WATER QUALITY OBJECTIVES:

Procedures used by the National Rivers Authority for the purpose of the Surface Waters (River Ecosystem) (Classification) Regulations 1994

NRA

National Rivers Authority

Guardians of
the Water Environment

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Preface

The Surface Waters (River Ecosystem) (Classification) Regulations 1994, SI 1994 No. 1057, prescribe a system for classifying the quality of rivers and canals, to provide the basis for setting statutory water quality objectives (WQOs) under section 83 of the Water Resources Act 1991 in respect of individual stretches of water.

The River Ecosystem classification comprises five hierarchical classes, in order of decreasing quality: RE1, RE2, RE3, RE4 and RE5. The criteria which samples of water are required to satisfy are set out, for ease of reference, in Table (i), below.

Regulation 3 of *The Surface Waters (River Ecosystem) (Classification) Regulations 1994* provides that certain matters relevant to the assessment of compliance with the requirements prescribed for each of the quality classes RE1-RE5 are to be determined by the NRA in accordance with the procedures and principles set out in this document.

Table (i) RIVER ECOSYSTEM CLASSIFICATION: WATER QUALITY CRITERIA

Class	Dissolved Oxygen % saturation 10 percentile	BOD (ATU) mg/l 90 percentile	Total Ammonia mg N/l 90 percentile	Un-ionised Ammonia mg N/l 95 percentile	pH lower limit as 5 percentile; upper limit as 95 percentile	Hardness mg/l Ca CO_3	Dissolved Copper µg/l 95 percentile	Total Zinc µg/l 95 percentile
RE1	80	2.5	0.25	0.021	6.0 – 9.0	≤ 10 > 10 and ≤ 50 > 50 and ≤ 100 > 100	5 22 40 112	30 200 300 500
RE2	70	4.0	0.6	0.021	6.0 – 9.0	≤ 10 > 10 and ≤ 50 > 50 and ≤ 100 > 100	5 22 40 112	30 200 300 500
RE3	60	6.0	1.3	0.021	6.0 – 9.0	≤ 10 > 10 and ≤ 50 > 50 and ≤ 100 > 100	5 22 40 112	300 700 1000 2000
RE4	50	8.0	2.5	-	6.0 – 9.0	≤ 10 > 10 and ≤ 50 > 50 and ≤ 100 > 100	5 22 40 112	300 700 1000 2000
RE5	20	15.0	9.0	-	-	-	-	-

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1.0 INTRODUCTION

The National Rivers Authority (NRA) uses various schemes for the assessment of river water quality. These procedures include periodic chemical and biological surveys, and reporting upon compliance with the requirements of EC Directives. *The Surface Waters (River Ecosystem) (Classification) Regulations 1994* introduce a component of a new scheme, the purpose of which is to place water quality targets on a statutory footing. This new scheme is known as the statutory water quality objectives (WQO) scheme.

The Water Resources Act 1991 contains provision to develop new schemes for the classification of Controlled Waters. On the basis of these classification schemes, the Act empowers the Secretaries of State for the Environment and for Wales to set statutory WQOs for specific stretches of water in order to secure specific water quality standards for them by given dates.

WQOs specify formal minimum quality standards, and have already been set to give effect to the EC Dangerous Substances legislation arising from Directive 76/464/EEC, and subsequent daughter Directives, (via the Surface Waters (Dangerous Substances) (Classification) Regulations 1989 (SI 2286) and 1992 (SI 337)), and the EC Bathing Waters legislation arising from Directive 76/160/EEC (via the Bathing Waters (Classification) Regulations 1991 (SI 1597)). The requirements of these Directives, and the methodologies necessary for compliance assessment, are contained within the Directives and the domestic Regulations and Notices arising from them.

The Surface Waters (River Ecosystem) (Classification) Regulations 1994 specify the classification scheme which will apply when setting WQOs for the River Ecosystem Use in rivers and watercourses in England and Wales. The Regulations specifically require that certain matters relevant to the assessment of compliance with WQOs, set using the River Ecosystem classification, are to be determined by the NRA strictly according to the procedures and principles laid out in this document. These cover frequency, location and methods of sampling; analytical requirements for samples; and statistical methods for the assessment of compliance with the standards in the Regulations.

The relevant NRA Regional General Manager will be responsible for ensuring that the procedures laid down in this manual are followed at all times.

