86.45	125.00	146.50	159.50	46		0

	Alkalinity pH 4.5	mg/l	88.03	26.09	39.55	51.95	91.50	117.00	125.00	46	10	1
	Ortho-Phosphate	mg/l	0.04	0.02	0.02	0.02	0.03	0.06	0.08	66	0.02	30
	Copper Dissolved - as Cu	ug/l	1.26	0.57	0.74	0.79	1.05	1.93	2.61	53	0.5	1
	Zinc - as Zn	ug/l	6.33	2.43	5.00	5.00	5.00	9.95	12.40	53	5	30
	DO % (Instrumental)	%	97.74	6.36	91.35	92.00	97.00	105.00	111.00	68		0
	DO conc. (Instrumental)	mg/l	11.10	1.17	9.49	9.63	11.05	12.93	13.17	68		0
	pH - as pH units		7.54	0.40	6.89	6.99	7.60	8.04	8.10	60		0
	Temperature Water	ºC	8.95	3.83	3.95	4.64	8.50	14.42	15.52	60		0
	BOD ATU	mg/l	1.42	0.51	0.89	0.99	1.40	2.00	2.01	60	2	17
	Ammonia - as N	mg/l	0.05	0.07	0.03	0.03	0.03	0.04	0.12	60	0.03	53
	Nitrogen Total Oxidised - as N	mg/l	0.54	0.38	0.20	0.20	0.42	0.98	1.31	60	0.2	9
	Nitrate	mg/l	0.54	0.38	0.20	0.20	0.41	0.98	1.31	60	0.195	7
	Nitrite	mg/l	0.00	0.00	0.00	0.00	0.01	0.01	0.01	60	0.005	56
41000037	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	59	0.0001	53
	Solids Suspended @105C	mg/l	2.78	2.41	1.00	1.00	2.00	6.55	9.05	60	2	21
	Hardness Total	mg/l	35.34	10.25	20.53	23.49	33.45	45.85	53.81	38		0
	Alkalinity pH 4.5	mg/l	24.28	9.18	10.17	13.49	23.40	36.31	42.03	38	10	2
	Ortho-Phosphate	mg/l	0.02	0.01	0.02	0.02	0.02	0.02	0.03	58	0.02	50
	Copper Dissolved - as Cu	ug/l	0.78	0.36	0.50	0.50	0.66	1.35	1.59	45	0.5	14
	Zinc - as Zn	ug/l	5.30	1.59	5.00	5.00	5.00	5.32	5.47	45	5	38
	DO % (Instrumental)	%	99.75	2.98	95.00	96.00	100.00	103.10	105.05	60		0
	DO conc. (Instrumental)	mg/l	11.61	1.16	9.78	10.00	11.60	13.10	13.31	60		0
	pH - as pH units		7.64	0.41	7.03	7.19	7.59	8.20	8.40	66		0
	Temperature Water	ºC	9.97	4.14	3.56	4.26	9.70	15.78	16.10	67		0
	BOD ATU	mg/l	1.48	0.47	1.00	1.00	1.30	2.15	2.38	66	1	11
	Ammonia - as N	mg/l	0.04	0.03	0.03	0.03	0.03	0.06	0.08	67	0.03	35
41000051	Nitrogen Total Oxidised - as N	mg/l	2.16	0.93	0.77	1.08	2.23	3.29	3.51	67		0
	Nitrate	mg/l	2.15	0.93	0.77	1.06	2.21	3.28	3.50	67		0
	Nitrite	mg/l	0.01	0.01	0.00	0.00	0.01	0.02	0.02	67	0.005	19
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66	0.0008	37
	Solids Suspended @105C	mg/l	5.48	9.01	1.00	1.00	3.50	8.70	10.55	67	2	10

