UK Technical Advisory Group
on the Water Framework Directive

# Updated Recommendations on Environmental Standards

## River Basin Management (2015-21)

## Draft

(SR3 – 2012)

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WFD UK TAG
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# CHAPTER 1 – INTRODUCTION

The UK Technical Advisory Group (UKTAG) develops and makes recommendations to the UK's government administrations on the environmental standards[1] for implementing the Water Framework Directive. The UKTAG is a working group of experts drawn from environment agencies and conservation agencies[2]. It also includes representatives from the Republic of Ireland.

The group also offers advice to the agencies that provide its members.

In using the term "standard", the UKTAG means numerical limits on things like the concentrations of chemicals, river flow or water levels, or measurements for biological communities. In some cases a failure of a standard leads directly to firm action on protection. In others, a failure leads only to further investigation and monitoring

Proposals for standards were first published in 2007 and 2008 [1-5]. These were adopted for the first cycle of the Directive's river basin management plans. The plans were published in 2009. The standards help focus efforts to improve and protect the water environment.

The present document contains proposals for new and revised standards. The proposals are seen as sufficiently developed to help with the second cycle of plans.

As understanding improves, any standard can be revised. The UKTAG's role is to look at the evidence. This can lead to proposals that are tighter or more relaxed than current standards. The report also maps out plans for future work.

**As part of the review of its proposals, the UKTAG welcomes your comments via its website: www.wfduk.org/stakeholders/stakeholder-review**

Once the UKTAG has taken your comments into account, a final report will be sent as advice to the government administrations, and to environment agencies and conservation agencies.

The approach to the adoption and implementation of proposals can vary for each country within the UK, depending on present and proposed legislation, and on policy in each country. This is for Ministers to decide.

[1] These encompass the words of the Directive - values, concentrations and Environmental Quality Standards. It covers standards used for classification, and standards used to decide action. It also covers guideline values, thresholds and conditions that might be used to take a next step in further work on classification and in investigations needed to decide action.

[2] Countryside Council for Wales (CCW), Natural England (NE), Environment Agency (England and Wales), Northern Ireland Environment Agency (NIEA), Joint Nature Conservation Committee (JNCC), Scottish Environment Protection Agency (SEPA), Scottish Natural Heritage (SNH), Republic of Ireland's Department of Environment, Community and Local Government (DECLG).

## SCOPE OF THE REPORT

This report covers:

- standards for certain chemicals known as Specific Pollutants
- developments in the assessment of risks to groundwater
- non-native species
- standards for flows in rivers
- standards for levels in lakes
- standards for acidity in rivers.

The standards recommended:

- are matched correctly to processes of monitoring and mathematical modelling;
- allow a proper assessment of compliance;
- lead to sound and transparent methods for taking decisions to protect and improve the water environment.

This report does not describe all the details of these three activities. This is done by the individual agencies and countries, within the requirements of the Directive.

## THE WATER FRAMEWORK DIRECTIVE

The Directive[1] sets out objectives for rivers, lakes, groundwater, estuaries and coastal waters. The objectives are set for "water bodies" and expressed in terms of "status". The objectives include:

- prevent a deterioration in status;
- aim to restore water bodies to good status by 2015.

"Alternative objectives" can be set, for example, if the measures that achieve good status by 2015 would be "technically infeasible" or "disproportionately expensive"[2]. In such cases, the Directive allows an extension to the timetable, or, subject to review every six years, an objective that is less stringent than good status.

Certain uses of water, such as navigation, flood defence and the generation of hydropower, might lead to and depend on physical alterations to a water body. These can be incompatible with good status. Such waters can be defined as Heavily Modified Water Bodies. Objectives are set for these waters that can be met without having a significant effect on the uses that led to the designation of "Heavily Modified".

[1] 2000/60/EC
[2] The circumstances under which Alternative Objectives are used are outlined in UKTAG recommendations on a consistent list of reasons for setting alternative objectivesin accordance with the Water Framework Directive' (refer to: http://www.wfduk.org/reference/setting-objectives-water-environment and in the European guidance on objective setting (refer: http://ec.europa.eu/environment/water/water-framework/objectives.html).

## THE ROLE OF STANDARDS

Standards are matched to the objectives of the Directive. The environment agencies use standards to suggest, for example, limits on the amount of water that can be abstracted, and restrictions on how much pollutant can enter the environment. In this way, the environment agencies assess and control, for example, the impact of industries and the effects of land use.

A new discharge will not be allowed, for example, to cause the concentration of a pollutant to increase in a water body up to the limit defined by a standard for the water body. In practice, less than this is authorised. The decision on how much of a pollutant can be discharged or how much water can be abstracted is taken in the context of long term plans for development, and will address the requirements of the legislation in terms of caution or exceptions.

Where standards are met, the agencies seek to prevent new developments from causing a future deterioration of status. They do this by limiting, for example, how much of a pollutant can be discharged, so that environmental standards are not breached in future.

In cases where a standard has already been failed, there are at least two ways in which standards are used to make decisions:

- Direct: In this case there is no need, for example, to collect and assess local data on biology to confirm that there is damage – the standard is such that the risk is clear once it is failed.

- Indirect: This applies where there is less confidence that failure of the standard is always associated with harm. We need to examine whether a water body is actually damaged by the failure. We check, for example, for the absence of key species, the occurrence of nuisance species, or do calculations using mathematical models to confirm a link between the failure and the damage.

Action to improve or protect the condition of the water environment may take at least two forms:

- Calculate local and bespoke controls, in order to meet a standard in a particular water body.

- Apply uniform controls across all operators of a certain type or size. This constitutes a step that benefits all water bodies in a region or nation – a step that can be reduced or extended once its impact is demonstrated.

### Assessing compliance and confidence

In most cases, data from monitoring are used to make a comparison with the standard. In others, calculations with mathematical models are also used to assess whether a standard is passed or failed. The output from such data or models will always be associated with uncertainty. The UKTAG requires that such errors can be and are quantified, and that they can be used in all assessments of compliance. This allows a general facility to state the confidence that any standard has been met or failed.

The Directive expects us to know and report these levels of confidence. They help decide the amount of monitoring required to detect particular levels of failure or deterioration. The confidence that the standard has been failed or met is also important in deciding action to secure compliance or prevent deterioration.

In many cases where a standard is used to assess compliance, the same standard plays a direct part in designing action to achieve compliance or prevent deterioration. Within the process of deciding action to remove failure, the advice of the UKTAG is often that that standard be used in a way that demands more statistical confidence than might have been used to assess the reported failure in the first place.

For some standards action may also be deemed to require extra corroboration such as that provided by biological and chemical evidence that both point to the same damage or risk. Lack of such corroboration may indicate that action should be postponed.

The net result is that initial assessments of compliance can indicate more failure than will justify eventual action.

## Classification

We have already noted the term “good status”. Surface water bodies are assigned to one of five classes: high, good, moderate, poor or bad status. To assign a class, the UK agencies start by assessing the condition of communities of plant and animals. The achievement of environmental standards for things like chemicals is also taken into account. For example, if a water quality standard identified for good status is not met, the status will be moderate or worse.

The Directive requires that the overall status of the water body is determined by the lowest status from all the standards that have been assessed. This is known as the ‘one out – all out’ rule. To have high status, for example, a water body cannot fail any of the standards associated with high status[1].