2.0 MONITORING ACTIVITIES TO SUPPORT COMPLIANCE ASSESSMENT

In order to assess compliance with WQOs it is necessary to obtain reliable, accurate and appropriate data on the quality of rivers. The requirements of WQOs therefore govern the design of components of the NRA's monitoring programme.

2.1 Location of Sampling Points

WQOs are established for lengths of river ('river stretches') which share the same quality target. River stretches are defined according to their upstream and downstream limits; a target River Ecosystem Class is applied, together with a date for its achievement. Physical features such as tributaries, weirs or significant discharges often mark the ends of river stretches owing to their potentially significant effects on water quality.

In order to assess quality (and hence compliance with WQOs), the NRA will identify and select those key 'nodal' sampling points which reflect the quality of those river stretches. In many circumstances the quality of the river stretch can be ascertained using a single sampling point; in others, more than one sampling point may be used. Sampling points will be chosen having regard to the avoidance of mixing zones immediately downstream of tributaries or discharges, where quality would be unrepresentative. They will also be chosen with regard to their accessibility throughout the year, with particular regard to aspects of health and safety for those carrying out the sampling.

Once selected, sampling points will not generally change over time. However, it may sometimes be necessary to agree a change in the location of a sampling point due to, for example, changes in significant discharges or road-building schemes.

2.2 Methods of Sampling

Spot sampling methodology in the NRA follows detailed procedures, work instructions (for detailed applications) and records to be used for control purposes. The procedures and work instructions include lists of references, definitions, equipment to be used for sampling, and actions to be taken. In general, these methods conform with British Standard BS6068 Part 6 and accompanying glossaries in Part 0 and Part 1 of the same Standard. The NRA's spot sampling methodology will be subject to agreed, effective quality control procedures, which may include field blanks, field use of synthetic standards, or the taking of duplicate samples. Spot data collected in situ using hand-held meters, where these are recognised as meeting the required standards of accuracy, precision and limit of detection, may be used in the assessment of compliance with WQOs. For the purposes of both spot samples collected for subsequent laboratory analysis, and data collected using hand-held meters, audit checks will be employed and all relevant documentation will be subject to revision control procedures.

The introduction of widespread continuous monitoring would have implications for the revision of standards, as the published River Ecosystem standards have been derived on the basis of spot sampling during daytime sampling windows. Currently, few of the determinands covered by the Regulations can be effectively monitored, to the required standards of accuracy, with available automatic monitoring equipment. Any results from such equipment will not therefore be used currently in the assessment of compliance with WQOs. This position will however be kept under review as continuous monitoring technology develops, and any subsequent widespread introduction of continuous monitoring equipment would be accompanied by a significant review of standards.

2.3 Frequency of Sampling

All chemical sampling sites will be regularly spot sampled by the NRA at a minimum 12 times per year. This sampling frequency represents a compromise between statistical confidence and cost-effectiveness. No reduction to the NRA's routine monitoring programme is implied by this requirement; reviews of sampling regime are governed by separate processes within the NRA.

The NRA will continue to take samples outside the working day and working week for the purposes of investigative work and other pollution control activities. However, for the purpose of assessing compliance with WQOs, only those samples collected during the Authority's routine, predetermined sampling programmes during the working week and the working day will be considered. Significant diurnal variations in river water chemistry are known to occur as a result of biological, physico-chemical and anthropogenic factors. The River Ecosystem standards have been explicitly set on the assumption that sampling will be carried out during working hours. To require sampling outside of these times for the purpose of assessing compliance with WQOs would be exceptionally costly as it would be necessary to distribute sampling on a 24 hour basis throughout the 7-day week, and it would also be inconsistent with the way in which the River Ecosystem standards have been set. Care will be taken to ensure that samples taken for the purpose of compliance assessment at a particular site are reasonably distributed throughout the working day and working week, and throughout the calendar year. This will ensure that the adoption of a standard 'sampling run' does not result in all samples at a site being taken during a very narrow time window or on the same day of the week.

It is not necessary to report compliance for all determinands for some River Ecosystem classes or where exceptions have been applied as set out in section 5 below. The NRA will nevertheless take spot samples appropriate for all determinands for the purpose of monitoring the current quality of the water. This will assist in the assessment of potential target class when WQOs are subject to periodic review.