	Hardness Total	mg/l	78.81	9.41	60.56	68.86	80.60	88.38	90.08	45		0
	Alkalinity pH 4.5	mg/l	64.96	12.87	39.64	46.98	65.30	81.44	83.46	45		0
	Ortho-Phosphate	mg/l	0.03	0.02	0.02	0.02	0.03	0.06	0.08	66	0.02	26
	Copper Dissolved - as Cu	ug/l	1.15	0.39	0.58	0.79	1.08	1.68	1.95	51	0.5	1
	Zinc - as Zn	ug/l	5.54	2.04	5.00	5.00	5.00	5.93	7.71	52	5	43
	DO % (Instrumental)	%	98.85	9.92	88.00	90.00	97.00	107.40	120.50	67		0
	DO conc. (Instrumental)	mg/l	11.22	1.34	9.10	9.48	11.30	13.00	13.37	67		0
41000102	pH - as pH units		7.59	0.48	6.64	6.97	7.63	8.20	8.24	68		0
	Temperature Water	ºC	10.02	4.64	3.17	4.30	9.60	16.23	17.20	68		0
	BOD ATU	mg/l	1.48	0.57	0.83	1.00	1.30	2.20	2.30	66	1	18
	Ammonia - as N	mg/l	0.04	0.02	0.03	0.03	0.03	0.04	0.06	68	0.03	61
	Nitrogen Total Oxidised - as N	mg/l	0.41	0.25	0.20	0.20	0.29	0.78	0.92	68	0.2	19
	Nitrate	mg/l	0.41	0.25	0.20	0.20	0.29	0.77	0.92	68	0.195	14
	Nitrite	mg/l	0.00	0.00	0.00	0.00	0.01	0.01	0.01	68	0.005	61
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	68	0.0004	61
	Solids Suspended @105C	mg/l	2.34	1.59	1.00	1.00	2.00	5.00	6.00	68	1	24
	Hardness Total	mg/l	39.71	9.84	23.33	25.75	38.65	52.55	55.08	46		0
	Alkalinity pH 4.5	mg/l	34.01	13.56	11.88	17.25	31.50	51.35	55.95	46	10	1
	Ortho-Phosphate	mg/l	0.02	0.01	0.02	0.02	0.02	0.03	0.03	66	0.02	52
	Copper Dissolved - as Cu	ug/l	1.03	0.38	0.61	0.65	0.93	1.51	1.66	68	1	1
	Zinc - as Zn	ug/l	5.40	1.51	5.00	5.00	5.00	5.92	7.02	68	5	58
	DO % (Instrumental)	%	99.82	5.93	92.00	93.00	99.50	108.00	109.65	68		0
	DO conc. (Instrumental)	mg/l	11.34	1.25	9.48	9.54	11.35	13.00	13.23	68		0
41000358	pH - as pH units		7.77	0.35	7.14	7.34	7.80	8.28	8.40	25		0
	Temperature Water	ºC	8.58	3.93	2.00	4.40	8.40	13.66	14.10	25		0
	BOD ATU	mg/l	1.46	0.44	0.82	0.90	1.60	1.96	2.16	25		0
	Ammonia - as N	mg/l	0.04	0.02	0.03	0.03	0.03	0.06	0.09	25	0.03	21
	Nitrogen Total Oxidised - as N	mg/l	2.49	1.86	1.07	1.20	2.00	3.48	3.86	25		0
	Nitrate	mg/l	2.48	1.85	1.07	1.20	2.00	3.48	3.86	25		0
	Nitrite	mg/l	0.01	0.01	0.00	0.00	0.00	0.01	0.02	25	0.005	18
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25	0.00015	21

Solids Suspended @105C	mg/l	2.96	2.31	1.00	1.00	2.00	6.60	7.00	25	1	3
Hardness Total	mg/l	72.27	23.15	45.46	48.92	76.60	93.88	96.04	3		0
Alkalinity pH 4.5	mg/l	50.50	15.62	32.00	34.60	55.40	64.44	65.57	3		0
Ortho-Phosphate	mg/l	0.11	0.30	0.02	0.02	0.02	0.13	0.28	25	0.02	14
Copper Dissolved - as Cu	ug/l	1.83	1.42	0.85	0.97	1.42	3.65	5.51	25		0
Zinc - as Zn	ug/l	5.31	0.71	5.00	5.00	5.00	6.31	6.59	25	5	19
DO % (Instrumental)	%	98.88	4.84	92.00	92.80	99.00	106.20	107.80	25		0
DO conc. (Instrumental)	mg/l	11.61	1.13	10.04	10.46	11.50	13.12	13.80	25		0