The use of the one-out all-out rule means that numbers expressed in terms of the percentage of water bodies in good or better status have a strong pessimistic bias. This error is caused by the largely unavoidable uncertainties in monitoring. These generate a risk of declaring wrongly that a standard is passed or failed[2].

To help minimise this bias, UKTAG recommends that in cases where a pressure can be measured in several ways, only the single most sensitive indicator is used in classification. It also recommends that, in reporting results, emphasis is given to reports of the separate assessments of each type of impact on water bodies (for example, the effect of abstractions; impact of pollution by nutrients; etc) rather than to summaries that combine all assessments across all the impacts.

[1] This covers all the indicators used to classify, whether for biological quality, river flow and water levels, chemical quality, or whatever, are covered by the general description “quality elements”.
[2] Consider a site that is truly in good status which has six separate standards that have confidence from monitoring that they are wrongly reported as falling in one year in 10. This site will be will be reported wrongly as worse than good in 5 years in 10. For 20 standards this rises to 9 in 10.

## River Basin Management Plans

The environment agencies will produce drafts for the second cycle of river basin management plans and issue them for public consultation by the end of 2014. To prepare the plans, the agencies estimate the shortfall in meeting the standards established for the Directive's objectives. The agencies use monitoring and assessment, targeted at risk, and focused on the causes of these risks. They seek to calculate what needs to be done to achieve the standards.

All contributions to current or potential failure are considered. This means looking at water quality, water quantity, and the impact of man-made structures. It involves checking the contributions from groundwater to the failure of standards in rivers, lakes and wetlands. It means looking at the effect of physical changes to water bodies, at the impact of current and future abstractions and discharges, and at contributions from the uses made of land.

The agencies, in partnership with others, appraise options to meet the objectives and identify the most cost-effective combinations of actions. The plans are also subject to "regulatory impact assessment" and "strategic environmental assessment", where appropriate. These cover estimates of the full costs and benefits and who will pay and receive these.

## Protected Areas

Member States must also meet objectives that originate in legislation outside the Water Framework Directive. Such legislation can lead to the definition of waters as various types of "protected area". Where this means that a water body has more than one objective, the most stringent requirement applies. The context of the particular legislation can dictate the eventual action.

As well as protecting and improving the status of water bodies, river basin management planning is intended to help secure the achievement of the objectives for protected areas. These include areas designated for the conservation of habitats and species, such as Special Areas of Conservation, where the maintenance or improvement of the status of water is an important factor in their protection.

The conservation agencies set conservation objectives for Natura 2000 sites[1] and other Sites of Special Scientific Interest. These objectives are underpinned by standards which are used in reporting and to guide decision-making on designated sites. The standards are based on a Common Standards Guidance which is agreed across the conservation agencies.

[1] That is, sites designated under the Birds or Habitats Directives for species or habitats of importance at European level.

The UKTAG has examined the evidence used to develop Common Standards for a number of parameters (river flow, organic determinands and nitrate in wetlands [6-9]). The aim is to align, where possible, standards for the Water Framework Directive and Natura 2000 Protected Areas. This work is still ongoing and, as a result, proposals for Natura 2000 sites are not included in the chapters of this report. The indications are that some of the standards recommended for protecting the status of water bodies could also apply in the context of Natura 2000.

## DERIVING STANDARDS

The UKTAG seeks standards that apply to all water bodies of the same type. It wants standards that can lead to and make use of sound monitoring programmes and so produce unbiased estimates of compliance and national performance. These help take decisions to improve and protect waters, decisions that are well-targeted and which can be shown not to be wasteful.

In developing some of its standards, the UKTAG may be able to use biological data collected from hundreds or thousands of sites. The UKTAG can compare these with information for the same sites on the environmental conditions to which the plants and animals are sensitive. This process can identify standards that correspond directly with the biological definition of good status. Such standards are well matched to the objectives expanded in the preceding paragraph – produce sensible estimates of compliance and lead to good decisions.

In other cases, in estuaries and coastal waters for example, and generally for pollutants not subject to big programmes of monitoring, there are insufficient data to derive standards in this way. In such cases, the UKTAG uses the current scientific understanding of the causes of ecological change. The UKTAG compares this understanding with the Directive's biological descriptions of the classes. In doing this, the UKTAG relies on advice from independent experts from a range of scientific disciplines. The UKTAG has used this approach to identify limits for river flow and water levels, and for standards for particular chemicals.

## REVISING THE STANDARDS

Existing standards may need to be revised for two main reasons:

- Biological standards have changed: the UK works with Member States[1], and with the European Commission, to compare methods of biological classification. This is known as inter-calibration. The aim is to ensure that the boundaries of good status are consistent across Europe and within the Directive's requirements[2]. The results of inter-calibration may lead to new or revised biological standards. To achieve these may require that new or revised environmental standards are developed for water quality, water flows or levels, or morphological characteristics of water bodies.

[1] And Norway.
[2] So that what constitutes "good" status in the UK is consistent with "good" status in another European country.

- Improved scientific understanding: environmental standards are also revised where improved understanding through research and monitoring, or the benefit of experience in their practical application, shows that existing standards are not as well matched to ecological quality as they could be.

# CHAPTER 2: STANDARDS FOR SPECIFIC POLLUTANTS

The Water Framework Directive requires that Member States identify Specific Pollutants[1] and set standards for them. Specific Pollutants are toxic substances that are discharged in significant quantities into the water environment. Previous work by the UKTAG has led to standards for 19 Specific Pollutants [1]. These are:

| |
|---|
| ammonia, arsenic, chlorine, chromium(III), chromium(VI), copper, cyanide, cypermethrin, diazinon, 2,4-dichlorophenol, 2,4-dichlorophenoxyacetic acid (2,4-D), dimethoate, iron, linuron, mecoprop, permethrin, phenol, toluene and zinc |

The standards for these were used in the first cycle of river basin management plans. For 11 of the substances, the standards were the same as those set previously under the Dangerous Substances Directive. These substances are underlined in the above list. The UKTAG has looked again at these in the light of the latest scientific information.

The UKTAG now recommends that 10 further pollutants are identified as Specific Pollutants. This chapter sets out the UKTAG's proposals on standards for these [2]. The standards are set out later in Table 2.1 to 2.18. This chapter describes:

(a) the way proposed new Specific Pollutants are selected;
(b) the process used to derive the standards;
(c) the proposed standards;
(d) how these differ from the existing standards;
(e) estimates of the extent of compliance with the standards.

This chapter also suggests how the proposed standards should be used to:

- assess the ecological status of bodies of surface water;
- identify where action should be taken and what action is needed.

The UKTAG uses a process that reviews the scientific basis of a standard [3]. The process also looks at the use of the standard to take decisions, and ensures the standard could be used to assess correctly the impact on those who will need to invest in action to secure compliance. The standard must be expressed in a way that renders it suitable for use in an economic assessment of the action needed to comply[2].

[1] Pollutants covered by Annex VIII, points 1 to 9, of the Water Framework Directive. The identification of Priority and Priority Hazardous Substances and the setting of their standards is done at the European level. There is no requirement in the Water Framework Directive for standards for Specific Pollutants to be set so as to protect human health. Separate EU legislation, such as the Drinking Water Directive and the Food Hygiene Regulations, cover the requirements of human health.
[2] For example, to allow correct calculations in any Regulatory Impact Assessment that may be required.