3.0 ANALYTICAL REQUIREMENTS

The analytical requirements for measuring determinands in samples are qualified by specified performance measures. All performance measures are applicable to standard methods with direct traceability to those set out in the Standing Committee of Analysts publications. The procedures include: specifying requirements for accuracy, precision and limit of detection; ensuring all laboratories have audited quality control systems; and ensuring that similar quality criteria are used for field instrumentation.

- **Accuracy** is the overall difference between the reported results and the true values. (The term "bias" may also sometimes be used in this context.) It is the mean of many measurements and is usually expressed as a percentage.
- **Precision** is the degree of agreement when measuring the same sample repeatedly. It is based on the standard deviation of differences between replicate measurements and is also usually expressed as a percentage.
- **Limit of Detection** is the concentration below which it is not possible to distinguish between the presence or absence of the material, according to the limitations of the analytical technique employed.

Analytical requirements for assessment of compliance with WQOs are detailed in Table 1.

Table 1: Summary of Analytical Requirements

Determinand	Accuracy (% of relative standard deviation)	Precision (% of relative standard deviation)	Limit of Detection
Dissolved Oxygen	10%	5%	(0.2 mg/l O)
BOD[ATU]	10%	8%	1.0 mg/l
Total Ammonia	10%	5%	0.025 mg/l
Un-ionised Ammonia	Un-ionised ammonia is calculated from total ammonia, pH & temperature		
pH	10%	5%	-
Hardness ($CaCO_3$)	10%	10%	5 mg/l $CaCO_3$
Dissolved Copper	10%	5%	0.5 µg/l Cu
Total Zinc	10%	5%	3.0 µg/l Zn
Temperature	Temperature will be measured with a proven traceability to the National Standard with a total uncertainty of ±0.2°C.		

4.0 STATISTICAL METHODS FOR ASSESSING COMPLIANCE

4.1 Introduction to Compliance Assessment

Standards for several different WQO Use Classes may eventually apply to a particular stretch of river. In these circumstances, the most stringent requirements for each determinand will provide the planning target. However, compliance with each WQO Use Class will be assessed independently, using the standards appropriate to that Use Class. Compliance will be assessed on the basis of data gathered by the NRA over **complete** calendar years, commencing with the first full calendar year following the date specified in the Notice establishing the WQO. If, for example, a date of 1st January 1998 is specified, data gathered during the course of 1998 would constitute the first year-class of data upon which compliance will be assessed.

Where at least three full years have elapsed since the date specified in the Notice establishing the WQO, sampling data gathered during the preceding three years (that is, three year-classes of data) will be used to assess compliance. However, where three years have not elapsed since the date specified in the Notice, the maximum available number of year-classes of data available (in practice, either one or two years) would be used. This approach will ensure the most cost-effective use of monitoring data.

Only the results from routine, predetermined sampling programmes will be used. All validated results from these sampling programmes will be placed on the Water Resources Act Public Registers. None of these results will be set aside when assessing compliance, unless the exceptions set out in section 5 below are applicable. The WQO will not have been achieved if any one of the relevant determinands fails to meet the requirements in the Classification.

It is inevitable that the concentration of substances in some samples will be found to be lower than the limits of detection. These results will be quoted as **"less-than" values** on the Registers. Such results will be taken as "zero" in the assessment of compliance. On rare occasions, results will be qualified as "greater-than" values. These will be taken as the value specified.

4.2 Assessment of Compliance

In order to assess compliance with River Ecosystem standards, which are defined as percentiles, recognised parametric statistical methods will be used. First it is necessary to calculate the mean and standard deviation values for each determinand from monitoring data held on Public Registers. For a set of n results, $x_1, x_2, \ldots x_n$, the mean, m, is given in:

$$m = \frac{1}{n} \sum_{i=1}^{n} x_i$$

The standard deviation, s, is given in:

$$s = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (m - x_i)^2}$$

From these mean and standard deviation values, it is then necessary to calculate percentile values, and to do so in a way that recognises that the taking of spot samples provides only an **estimate** of the underlying water quality which is being sampled. Thus, the confidence limits within which the "real" quality is assumed to lie are calculated. This is necessary to establish, with a known degree of confidence, that a failure to meet the relevant standards has occurred, in order to avoid unnecessary expenditure on improvements to discharges which are not truly justified. The level of confidence chosen for assessment of compliance with WQOs is 95%. Thus, to take account of the uncertainty resulting from spot sampling, compliance assessment will be based on calculation of confidence limits, rather than on a straight calculation of percentiles.