Table A2.24. Water Quality statistics for the River Wensum (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
WEN010	pH - as pH units		7.79	0.31	7.30	7.46	7.85	8.10	8.29	67		0
	Conductivity @20C	uS/cm	587.67	22.63	543.20	561.40	591.00	604.60	608.40	33		0
	Temperature Water	ºC	10.50	2.78	6.47	6.99	10.68	13.81	14.86	69		0
	Conductivity @25C	uS/cm	632.20	98.58	589.50	632.50	652.00	665.00	670.50	36		0
	DO % (Lab)	%	1.18	0.25	1.00	1.00	1.10	1.50	1.76	69	1	30
	DO conc. (lab)	mg/l	0.04	0.01	0.03	0.03	0.03	0.05	0.05	69	0.03	38
	BOD ATU	mg/l	9.12	1.07	7.23	7.75	9.22	10.40	10.56	69		0
	Ammonia - as N	mg/l	9.09	1.14	7.08	7.44	9.20	10.48	10.58	33		0
	Nitrogen Total Oxidised - as N	mg/l	0.03	0.01	0.02	0.02	0.03	0.04	0.05	33		0
	Nitrate	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67	0.001	38
	Nitrite	mg/l	232.69	11.64	218.40	222.20	228.00	250.20	252.40	13		0
	Ammonia Non-Ionised (Calc.)	mg/l	34.23	2.11	31.64	32.02	33.80	36.56	37.60	69		0
	Alkalinity pH 4.5	mg/l	0.15	0.05	0.09	0.10	0.14	0.19	0.21	69		0
	Chloride Ion - as Cl	mg/l	0.15	0.04	0.11	0.11	0.14	0.21	0.22	9		0
	Ortho-Phosphate	mg/l	9.09	0.55	8.29	8.47	9.05	9.63	9.82	7		0
	Phosphorus Total - as P	mg/l	177.96	47.39	119.20	120.80	171.00	234.60	248.20	25		0
	DO % (Instrumental)	%	88.75	12.03	75.96	77.16	86.40	104.10	110.80	69		0
	DO conc. (Instrumental)	mg/l	9.86	1.85	7.83	7.97	9.56	11.90	13.26	33		0
WEN235	pH - as pH units		8.07	0.26	7.58	7.77	8.10	8.40	8.41	67		0
	Conductivity @20C	uS/cm	657.52	37.05	589.60	631.00	664.00	693.80	704.20	33		0
	Temperature Water	ºC	11.82	4.87	4.45	5.90	11.80	18.17	19.61	69		0
	Conductivity @25C	uS/cm	741.54	47.55	713.45	718.00	747.50	776.00	782.50	36		0
	DO % (Lab)	%	1.45	0.73	1.00	1.00	1.20	2.04	2.66	69	1	17
	DO conc. (lab)	mg/l	0.05	0.03	0.03	0.03	0.04	0.08	0.12	69	0.03	29
	BOD ATU	mg/l	6.59	1.03	4.96	5.25	6.71	7.89	8.25	69		0
	Ammonia - as N	mg/l	6.39	1.12	4.78	4.93	6.53	7.60	8.18	33		0