## SELECTING SPECIFIC POLLUTANTS

### Selecting new candidate substances

The UKTAG started by considering more than 300 chemicals[1]. The list included substances covered by existing legislation, substances subject to obligations for monitoring, and substances that have emerged as possible concerns.

The substances were ranked using a process consistent with European guidance [4][2]. For each substance, this covers:

- the hazardous properties: the toxicity, persistence, and potential to accumulate in organisms;
- potential exposure of the environment to the substance. This is based on the extent and pattern of use, and on data from monitoring.

Each substance is scored against these criteria and the results are combined into a single number. A value of 1 indicates high risk; a value of 5 suggests very low risk. Substances ranked 1 or 2 are considered as candidates for Specific Pollutants.

Sixty-nine substances were scored as 1 or 2. Their ranking was subject to peer review. As a result of this review a substance either:

- is a priority for the development of standards (and a candidate Specific Pollutant); or
- is not a priority because other issues influence the potential use of the substance[3], or because controls of the substance are already in place; or
- requires investigation or monitoring to improve confidence in the ranking.

Fifteen substances emerged as potential new Specific Pollutants. The list was reduced to ten because three are under consideration at the European level as Priority Substances[4], and, for another two, aluminium and silver[4,5], the review concluded that there was insufficient information to derive standards. The UKTAG recommends that the remaining 10 are identified as Specific Pollutants:

| |
|---|
| benzyl butyl phthalate, carbendazim, chlorothalonil, 3,4-dichloroaniline, glyphosate, manganese, methiocarb, pendimethalin, tetrachloroethane and triclosan |

[1] The list of substances for identifying candidate Specific Pollutants is kept under review by the UKTAG.
[2] The process of ranking applies to organic chemicals, but the UKTAG looked also at inorganic substances, (metals) and substances identified as potential candidates during the previous review of Specific Pollutants [1].
[3] For example, the substance is no longer approved for use.
[4] And so need not be considered as Specific Pollutants at this time.
[5] For silver, for example, a standard could be derived and data from monitoring indicates low risk. But there is a need to consider the issue of nanosilver as more data become available. It was therefore decided not to take forward a proposal at this time.

### Looking again at established Specific Pollutants

As noted above, the UKTAG has also reviewed standards for 11 Specific Pollutants for which it had previously recommended the continued use of old standards [1][1]. Because of new scientific information, the UKTAG is now in a position to recommend revised standards for the following eight of these:

| |
|---|
| copper, cyanide, diazinon, 2,4-dichlorophenol, iron, permethrin, toluene, zinc |

The standards these eight substances are set out later in Table 2B. For the other three, arsenic, ammonia and chlorine, the UKTAG recommends keeping the existing standards.

### Uses and sources of the chemicals

A summary of the main uses and likely sources of these chemicals is given in Table 1.

**Table 1: Main uses of the chemicals and their potential sources**

| Substance | Major uses | Likely sources in surface waters |
|---|---|---|
| benzyl butyl phthalate | PVC plasticizer occurring in a wide range of industrial and domestic products | wastewater treatment works, industrial effluents |
| carbendazim* | fungicide used in horticulture and agriculture | diffuse agricultural |
| chlorothalonil* | fungicide used in agriculture, horticulture and amenity turf | diffuse agricultural |
| copper | widespread occurrence in domestic and industrial applications | domestic sources (wastewater treatment works), industrial effluents, minewaters, sediments |
| cyanide | industrial applications and a chemical intermediate | industrial effluents, wastewater treatment works |
| diazinon* | organophosphate insecticide, with agricultural, horticultural and veterinary uses (sheep dip) | diffuse and point source agricultural |
| 3,4-dichloroaniline | industrial intermediate | industrial effluents, wastewater treatment works |
| 2,4-dichlorophenol | industrial intermediate | industrial effluents, wastewater treatment works |
| glyphosate* | herbicide, including aquatic weed control | diffuse, including amenity, industrial and agricultural uses |
| iron | wide range of industrial and domestic applications; wastewater treatment | domestic sources (wastewater treatment works), industrial effluents, minewaters |

[1] These substances were set up as Specific Pollutants through Directions in England, Wales and Scotland and Regulation SR 2011 Number 10 in Northern Ireland.

| | | |
|---|---|---|
| manganese | industrial applications (e.g. metal alloys, pigments, electrical) | industrial effluents, minewaters, domestic sources (wastewater treatment works), sediments |
| methiocarb* | carbamate insecticide and molluscicide | diffuse agricultural |
| pendimethalin* | agricultural herbicide | diffuse agricultural |
| permethrin* | pyrethroid insecticide, including some household uses | diffuse agricultural and domestic sources |
| tetrachloroethane | industrial solvent and intermediate | industrial effluents, wastewater treatment works |
| toluene | industrial solvent and intermediate | industrial effluents, wastewater treatment works |
| triclosan | biocide (antibacterial); widely used in domestic products and personal care products | domestic sources (wastewater treatment works) |
| zinc | wide range of uses in domestic and industrial applications | domestic sources (wastewater treatment works), industrial effluents, minewaters, sediments |
| * A pesticide currently approved for use in the UK | | |

**Other existing standards**

A number of substances were previously identified in the UK under the Dangerous Substances Directive and standards set for them at national level. These are known as "List II" substances. Twelve of these were not included in the previous lists of Priority Substances identified at European level nor in the lists of Specific Pollutants recommended by UKTAG. The Dangerous Substances Directive will be repealed in 2013. The UKTAG has reviewed the risks posed by these List II substances [5]. The 12 substances are[1]:

bentazone, biphenyl, 4-chloro-3-methylphenol, chloronitrotoluenes, 2-chlorophenol, dichlorvos, fenitrothion, malathion, 1,1,1-trichloroethane, 1,1,2-trichloroethane, triphenyltin, xylene

Nearly all of these are no longer used in the UK or have extensive controls on their marketing and use. None has been identified in significant concentrations by programmes of monitoring. Consequently, the UKTAG is not recommending these pollutants as Specific Pollutants. Existing measures and policies will deliver progressive reductions without further action at this time.

One of the substances, dichlorvos, has recently been suggested by the European Commission for identification as a Priority Substance; future controls for this substance may be put in place at the European level.

Standards previously established under the Dangerous Substances Directive can still be used as operational values for those situations where the substances occur.

[1] Substances no longer authorised for use were not included in the main review, but were considered in an annex [6]. These were azinphos-methyl, demeton, omethoate, triazophos, PCSDs, sulcofuron and flucofuron.

## DERIVING THE STANDARDS FOR SPECIFIC POLLUTANTS

The method is based mainly on laboratory work on toxicity, supported by field data where available[1]. The process is outlined below[2]:

**Step 1:** Identify what may be at risk. This covers, for example, aquatic animals and plants, sediment-dwelling organisms, or predators that feed on aquatic organisms.

**Step 2:** Collate information on the effects on aquatic biota[3]. Assess the quality of the data and decide which are critical. This work includes determining:

- the quality of the toxicity data – whether the observed effects are relevant and big enough to be of concern, and whether the studies that produced them are reliable;
- the particular chemical form of the substance that is toxic;
- whether naturally occurring concentrations are likely, and whether biota acclimatise to these.