A prescribed **parametric method** is used to estimate percentiles. Percentiles are a weighted sum of the standard deviation and the mean:

Percentile = mean + (weighting factor × standard deviation)

After calculating mean and standard deviation values, the procedure is slightly different for each determinand, depending upon the nature of the standard and the assumed distribution of concentration over time.

- There are **two types of standard** used in the River Ecosystem classification, and the statistical methods used to assess compliance vary according to which type of standard is applicable. For those standards for which an upper limit is applicable (such that it must not be exceeded, as a 90-percentile or a 95-percentile), the weighting factor used in calculating the percentile is positive. For those standards for which a lower limit is applicable (such that quality must not be less than the standard, as a 5-percentile or a 10-percentile), the weighting factor used in calculating the percentile is negative.

- Two **types of distribution** are found to approximate to the observed behaviour of class-limiting determinands

in rivers: a **normal distribution** or a **log-normal distribution**. (Any error introduced by the assumption of these particular distributions is small compared with the errors from chance in sampling).

For those determinands for which an upper limit standard is applicable (BOD[ATU], Total Ammonia, Un-ionised Ammonia, high pH, Copper and Zinc), for which a 90-percentile or 95-percentile standard is therefore applicable, the lower confidence limit is used for compliance assessment. For those determinands for which a lower limit standard is applicable (Dissolved Oxygen and low pH), for which a 10-percentile or 5-percentile standard is therefore applicable, the upper confidence limit is used for compliance assessment.

For a **normal distribution**, the lower confidence limit for a 90- or 95-percentile is given as q_l in:

$$q_l = m + (w * s)$$

and the upper confidence limit for a 5- or 10-percentile is given as q_u in:

$$q_u = m - (w * s)$$

where, in both cases, m is the mean, s is the standard deviation, and w is the weighting factor.

For a **log-normal distribution**, the values of the mean, m, and the standard deviation, s, are converted to the values for the logarithms of the data using **the method of moments**:

$$S = \sqrt{\ln (1 + s^2/m^2)}$$

$$M = \ln \left\{ \frac{m}{\sqrt{(1 + s^2/m^2)}} \right\}$$

M and S stand for the mean and standard deviation of the logarithms of the data. The lower confidence limit, q, is then the exponential of (M + (w * S)):

$$q = e^{(M + (w*S))}$$

where, once again, w is the weighting factor.

Appendix 1 provides factors for the calculation of 95% confidence limits on estimates of 10-percentiles or 90-percentiles, and 5-percentiles or 95-percentiles, for different sampling frequencies.

4.2.1 Dissolved Oxygen

The **Oxygen Saturation**, *%Sat*, is computed for each sample, using the following equation[1]. The calculation uses the concentration of oxygen in mg/l, *mgO*, and the temperature, *t*, in degrees C:

$$\%Sat = 100 * mgO / (14.16 - 0.3943 * t + 0.00771 * t^2 - 0.0000646 * t^3)$$

For Dissolved Oxygen, a normal distribution and the upper confidence limit are used. A site will fail the WQO for Dissolved Oxygen if the upper confidence limit is less than the standard.

4.2.2 BOD[ATU]

For BOD[ATU] (the Biochemical Oxygen Demand, analyzed in the presence of allylthiourea [ATU] to suppress the uptake of oxygen by ammonia), a log-normal distribution and the lower confidence limit are used. A site will fail the WQO for BOD[ATU] if the lower confidence limit exceeds the standard, unless the exceptions set out in section 5 below are applicable.

4.2.3 Total Ammonia

For Total Ammonia, a log-normal distribution and the lower confidence limit are used. A site will fail the WQO for Total Ammonia if the lower confidence limit exceeds the standard.

4.2.4 Un-ionised Ammonia

The concentration of **Un-ionised Ammonia**, *UnAmm*, is computed for each sample, using the following equation[2]. The calculation uses the concentration of Total Ammonia, *TotAmm*, the temperature, *t*, in degrees C, and the pH:

$$UnAmm = TotAmm / (1.0 + 10.0^{(10.055 - (0.0324 * t) - pH)})$$

In this equation, values of pH which exceed 8.0 are set equal to 8.0. This is done to take account of the observed toxicity of Un-ionised Ammonia in rivers of high pH.

For Un-ionised Ammonia, a log-normal distribution and the lower confidence limit are used. A site will fail the WQO for Un-ionised Ammonia if the lower confidence limit exceeds the standard.