Nitrogen Total Oxidised - as N	mg/l	0.03	0.01	0.02	0.02	0.03	0.05	0.06	33		0
Nitrate	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67	0.001	28
Nitrite	mg/l	238.38	12.60	221.20	224.20	239.00	253.00	254.20	13		0
Ammonia Non-Ionised (Calc.)	mg/l	49.45	5.22	42.18	43.74	50.00	54.64	57.72	69		0
Alkalinity pH 4.5	mg/l	0.13	0.05	0.05	0.07	0.13	0.19	0.24	69		0
Chloride Ion - as Cl	mg/l	0.11	0.02	0.08	0.08	0.11	0.13	0.13	8		0
Ortho-Phosphate	mg/l	7.15	0.90	5.94	5.95	7.22	8.27	8.33	7		0
Phosphorus Total - as P	mg/l	152.64	46.52	88.60	92.60	154.00	192.80	207.60	25		0
DO % (Instrumental)	%	95.65	10.68	80.35	83.28	95.00	106.00	110.52	68		0
DO conc. (Instrumental)	mg/l	10.51	2.24	7.76	8.10	10.10	13.28	14.32	33		0

Table A2.25. Water Quality statistics for the Rivers Wye (Wales) (based on GQA data).

GQA Point Reference	Determinand	Unit	Mean	SD	Percentiles 5th	10th	50th	90th	95th	Number Samples	Detection limit (DL)	Nb samples < DL
50021	pH - as pH units		7.74	0.25	7.33	7.45	7.72	8.06	8.21	73		0
	Temperature Water	ºC	11.38	4.71	4.56	5.60	11.16	18.18	20.04	73		0
	DO % (lab)	%	96.13	9.97	83.16	85.86	94.10	107.60	112.00	13		0
	DO Conc. (lab)	mg/l	10.33	1.26	8.48	8.92	10.00	11.92	12.28	13		0
	BOD ATU	mg/l	1.18	0.43	0.50	0.60	1.10	1.78	1.94	73	1	18
	Ammonia - as N	mg/l	0.02	0.02	0.01	0.01	0.02	0.04	0.06	73	0.01	24
	Nitrogen Total Oxidised - as N	mg/l	1.08	0.41	0.53	0.62	1.03	1.73	1.86	73		0
	Nitrate	mg/l	1.07	0.41	0.52	0.62	1.02	1.72	1.86	73		0
	Nitrite	mg/l	0.01	0.01	0.00	0.00	0.01	0.01	0.02	73	0.002	5
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	73	0.0001	29
	Solids Suspended @105c	mg/l	9.25	10.02	1.50	1.50	4.00	24.90	30.60	38	1.5	7
	Hardness Total	mg/l	55.62	17.42	27.45	33.00	55.90	81.10	85.30	51		0
	Alkalinity pH 4.5	mg/l	43.76	22.94	18.76	21.00	38.00	60.40	80.40	13		0
	Ortho-Phosphate	mg/l	0.02	0.01	0.00	0.00	0.01	0.03	0.04	73	0.004	15
	Phosphate	mg/l	0.04	0.02	0.02	0.02	0.03	0.06	0.07	33		0
	Copper Dissolved - as Cu	ug/l	1.26	0.82	1.00	1.00	1.00	1.75	1.89	73	1	38
	Zinc - as Zn	ug/l	5.64	5.65	2.00	2.15	4.44	8.81	9.75	73	2	7
	Phosphate - as P	ug/l	24.40	9.22	11.40	12.80	30.00	32.60	32.80	5		0
	DO % (Instrumental)	%	96.97	6.34	88.74	89.45	96.25	105.10	109.00	60		0
	DO conc. (Instrumental)	mg/l	10.74	1.35	8.30	9.12	10.76	12.41	12.76	60		0
50042	pH - as pH units		7.96	0.20	7.60	7.73	8.00	8.20	8.25	67		0
	Temperature Water	ºC	10.67	3.35	5.46	6.50	10.47	15.16	15.93	68		0
	DO % (lab)	%	96.47	8.64	87.67	87.82	96.10	106.70	111.05	12		0
	DO Conc. (lab)	mg/l	10.93	0.50	10.16	10.22	10.95	11.48	11.68	12		0
	BOD ATU	mg/l	1.24	0.71	0.60	0.70	1.00	1.93	2.59	68	0.5	16
	Ammonia - as N	mg/l	0.03	0.03	0.01	0.01	0.02	0.07	0.11	68	0.01	20