**Step 3:** Use these data to derive Predicted No-Effects Concentrations (PNEC)[4]. This is done by extrapolating from a concentration that shows no effect on biota in laboratory experiments. This projection can be done in two ways:

1. Start from the most sensitive species

   The process for the Water Framework Directive starts with the lowest credible toxic concentration for any of the biota tested. This concentration is tightened by a safety factor[5] that lies between 10 and 1000. Low confidence in the set of data, for example because only a small range of species is covered, leads to the use of a high safety factor[6].

2. Use mathematical models

   Species Sensitivity Distribution Models describe the number of species likely to be affected by a particular concentration. Such models can be used for chemicals where data are plentiful. The model can improve confidence in the value chosen to derive the PNEC and so allow the safety factor to be reduced to between 1 and 5.

In the case of iron, conventional laboratory data on toxicity are difficult to interpret. The UKTAG has applied an approach based on the use of field data to identify the concentration of total iron at which invertebrates appear consistent with good (or better) status. This threshold has been used as the basis for the proposed standard.

[1] For most substances, extensive sets of field data on chemistry and biology are not available.
[2] Annex B of the supporting report [2] sets out in more detail the process for developing standards.
[3] The UKTAG uses the outputs of European risk assessments where these are available.
[4] The PNEC is the concentration below which no harmful effects would be expected.
[5] These factors, called "assessment factors", are applied as specified in the EU guidance [5]. A smaller assessment factor might be justified, for example when the toxicity dataset on which the PNEC is based includes taxa that the UKTAG expects to be particularly sensitive to that substance.
[6] A factor of 10 means that the standard will be one tenth of the value derived from the laboratory work.

**Step 4:** Set up a peer review of the PNECs to seek confirmation that they are valid scientifically, and that the data used to derive them are sound and complete. The PNECs that come through this process can then be recommended as the basis for new standards. Those that do not are the subject of proposals for further work.

Separate PNECs are derived for freshwaters and marine waters. These reflect differences in chemical behaviour in these media, and the different assemblages of organisms that might be exposed. Within these, two PNECs are often provided for each substance. The first leads to a short-term standard. The PNEC for this is usually based on data from studies of acute toxicity from experiments that last for hours or a few days. The standard aims to protect against brief periods of exposure.

The second PNEC leads to a long-term standard. This is derived from chronic toxicity tests, typically conducted over weeks, months or even years. The tests measure the effects on reproduction, growth and development; the PNEC is designed to protect against prolonged or continuous exposure.

### Scientific peer review

A panel of independent scientists from the UK has advised on the adequacy of the data, the extent to which these data should influence the final PNEC, and how the UKTAG should interpret the data. The results have been discussed at several workshops attended by members of the UKTAG, contractors undertaking some of the scientific assessments, and peer reviewers.

Generally, the proposals of the UKTAG represent the consensus of the reviewers. Any differences are discussed in the technical reports.

**Step 5:** The final step looks at the practicalities of implementing a standard.

### Accepting a Predicted No-Effect Concentration as the basis for a standard

The UKTAG does not recommend a standard if the safety factor[1] is greater than 50 for freshwater, or 100 for salt water [2]. If for these reasons neither freshwater nor salt water standards can be recommended, the substance is not recommended for identification as a Specific Pollutant.

[1] Used in Step 3, above.

When data are sparse, a large safety factor is applied to allow for the uncertainty that results from this. However, a large safety factor can lead to standard that is too strict in terms of the cost and benefits of meeting the standard compared with the cost of getting better data. Failure of such a standard should trigger the generation of data to help reduce uncertainty and so lead to a smaller safety factor. The UKTAG will identify studies that could lead to smaller safety factors.

In a previous report [1], the UKTAG was unable to make proposals for some substances and so commissioned new data on toxicity. Some of the proposals in this report reflect these new data. Other data (for example, from field monitoring) have also increased confidence in some of the proposed standards.

Proposals for a salt water standard are not made where the use of a substance is likely to result only in discharges to freshwater, and the impact disappears before rivers reach the sea. This is the case, for example, for many agricultural pesticides.

## RECOMMENDATIONS

The UKTAG recommends new standards for 18 substances: benzyl butyl phthalate, carbendazim, chlorothalonil, copper, cyanide, diazinon, 3,4-dichloroaniline, 2,4-dichlorophenol, glyphosate, iron, manganese, methiocarb, pendimethalin, permethrin, tetrachloroethane (TCE), toluene, triclosan and zinc [2,6][1].

Tables 2.1 to 2.18 set out the UKTAG's proposed standards for the recommended new Specific Pollutants and the proposed revisions to standards for existing Specific Pollutants. Unless specified otherwise, the standards apply to unfiltered samples[2].

| **Table 2.1: Recommended standards benzyl butyl phthalate (µg/l)** | | | | |
|---|---|---|---|---|
| Water | Exposure | Annual statistic | UKTAG proposal | Existing standard |
| Fresh | Long-term | Mean | 7.5 | *20* |
| | Short-term | 95-percentile | 51 | *100* |
| Salt | Long-term | Mean | 0.75 | *20* |
| | Short-term | 95-percentile | 10 | *100* |
| The proposed salt water standard is derived using a safety factor of 100. Where the standard is failed, it is recommended that supporting evidence of ecological damage should be obtained before committing to expensive action. | | | | |

[1] The supporting report [2] sets out information for each proposed standard. The detailed documents are available via the UKTAG [6]. The standards apply to the water column as opposed, say, to sediments.
[2] This is in line with the approach adopted at EU level for setting standards for priority substances.

| Table 2.2: Recommended standards for carbendazim (μg/l) | | | | |
|---|---|---|---|---|
| Water | Exposure | Annual statistic | UKTAG proposal | Existing standard |
| Fresh | Long-term | Mean | 0.15 | *0.1* |
| | Short-term | 95-percentile | 0.7 | *1.0* |

| Table 2.3: Recommended standards for chlorothalonil (μg/l) | | | | |
|---|---|---|---|---|
| Water | Exposure | Annual statistic | UKTAG proposal | Existing standard |
| Fresh | Long-term | Mean | 0.035 | *0.1* |
| | Short-term | 95-percentile | 1.2 | *1.0* |

| Table 2.4: Recommended standards for 3,4-dichloroaniline (μg/l) | | | | |
|---|---|---|---|---|
| Water | Exposure | Annual statistic | UKTAG proposal | Existing standard |
| Fresh | Long-term | Mean | 0.2 | – |
| | Short-term | 95-percentile | 5.4 | – |
| Salt | Long-term | Annual mean | 0.2 | – |
| | Short-term | 95-percentile | 5.4 | – |

| Table 2.5: Recommended standards for glyphosate (μg/l) | | | | |
|---|---|---|---|---|
| Water | Exposure | Annual statistic | UKTAG proposal | Existing standard |
| Fresh | Long-term | Mean | 196 | – |
| | Short-term | 95-percentile | 398 | – |
| Salt | Long-term | Mean | 196 | – |
| | Short-term | 95-percentile | 398 | – |