[1] This equation is provided in Truesdale G.A. and Gameson A.L.H. (Water Pollution Research Laboratory) (1957). *The Solubility of Oxygen in Saline Water.* Etrait du Journal du Conseil International pour l'Exploration de la Mer. Vol.XXII. No.2.

[2] This equation is provided in Water Research (1973). Vol.7. pp1011-1022. Water quality criteria for European freshwater fish - Report on ammonia and inland fisheries.

4.2.5 Copper and Zinc

For dissolved Copper and total Zinc, a log-normal distribution and the lower confidence limit are used. A site will fail the WQO for these determinands if the lower confidence limit exceeds the appropriate standard, unless the exceptions set out in section 5 below are applicable.

However, the concentration of either or both of these metals may be found to be consistently 20% of, or less than 20% of, the value specified as the class-limiting standard, and therefore unlikely to cause a breach of standard. In such a case, for each affected metal, samples need to be analyzed only on a low frequency basis to ensure that the metal remains at a low concentration. In these circumstances, the methods of calculation specified above will not apply.

4.2.6 Hardness

Samples will be analyzed for hardness every time they are analyzed for zinc and/or copper. If hardness remains within one banding for all samples, this hardness band will be used for the purpose of assessing compliance with metal standards. However, if hardness data gathered over one, two or three years spans more than one band, the average hardness will be used to assign a hardness band for the purpose of assessing compliance with metal standards.

4.2.7 pH Range

For the pH range, the upper and lower limits of the range are treated as 95-percentile and 5-percentile respectively. A Normal Distribution is used. A site will fail the WQO for pH if the upper confidence limit calculated for the 5-percentile is less than the 5-percentile standard, or if the lower confidence limit calculated for the 95-percentile exceeds the 95-percentile standard, unless the exceptions set out in section 5 below are applicable.

4.3 Comparison with Other Assessment Schemes

Some of these statistical methods differ from those generally used to assess compliance with existing EC Directives. The reason for using different methods for assessing compliance with WQOs is that the methods in Directives take no account of the random errors introduced by spot sampling. The methods used to assess compliance with WQOs make allowance for this error by assessing the statistical significance of compliance or failure in a way which makes maximum use of the information obtained from monitoring. This controls the risk of wasting resources on improvements to discharges into compliant sites which might be declared wrongly to have failed because of the effect of chance in sampling. Such differences in method may lead occasionally to differences in compliance, at any given site, assessed against the requirements of a Directive and against the same or similar requirements for the WQO. These will be sites at which the failure is not statistically significant.

5.0 DEALING WITH EXCEPTIONAL CIRCUMSTANCES

5.1 The Principles Involved

In some instances, exceptional circumstances may require that some or all of the results for certain determinands are not taken into account for the purpose of assessing compliance with a WQO. This will occur in areas where natural conditions give rise to reduced pH and/or elevated metal concentrations, or where these arise from anthropogenic effects which are not readily amenable to controls operated by the NRA. The need to discount data in assessing compliance with WQOs may also arise in respect of BOD where high values arise from dense growths of planktonic algae, which corrupt the analytical techniques used to assess BOD levels. Where, in accordance with the procedures laid down below, 'exceptional circumstances' are identified by the NRA as applying, these will be noted in WQO consultation documentation, and Public Registers will be annotated once WQOs have been set.

WQOs are one of a suite of water quality and pollution control schemes operated by the NRA and, in the short to medium term, may not be the primary vehicle for addressing all water quality problems, for example resulting from acidification. Nevertheless, the approach of proposing an exception as applying due to 'exceptional conditions' will serve to highlight the fact that a problem exists, and the problem will thus remain in the public eye not only during the WQO consultation period but also during periodic reviews, at which time a solution may be identified. This approach also ensures that, where it is not practicable to secure compliance with one or more of these determinands, the remaining River Ecosystem determinands continue to operate to maintain the overall quality of the relevant river stretches, and thus to control the quality of relevant discharges. Where an exception applies to a particular determinand for a subset of samples, compliance will be assessed on the basis of less than 12 samples. Although it is not necessary to assess compliance on the basis of data for all determinands where exceptions have been applied, the NRA will nevertheless analyze samples for all determinands for the purpose of monitoring the current quality of the water. This will assist in the assessment of potential target class when WQOs are subject to periodic review, and in the quantification of problems when evaluating potential solutions.