	Nitrogen Total Oxidised - as N	mg/l	4.86	1.09	3.47	3.90	4.75	6.10	6.25	68	4.494	1
	Nitrate	mg/l	4.84	1.09	3.44	3.89	4.74	6.08	6.24	68	4.48	1
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.03	0.04	68	0.014	1
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67	0.0002	19
	Solids Suspended @105c	mg/l	25.03	65.60	2.00	2.00	7.00	58.80	86.45	68	1.5	4
	Hardness Total	mg/l	195.40	31.39	139.60	146.60	197.00	232.60	241.20	45		0
	Alkalinity pH 4.5	mg/l	165.45	27.00	124.50	127.00	175.00	200.00	200.50	11		0
	Ortho-Phosphate	mg/l	0.03	0.03	0.00	0.00	0.03	0.06	0.07	68	0.004	10
	Phosphate	mg/l	0.05	0.03	0.02	0.02	0.05	0.10	0.12	29		0
	Copper Dissolved - as Cu	ug/l	1.23	0.36	1.00	1.00	1.04	1.67	2.10	68	1	32
	Zinc - as Zn	ug/l	5.74	10.37	2.00	2.00	3.45	8.24	11.23	68	2	16
	Phosphate - as P	ug/l	57.00	43.46	21.20	22.40	42.00	106.80	123.40	5		0
	DO % (Instrumental)	%	99.09	8.72	84.80	89.80	100.00	105.00	108.75	56		0
	DO conc. (Instrumental)	mg/l	10.98	1.15	8.98	9.75	10.88	12.24	12.70	56		0
	pH - as pH units		7.83	0.23	7.48	7.58	7.84	8.02	8.19	63		0
	Temperature Water	ºC	10.49	3.73	5.77	6.00	10.00	15.60	16.83	63		0
	DO % (lab)	%	86.11	8.59	70.55	72.70	88.50	94.40	95.90	11		0
	DO Conc. (lab)	mg/l	9.84	0.81	8.55	8.60	9.80	10.90	10.95	11		0
	BOD ATU	mg/l	1.25	0.55	0.52	0.80	1.00	1.78	2.19	63	1	12
	Ammonia - as N	mg/l	0.04	0.04	0.01	0.01	0.03	0.08	0.12	63	0.01	18
	Nitrogen Total Oxidised - as N	mg/l	5.10	1.39	3.60	4.11	4.79	6.36	6.88	63	4.944	1
50044	Nitrate	mg/l	5.07	1.39	3.56	4.08	4.74	6.34	6.86	63	4.93	1
	Nitrite	mg/l	0.02	0.01	0.01	0.01	0.02	0.04	0.04	63	0.018	1
	Ammonia Non-Ionised (Calc.)	mg/l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63	0.0002	17
	Solids Suspended @105c	mg/l	15.26	20.13	3.00	3.00	7.00	42.40	50.00	63	1.5	2
	Hardness Total	mg/l	199.30	41.64	134.15	152.30	196.50	238.40	254.75	40		0
	Alkalinity pH 4.5	mg/l	165.91	24.55	129.00	130.00	168.00	199.00	200.50	11		0
	Ortho-Phosphate	mg/l	0.06	0.04	0.00	0.00	0.05	0.11	0.14	63	0.004	11
	Phosphate	mg/l	0.10	0.05	0.05	0.05	0.07	0.16	0.18	24		0
	Copper Dissolved - as Cu	ug/l	1.39	0.42	1.00	1.00	1.27	1.99	2.07	63	1	20

Zinc - as Zn	ug/l	4.57	3.76	2.00	2.00	3.26	8.25	9.76	63	2	14
Phosphate - as P	ug/l	57.80	31.38	15.80	18.60	78.00	86.20	87.60	5		0
DO % (Instrumental)	%	91.53	8.21	82.20	83.70	92.10	99.30	101.50	51		0
DO conc. (Instrumental)	mg/l	10.24	1.39	8.45	8.74	9.97	12.10	12.41	51		0