| Table 2.6: Recommended standards for manganese | | | | |
|---|---|---|---|---|
| Water | Exposure | Annual statistic | UKTAG proposal | Existing standard |
| Fresh | Long-term | Mean | 123 μg/l bioavailable | *30* μg/l dissolved |
| "Bioavailable" means the fraction of the dissolved concentration of manganese likely to result in toxic effects as determined in accordance with the Metal Bioavailability Assessment Tool (also referred to as a PNEC Estimator) for manganese [7] | | | | |

| Table 2.7: Recommended standards for methiocarb (μg/l) | | | | |
|---|---|---|---|---|
| Water | Exposure | Annual statistic | UKTAG proposal | Existing standard |
| Fresh | Long-term | Mean | 0.01 | *0.01* |
| | Short-term | 95-percentile | 0.77 | *0.16* |

| Table 2.8: Recommended standards for pendimethalin (µg/l) | | | | |
|---|---|---|---|---|
| Water | Exposure | Annual statistic | UKTAG proposal | Existing standard |
| Fresh | Long-term | Mean | 0.1 | *1.5* |
| | Short-term | 95-percentile | 0.58 | *6.0* |

| Table 2.9: Recommended standards for tetrachloroethane (TCE) (µg/l) | | | | |
|---|---|---|---|---|
| Water | Exposure | Annual statistic | UKTAG proposal | Existing standard |
| Fresh | Long-term | Mean | 140 | – |
| | Short-term | 95-percentile | 1848 | – |

| Table 2.10: Recommended standards for triclosan (µg/l) | | | | |
|---|---|---|---|---|
| Water | Exposure | Annual statistic | UKTAG proposal | Existing standard |
| Fresh | Long-term | Mean | 0.1 | – |
| | Short-term | 95-percentile | 0.28 | – |
| Salt | Long-term | Mean | 0.1 | – |
| | Short-term | 95-percentile | 0.28 | – |

| Table 2.11: Recommended standards for copper | | | | |
|---|---|---|---|---|
| Water | Exposure | Annual statistic | UKTAG proposal | Existing standard |
| Fresh | Long-term | Mean | 1µg/l bioavailable | *1–28* µg/l dissolved |
| Salt | Long-term | Mean | 2.64 µg/l dissolved, where DOC ≤ 1 mg/l | *5* µg/l dissolved |
| | | | 2.64 + (2.677 x ((DOC/2) - 0.5)) µg/l dissolved, where DOC > 1 mg/l | |

Notes:

"Bioavailable" means the fraction of the dissolved concentration of copper likely to result in toxic effects as determined using the Metal Bioavailability Assessment Tool (also referred to as a PNEC Estimator) for copper [8].

"DOC" means the annual mean concentration of dissolved organic carbon in mg/l.

The proposed salt water standard applies to the fraction of a water sample that passes through a 0.45-µm filter or that is obtained by any equivalent pre-treatment.

The existing freshwater standard depends on the hardness of the water.

| **Table 2.12: Recommended standards for cyanide ('free' i.e. µg/l of HCN/l)** | | | | |
|---|---|---|---|---|
| Water | Exposure | Annual statistic | UKTAG proposal | Existing standard |
| Fresh | Long-term | Mean | 0.26 | *1* |
| | Short-term | 95-percentile | 2.8 | *5* |
| Salt | Long-term | Mean | 0.052 | *1* |
| | Short-term | 95-percentile | 0.42 | *5* |

| **Table 2.13: Recommended standards for diazinon (µg/l)** | | | | |
|---|---|---|---|---|
| Water | Exposure | Annual statistic | UKTAG proposal | Existing standard |
| Salt | Short-term | 95-percentile | 0.26 | *0.1* |
| No changes are proposed to the UKTAG"s existing recommendations on freshwater standards for diazinon or to its recommended long-term salt water standard. | | | | |

| **Table 2.14: Recommended standards for 2,4-dichlorophenol (µg/l)** | | | | |
|---|---|---|---|---|
| Water | Exposure | Annual statistic | UKTAG proposal | Existing standard |
| Fresh | Long-term | Mean | 4.2 | *20* |
| | Short-term | 95-percentile | 140 | – |
| Salt | Long-term | Mean | 0.42 | *20* |
| | Short-term | 95-percentile | 6 | – |

| **Table 2.15: Recommended standards for iron** | | | | |
|---|---|---|---|---|
| Water | Exposure | Annual statistic | UKTAG proposal | Existing standard |
| Fresh | Long-term | Mean | 730 µg/l total | 1000 µg/l dissolved |
| No change is proposed to the UKTAG's previously recommended standard for iron in salt waters | | | | |

| **Table 2.16: Recommended standards for permethrin (µg/l)** | | | | |
|---|---|---|---|---|
| Water | Exposure | Annual statistic | UKTAG proposal | Existing standard |
| Fresh | Long-term | Mean | 0.001 | - |
| | Short-term | 95-percentile | 0.01 | *0.01* |
| Salt | Long-term | Mean | 0.0002 | - |
| | Short-term | 95-percentile | 0.001 | *0.01* |

| **Table 2.17: Recommended standards for toluene (µg/l)** | | | | |
|---|---|---|---|---|
| Water | Exposure | Annual statistic | UKTAG proposal | Existing standard |
| Fresh | Long-term | Mean | 74 | *50* |
| Salt | Long-term | Mean | 74 | *40* |
| No changes are proposed to the UKTAG's existing recommendations on short-term standards for toluene in freshwaters and salt waters | | | | |

| Table 2.18: Recommended standards for zinc | | | | |
|---|---|---|---|---|
| Water | Exposure | Annual statistic | UKTAG proposal | Existing standard |
| Fresh | Long-term | Mean | 10.9 µg/l bioavailable additional to natural background | *8–125* µg/l total |
| Salt | Long-term | Mean | 3.4 µg/l dissolved additional to natural background | *40* µg/l total |

"Bioavailable" means the fraction of the dissolved concentration of zinc likely to result in toxic effects as determined in accordance with the Metal Bioavailability Assessment Tool (also referred to as a PNEC Estimator) for zinc [9].

"Natural background" means the concentration expected with no or only minor anthropogenic inputs [10]. See also box below. For freshwaters, the natural background concentration refers to the bioavailable fraction.

The existing freshwater standard depends on the hardness of the water.

**Methods for deriving natural background concentrations for zinc**

There are several methods by which background concentrations for zinc may be derived in practice [10]. For freshwaters, these include:

a. concentrations in springs or in water bodies in pristine areas in the given region, for example in headwaters
b. the 10-percentile concentration of dissolved metal of all the monitoring data available for the water body or region (after removing sample results with elevated concentrations from known point source discharges or pollution events). The UKTAG has started to explore this option.
c. existing data in national or international databases, such as the FOREGS Geological Baseline Programme (http://www.gsf.fi/foregs/geochem).
d. modelled estimates of the contribution to surface waters from erosion.
e. concentrations found in groundwater
f. background concentrations found in the sediment using equilibrium partitioning models.

For salt water, these include:

g. concentrations out at sea; in freshwater draining to the coastal water; or the combination of both.
h. the 10-percentile of concentrations measured in coastal waters that are considered to be largely uncontaminated.

The standards are defined as summary statistics so that they can be used correctly in classification, and in a transparent manner to calculate the action needed for compliance. For a long-term PNEC, the standard is an annual mean.