Given the diversity of sources of copper, zinc and low pH, and the variability in algal abundance, it is not possible to apply a precise statistical definition of 'exceptional circumstances'. Therefore, the results of sample analyses will be treated, for compliance assessment purposes, according to the descriptive procedures set out in sections 5.2 and 5.3 below.

5.2 Elevated Values of BOD Resulting from Algae

Substantial growths of planktonic algae can occur in slower flowing, nutrient-rich rivers. Where the algal growth is dense, the algal cells themselves can exert a high BOD during laboratory analysis. However, these elevated BOD values do not necessarily represent the BOD exerted in rivers, or that resulting directly from effluent discharges. If this impact is not excluded from classification and compliance assessment, spurious results may be reported and there is therefore a risk that investment, put in place to improve discharges, will not be targeted efficiently.

In those river stretches where the NRA considers that 'exceptional conditions' exist because planktonic algae are the predominant cause of anomalously high BOD results, the affected BOD data may be set aside when assessing compliance with the WQO. Identification of 'exceptional circumstances' is aided by examination of other factors, for example where non-compliance is driven solely by BOD but values of dissolved oxygen and ammonia are fully compliant with the relevant standards, or where available data indicate high chlorophyll concentrations. Given the diversity of river types occurring throughout England and Wales, nationally consistent mathematical rules for identifying 'exceptional conditions' have not proved possible to derive. Detailed procedures for identifying affected river stretches will therefore be applied at a regional level, according to the descriptive procedures set out above. In many cases, BOD data may be treated as exceptional on a seasonal basis. Thus, if the BOD is found to be adversely affected by algae in four of the twelve samples taken in a calendar year, only the remaining eight un-corrupted data will be used for the purpose of assessing compliance.

5.3 Reduced pH and Elevated Zinc and Copper Concentrations

Both low pH and elevated zinc and copper concentrations can arise from natural causes or from anthropogenic inputs, which may be either diffuse or point sources. Point source discharges should be amenable to control through the setting of discharge consents and, for this reason, analytical results will be fully taken into account in assessing compliance with WQOs in river stretches contaminated by point sources.

5.3.1 Natural Sources

Rivers in areas containing base-poor rocks are particularly subject to, and often characterised by, low pH. In these situations, where the water is poorly buffered, natural

sources of acidity typically include decaying vegetation (such as peat bogs) or geological mineralisation (for example where sulphides in underlying rocks oxidise to sulphates during dry periods, resulting in a flush of acidic water when rain subsequently falls).

Natural sources of metal enrichment result from geological mineralisation. The process of mineralisation is accelerated at low pH, when metals become more soluble. Metal concentrations may therefore be temporarily elevated as an indirect result of mineralisation arising from the periodic low pH conditions described above. Acid deposition, which may itself have an anthropogenic cause, tends to accelerate the mineralisation process in acid-vulnerable areas.

Where 'exceptional circumstances' attributable to the above causes have been identified by the NRA as applying permanently, the analytical data for affected parameters (whether pH, zinc or copper, or any combination) will be set aside in assessing compliance. The Public Register will be annotated to this effect in respect of such a WQO.

Where 'exceptional circumstances' relate only to particular weather conditions, the register will be annotated to the effect that in these circumstances analytical data for parameters (whether pH, zinc or copper, or any combination) affected as a result of exceptional circumstances will need to be disregarded in assessing compliance; the affected samples will be annotated to this effect on the Register.

5.3.2 Diffuse Sources

Typical relevant sources of diffuse inputs to rivers include runoff, leachate, mine drainage, acidic rainfall or contaminated baseflows. These commonly arise from such sources as waste tips, contaminated land, abandoned mines, runoff from urban areas, the burning of fossil fuels or other anthropogenic activities.

It may be difficult in practice to assess whether reduced pH and/or elevated metal concentrations, apparently arising from genuinely natural causes, are free from all diffuse anthropogenic influences. Equally, diffuse emissions of identifiably anthropogenic origin may not be readily amenable to control though the powers available to the NRA, or indeed may not be causing a permanent problem (for example, where pH is not reduced as the acidic inputs do not exceed the buffering capacity of the catchment).

An approach is adopted accordingly, to situations where compliance with a WQO is jeopardised in respect of pH and/or metals, which addresses whether the source of the problem is, in practicable terms, soluble over an identified timescale, as follows.

Where problems arise which are **attributable to a known responsible party**, and where the responsible party is committed to the improvements necessary to secure compliance with the River Ecosystem Class determinands by the date specified in the Notice establishing the WQO, analytical data will be fully taken into account in assessing compliance with the WQO.

Where problems are identified, but **a solution is possible only in the longer term**, analytical data for the affected determinands (whether pH, zinc or copper, or any combination) will be set aside when assessing compliance, though only on the basis of a time limit specified for this purpose in association with the WQO, and annotated as such in respect of the Public Register entry for the WQO.

Where problems arise but **no practicable solution can yet be identified**, the analytical data for the affected determinands (whether pH, zinc or copper, or any combination) will be set aside when assessing compliance, pending periodic review and the possible identification of a solution. In these circumstances, the Public Register will be annotated to this effect in respect of the WQO.

6.0 REPORTING ON WQOs AND COMPLIANCE ASSESSMENT

Details of WQOs assigned to river stretches, compliance with WQOs, and the monitoring data upon which compliance assessment is based, together with any of the 'exceptional circumstances' covered by Section 5 above which have been identified by the NRA as applying, will be included on the Public Register.

The NRA will report upon compliance with the requirements of WQOs at each relevant sampling point.

For many river stretches, a single sampling point will represent the water quality in the stretch for which the WQO has been applied. However, for the formal purpose of assessing compliance with WQOs where multiple sampling points exist within a river stretch, the stretch will only be deemed to comply with its WQO if all sampling points within the stretch comply with the requirements of the WQO.

Appendix 1: Weighting Factors for the Calculation of Confidence Limits for the Purpose of WQO Compliance Assessment

The weighting factors used in the calculation of 95% confidence limits are shifted T-test numbers[3]. For convenience, the weighting factors for calculation of confidence limits for up to 72 analytical results are listed below.

No. Samples	10 or 90-%iles	5 or 95-%iles	No. Samples	10 or 90-%iles	5 or 95-%iles
4	0.4428	0.7434	39	0.9655	1.2928
5	0.5177	0.8179	40	0.9691	1.2967
6	0.5737	0.8748	41	0.9725	1.3005
7	0.6180	0.9204	42	0.9758	1.3041
8	0.6541	0.9581	43	0.9790	1.3077
9	0.6845	0.9900	44	0.9821	1.3111
10	0.7105	1.0174	45	0.9851	1.3144
11	0.7330	1.0413	46	0.9881	1.3176
12	0.7529	1.0625	47	0.9909	1.3207
13	0.7706	1.0815	48	0.9936	1.3237
14	0.7866	1.0985	49	0.9963	1.3267
15	0.8011	1.1140	50	0.9989	1.3295
16	0.8143	1.1282	51	1.0014	1.3323
17	0.8264	1.1412	52	1.0038	1.3350
18	0.8375	1.1532	53	1.0062	1.3376
19	0.8477	1.1643	54	1.0085	1.3402
20	0.8573	1.1747	55	1.0108	1.3427
21	0.8662	1.1843	56	1.0130	1.3451
22	0.8745	1.1934	57	1.0151	1.3475
23	0.8824	1.2019	58	1.0172	1.3498
24	0.8897	1.2099	59	1.0192	1.3521
25	0.8967	1.2175	60	1.0212	1.3543
26	0.9033	1.2247	61	1.0232	1.3564
27	0.9095	1.2315	62	1.0251	1.3585
28	0.9154	1.2379	63	1.0269	1.3606
29	0.9210	1.2441	64	1.0288	1.3626
30	0.9264	1.2499	65	1.0305	1.3646
31	0.9315	1.2555	66	1.0323	1.3665
32	0.9364	1.2609	67	1.0340	1.3684
33	0.9411	1.2660	68	1.0356	1.3702
34	0.9456	1.2709	69	1.0373	1.3720
35	0.9499	1.2756	70	1.0389	1.3738
36	0.9540	1.2802	71	1.0404	1.3755
37	0.9580	1.2846	72	1.0420	1.3772
38	0.9618	1.2888			

[3] These weighting factors can be calculated from Pearson E.S. and Hartley H.O. (1972). *Biometrika Tables for Statisticians.* Vol.II. Cambridge University Press.

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The NRA is committed to the principles of stewardship and sustainability. In addition to pursuing its statutory responsibilities as Guardians of the Water Environment, the NRA will aim to establish and demonstrate wise environmental practice throughout all its functions.