For most substances, the annual mean is well correlated with the probability that higher and lower concentrations occur within a year. Also, for many types of risk, measures taken to comply with an annual mean act in parallel on the risks associated with the full spread of concentrations that make up the annual mean.

Given a particular level of monitoring at a site, the annual mean is estimated more precisely than, say, the annual 95-percentile or a maximum. This means that the use of the annual mean, where appropriate, helps detect with confidence, smaller degrees of failure.

For a short-term standard, the PNEC is usually presented as a "Maximum Allowable Concentration (MAC)". If the MAC is used as an absolute "maximum", serious and arbitrary errors will result. These lead to a biased classification of water bodies, and wrong decisions on action to secure compliance. Any proposed short-term standard is therefore defined by the UKTAG as an annual 95-percentile[1].

Experience has shown that most decisions to protect water quality can be based successfully on samples collected 12 times per year. This means that we accept the risk of exceeding the MAC and not knowing (because we don't sample all the time). A sampling rate of 12–20 samples per year is the mathematical equivalent of assuming that the MAC is an annual 90 or 95-percentile.

For standards set as the annual mean or an annual percentile, there is full scope to calculate correctly the extent and costs of actions needed to secure compliance. For example, the improvements to discharges can be calculated to ensure the standard is met in the receiving water. This is not possible with a standard that is expressed as an absolute limit.

Where short-term standards are not proposed, the associated risk has been considered to be managed through the achievement of the long-term standards. The protection provided to meet the long-term standard is usually more stringent than the protection needed to meet the standards based on short-term toxicity.

Where the stringency embodied in the short-term standard is only slightly less than that in the long-term standard, compliance with the long-term standard may not give enough protection. For such substances, it may be necessary to use a short-term standard to protect more specifically against high concentrations that may occur in a year. Such circumstances also arise for substances whose concentrations are trivial most of the year, but high on rare occasions[2].

Generally, any protection that achieves an annual mean or an annual 95-percentile must be backed up with measures to control the risks from accidents and dramatic events. For some chemicals and their mode of use, the annual mean and annual 95-percentile may need to be augmented more prominently by extra measures to control the risks from accidents or illegal use.

[1] Unless a case is made for a seasonal mean or a different percentile.
[2] For example, in the case of a pesticide that is only used at a particular time of the year.

For substances such as pesticides, it may be useful to do additional monitoring during parts of the year when applications are most likely to occur. In such instances, it is important to avoid bias when determining compliance with a standard that is expressed as an annual mean or an annual percentile. For example, if we normally take 12 samples per year, but include an additional ten samples in a given month, all the data from that month would be used to provide an estimate of the monthly mean. This, in turn, would be used to calculate that month's contribution to the annual mean[1].

**Use of standards for taking action**

The UKTAG recommends that there should be at least 95% confidence that the standard is failed[2] before serious and expensive action to improve a site is sought.

For determining the compliance with the annual percentile, one method is to use a look-up table. Table 3 gives the number of failed samples required to give 95% confidence that a 95-percentile is failed[3]. Other methods, for example, assessing compliance with an annual mean, are based on an assumption of the statistical distribution of the spread of values of concentration. These approaches follow the International Standard ISO 5667-20 [11].

**Table 3: Look-up table for 95% confidence of failing a 95-percentile standard**

| Number of samples | Required number of exceeding samples |
|---|---|
| 4–7 | >1 |
| 8–16 | >2 |
| 17–28 | >3 |
| 29–40 | >4 |
| 41–53 | >5 |
| 54–67 | >6 |

Within a regime like Table 3, it remains important to note cases where a single sample result exceeds the concentration expressed as the annual 95-percentile short-term standard. This should be followed up as an indication of potential risk.

[1] Albeit with improved precision for the value for that month and in the estimate of the annual mean.
[2] Shortfalls in confidence can be made good by extra monitoring of compliance, or by seeking corroboration from other types of extra information.
[3] As used for 95% confidence of failure of 95-percentile standards under the Urban Waste Water Treatment Directive. Tables for other percentiles and other degrees of percentage confidence can easily be constructed.

**Use of standards for classification**

The annual mean long-term standard is usually the most appropriate and critical for classification. The UKTAG proposes that the annual 95-percentile standards are also used, within rules like those discussed above with Table 3.

## THE IMPLICATIONS OF THE PROPOSED STANDARDS FOR SURFACE WATERS

This section describes the likely implications of the standards in terms of compliance. Assessments have been made separately for each part of the UK and have relied mainly on existing monitoring data.

Much of current monitoring has been targeted at sites that are at risk on the basis of experience, or of knowledge of activities in the catchment.

Results[1] are given for face-value[2] estimates of failure and for failures recorded with high statistical confidence[3]. A good estimate of the proportion of failures at face value would be relevant to the development of national measures to improve compliance such as controls on the use of the chemical or land. Those with high statistical confidence imply high priority for local action.

For some substances there are few or no monitoring data available because the substances are not covered under existing legislation (and there is no requirement for monitoring) and because the substance has not previously been considered a threat to water quality.

These substances include the herbicide, glyphosate. This is sometimes used in the water environment to control aquatic plants. To do this, it has to be discharged in concentrations that are toxic to the target plants. This means there is a risk of exceedences of the type recorded under Table 3 for the proposed short-term standard. The target plants are often invasive species and their control can protect or improve the ecological quality of the water environment. Glyphosate is expected to break down quickly and so pose little risk to the wider aquatic ecosystem. Such occasional and short duration events would not be expected to affect decisions on classification.

Similarly the use of the standards proposed the UKTAG assumes ongoing application of the current controls and regimes that provide extra protection, where needed, against the risk extreme events, accidents, and the illegal actions that could might lead to incidents of pollution.

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[1] Using programmes of monitoring set up to meet the requirements of national or European laws.
[2] Face value gives at least at 50 per cent confidence of failure. Or, in stating compliance, at least 50% confidence of compliance. The estimates ignore statistical errors in monitoring data.
[3] 95–100% confident

Intermittent discharges of Specific Pollutants could result in concentrations in the environment that cause harm. Such concentrations may not be detected by the type of routine monitoring used to assess compliance with mean and 95 percentile standards in the receiving water, especially where compliance with the percentile standard is based on counting failed samples and using the ‘look up table’ reproduced in Table 3. In such a case, a water could be deemed compliant with the percentile even if one or two elevated (harmful) concentrations are picked up by monitoring. As noted above, the agencies would follow up such events.

Where such risks exist in known discharges, the UKTAG recommends that they are managed by the controls set in permits, perhaps designing the operation of the discharge to meet a 99 percentile standard in the receiving water as described in Chapter 7, or more extreme percentiles, and setting absolute limits on discharge quality. Where an intermittent discharge is expected to be frequent enough for the planned monitoring strategy to pick up occasional harmful concentrations, UKTAG also recommends using the parametric methods described in the relevant ISO Standard [11] to assess compliance with the percentile standards for waters.

### Implications for England

Table 4 gives estimates[1] of the numbers of monitored sites in England that would not meet the new long-term standards.

**Table 4: Specific Pollutants – implications for England**

| Substance | Freshwater sites ‘not good’ | | Number of sites assessed |
|---|---|---|---|
| | Face value | At 95% confidence | |
| Carbendazim | 0 | 0 | 6 |
| Chlorothalonil | 0 | 0 | 6 |
| 3,4-Dichloroaniline | 0 | 0 | 8 |
| 2,4-Dichlorophenol | 0 | 0 | 45 |
| Glyphosate | 0 | 0 | 15 |
| Iron | 130 (32%) | 49 (12%) | 403 |
| Methiocarb | 0 | 0 | 1 |
| Pendimethalin | 0 | 0 | 6 |
| Triclosan | 0 | 0 | 4 |
| Substance | Salt water sites ‘not good’ | | Number of sites assessed |
| | Face value | At 95% confidence | |
| Copper (dissolved)(1) | 81 (26%) | 46 (15%) | 311 |
| 2,4-Dichlorophenol | 0 | 0 | 24 |
| Glyphosate | 0 | 0 | 3 |
| Zinc (dissolved)(2) | 169 (59%) | 106 (37%) | 286 |

[1] Based on sites with sufficient samples assessed using analytical methods that are sufficiently sensitive.

| | |
|---|---|
| (1) | The salt water standard for copper includes a correction for dissolved organic carbon (DOC). The compliance assessment has not been able to take account of this because of limited data for DOC. The reported number of failed sites may be too high. |
| (2) | The salt water standard for zinc was derived using the 'added risk approach'. In this, background concentrations are added to the standard before compliance is assessed. The above assessment does not take background concentrations into account and may overestimate the true number of failed sites. |

The implications for copper, manganese and zinc in the freshwater environment have been reviewed by taking account of the bioavailability at sites for which matched data[1] are available [2]. The results are in Table 5.

**Table 5: Implications for England when applying bioavailable metal standards**

| Substance | Freshwater sites 'not good' (face-value assessment) | | Number of sites assessed |
|---|---|---|---|
| | Based on compliance with the existing standard | Based on compliance with the proposed bioavailable standard | |
| Copper | 85 (12%) | 35 (5%) | 698 |
| Manganese | (1) | 2 (1%) | 156 |
| Zinc | 22 (7.5%) (2) | 29 (10%) | 293 |

(1) As no established existing standards are available for manganese, compliance has not been assessed.
(2) This value is indicative because the existing standard for zinc is expressed as total zinc, but the data used were for dissolved zinc in order to evaluate the standard for bioavailable zinc. Therefore, the figure may underestimate failure of the existing standard.

Data for metals are more readily available than for other substances, although the number of sites with data on dissolved zinc is affected by the fact that the existing requirement is for measurements of total zinc[2]. In addition, there are over 3000 sites that have data on dissolved copper, but the assessment in Table 5 has been limited to those sites that have the data required to assess the bioavailability of the metal.

It is expected that number of failures of copper will fall as a result of introducing the approach based on bioavailability. However, there may be situations where sites may fail which currently comply, for example, in south-east England. This is because the approach takes account of a wider range of physico-chemical parameters[3].

An implication for freshwaters in England is more failures for iron than for the current standard. It is not possible to make a true comparison because the current standard is for dissolved iron and the proposed standard is for total iron. Of 798 sites measured for dissolved iron, 0.2% failed the current standard at 95% confidence. Table 4 suggests that 12% of sites fail the proposed standard. One of the main sources of iron in rivers is contaminated mine waters from past mine workings. Iron is also used by the water industry to treat phosphorus in water treatment works.

[1] Data on the metal concentration, pH, the dissolved organic carbon concentration and the calcium concentration.
[2] Which includes particulate zinc
[3] pH, Dissolved Organic Carbon and calcium, rather than just hardness.

For salt waters, there is likely to be a significant increase in the sites assessed as "not good" by the proposed standards for copper and zinc, particularly for zinc. With the current standards, all of the sites assessed for zinc comply, and only 0.6% of those monitored for copper fail at 95% confidence. The compliance indicated in Table 4 may increase when corrections for dissolved organic carbon are made for copper, and when the background concentrations for zinc are taken into account.

The compliance for 2,4-dichlorophenol does not look set to change. All sites comply.

Data from monitoring are sparse for most of the substances listed in Table 4. Additional data are available in some cases. Scans[1] of surface and groundwaters from England and Wales indicate widespread occurrence of triclosan, but only occasional occurrences of 3,4-dichloroaniline, pendimethalin, benzyl butyl phthalate, chlorothalonil and tetrachloroethane.

These data cannot be used to assess compliance because of their semi-quantitative nature and the limited number of results. However, the data indicate that for triclosan widespread failure of the new standard is not anticipated. For the other substances noted above the limited results for tetrachloroethane, chlorothalonil and 3,4-dichloroaniline indicate compliance with the proposed standards. For benzyl butyl phthalate and pendimethalin, although occasional results exceed the sort of concentrations proposed as standards, the data do not give a reliable reflection of what this means in terms of compliance.

**Implications for Northern Ireland**

The following indicates the implications of the proposed standards based on limited available surveillance data. No data are available for chlorothalonil, cyanide, 3,4-dichloroaniline, iron, manganese, methiocarb, pendimethalin, permethrin and dissolved zinc.

- Benzyl butyl phthalate: a limited amount of data is available covering seven months in 2009. There were four positive detections of benzyl butyl phthalate.
- Carbendazim: Data for 2008–2009 are available for 44 sites, although not covering 12 months at most sites. There were three positive detections of carbendazim.
- 2,4-Dichlorophenol: data for 2008–2009 are available for 20 sites for 12 months. There were four positive detections of 2,4-dichlorophenol.
- Glyphosate: Data for 2008–2009 for 28 sites produced 85 positive detections.
- Tetrachloroethane: data for 2007–2008 are available for 70 sites with less than 12 samples per site. There were no positive detections.
- Triclosan: There were 45 positive detections at 14 of 16 monitored sites for 2008–2009.

There were no face-value failures of the proposed freshwater standards for the above substances, although data were limited in some cases.

[1] By GC-MS ... Gas Chromatography–Mass Spectrometry

There is a large amount of monthly and quarterly data on dissolved copper data. These indicate where the proposed freshwater standard is exceeded, but this assumes the dissolved concentrations are completely bioavailable. An assessment taking account of bioavailability is not possible at this time.

**Implications for Scotland**

Table 6 gives an estimate[1] of the number of monitored sites that might not meet the new long-term standards.

| **Table 6: Specific Pollutants – implications for Scotland** | | | |
|---|---|---|---|
| Substance | Freshwater sites 'not good' | | Number of sites assessed |
| | Face value | 95% confidence | |
| Benzyl butyl phthalate | 0 | 0 | 58 |
| Chlorothalonil | 0 | 0 | 8 |
| 2,4-Dichlorophenol | 0 | 0 | 20 |
| Iron (total) | 147 (41%) | 90 (25%) | 359 |
| Pendimethalin | 0 | 0 | 8 |
| Permethrin | 1 | 0 | 21 |
| Substance | Salt water sites 'not good' | | Number of sites assessed |
| | Face value | 95% confidence | |
| Benzyl butyl phthalate | 0 | 0 | 1 |
| Copper (dissolved) (1) | 3 (2%) | 0 | 151 |
| Permethrin | 0 | 0 | 8 |
| Zinc (dissolved) (2) | 24 (16%) | 11 (7%) | 151 |

(1) The saltwater standard for copper includes a correction for dissolved organic carbon (DOC). The compliance assessment has not been able to take account of this because of limited data for DOC. The reported number of failed sites may be too high.

(2) The saltwater standard for zinc was derived using the 'added risk approach' - background concentrations are added to the standard before compliance is assessed. The above assessment does not take background concentrations into account and may overestimate the number of failed sites.

The implications for copper, manganese and zinc in the freshwater environment have been reviewed by taking account of bioavailability at sites for which matched data are available [2]. The results are in Table 7.

[1] Sites with sufficient samples and analytical methods that are sufficiently sensitive.

| **Table 7: Implications for Scotland when applying bioavailable metal standards** | | | |
|---|---|---|---|
| Substance | Freshwater sites 'not good' (face-value assessment) | | Number of sites assessed |
| | Based on compliance with the existing standard | Based on compliance with the proposed bioavailable standard | |
| Copper | 2 (1.8%) | 0 | 113 |
| Zinc | 3 (2.6%) | 0 | 116 |
| Manganese | (1) | 1 (1.3%) | 78 |
| (1) As no established existing standards are available for manganese, compliance here has not been assessed. | | | |

Monitoring data are sparse for some of the substances in Table 6 mainly because there has been no requirement for monitoring in the past or because there are only a few localised pressures. The implications are:

- Benzyl butyl phthalate: the monitoring covers major rivers across Scotland. There are no known sources of the chemical and the results from monitoring are thought to provide a reasonable estimate of the overall position across Scotland. The data indicate no failures of the recommended standard.

- 2,4-dichlorophenol: monitoring is targeted at the major urban rivers. Again there are no known sources and the results should provide a good estimate of compliance throughout Scotland. There are no failures of the proposed standard.

- Chlorothalonil, pendimethalin and methiocarb: monitoring for certain pesticides has been started recently in a limited number of agricultural catchments that have been identified as potentially at risk from pesticides. The data so far indicate no failures of the proposed standards.

- The monitoring for carbendazim, permethrin, tetrachloroethane, toluene and cyanide is limited and directed at point sources. Environmental monitoring is no longer done for some of the substances because the small numbers of sources are well controlled.

- 3,4-dichloroaniline, glyphosate: no monitoring is currently undertaken for these.

- Triclosan: although there are no environmental monitoring data for triclosan, an assessment of data from a small number of sites for waste water treatment was used to predict concentrations in the receiving waters. The results mirror similar work in England and Wales. The substance is widely present, but the levels are not expected to lead to widespread failures of the standard.

Data for metals are more readily available across Scotland. The data are augmented by a large number of sites that assess the impact of pressures such as mining.

The number of sites with data on dissolved zinc is affected by the fact that the existing standard is for total zinc. Concentrations of dissolved metal tend to be measured only where the total concentrations indicate potential concern over compliance. The number of sites assessed is limited to those that have supporting data on the parameters used to estimate the bioavailable concentrations.

The implications for Scotland indicate a reduction in the small number of failures in freshwaters for those metals with proposed bioavailable standards. One of the main reasons for breaches of the existing copper standards is discharges from distilleries.

For zinc in salt water, further work is required on background concentrations so that the number of failures can be better estimated.

There is likely to be a substantial increase in the number of sites assessed as “not good” for iron. Only one of the sites assessed in Scotland breaches the current UKTAG standard of 1000 µg/l of dissolved iron. Prior to the adoption of this standard, an operational standard of 1000 µg/l of total iron was used in Scotland: 24% of sites would be ‘not good’ at face-value (and 13% at 95% confidence). The proposed standard comes close to doubling these estimates (Table 6). The failures are thought to be due mainly to historic mining, although a more thorough assessment is required.

**Implications for Wales**

Table 8 gives an estimate[1] of the number of monitored sites in Wales that might not meet the new long-term standards. The implications for copper, manganese and zinc in freshwaters have been reviewed by taking account of bioavailability at sites for which matched data are available [2]. The results are in Table 9.

**Table 8: Specific Pollutants – implications for Wales**

| Substance | Freshwater sites ‘not good’ | | Number of sites assessed |
|---|---|---|---|
| | Face value | 95% confidence | |
| Carbendazim | 0 | 0 | 2 |
| 2,4-Dichlorophenol | 0 | 0 | 3 |
| Glyphosate | 0 | 0 | 3 |
| Iron | 20 (21%) | 8 (8%) | 95 |
| Methiocarb | 0 | 0 | 1 |
| Substance | Salt water sites ‘not good’ | | Number of sites assessed |
| | Face value | 95% confidence | |
| Copper (dissolved)(1) | 3 (6%) | 0 | 51 |
| Zinc (dissolved)(2) | 22 (39%) | 6 (11%) | 56 |

[1] Based on sites that have sufficient samples, and analytical methods that are sufficiently sensitive.

(1) The salt water standard for copper includes a correction for dissolved organic carbon (DOC). The compliance assessment has not been able to take account of this because of limited data for DOC. The reported number of failed sites may be too high.

(2) The saltwater standard for zinc was derived using the 'added risk approach' - background concentrations are added to the standard before compliance is assessed. The above assessment does not take background concentrations into account and may overestimate the true number of failed sites.

**Table 9: Implications for Wales when applying bioavailable metal standards**

| Substance | Freshwater sites 'not good' (face-value assessment) | | Number of sites assessed |
|---|---|---|---|
| | Based on compliance with the existing standard | Based on compliance with the proposed bioavailable standard | |
| Copper | 85 (35%) | 2 (1%) | 243 |
| Manganese | (1) | 3 (6%) | 51 |
| Zinc | 36 (41%) (2) | 38 (43%) | 88 |

(1) As no established standards are available for manganese, compliance here has not been assessed.

(2) This value is indicative because the existing standard for zinc is expressed as total zinc, but the data used were for dissolved zinc in order to evaluate the standard for bioavailable zinc. Therefore, the figure may underestimate failure of the existing standard.

Monitoring data are sparse for most of the substances listed in Table 8. As noted above for England and Wales (in the section on England), scans indicate widespread occurrence of triclosan, and only occasional occurrences of 3,4-dichloroaniline, pendimethalin, benzyl butyl phthalate, chlorothalonil and tetrachloroethane.

Data for metals are more readily available though the number of sites with data on dissolved zinc is affected by the fact that the current standard is for total zinc. In addition, there are over 850 sites with data on dissolved copper, but the assessment in Table 9 is limited to those that have the matched data required to assess bioavailability.

The implications for Wales indicate higher failure for iron in freshwaters. It is not possible to make a solid comparison as the current standard is for dissolved iron rather than the total metal. Of 155 sites measured for dissolved iron, 1.3% failed at 95% confidence. The corresponding figure is 8% for the proposed standard and the 95 sites measured for total iron (Table 8). Mining is likely to be the main source of iron in freshwaters in Wales.

For salt waters, there is a predicted increase in the number of sites assessed as "not good" for zinc. With the current standards, all sites assessed for zinc (and copper) comply. However, the predicted compliance with the proposed standards for zinc shown in Table 8 may improve once background concentrations are taken into account.

## THE RESPONSE TO FAILURE OF THE PROPOSED STANDARDS

The first response is to assess whether we are sufficiently confident that the standard is truly breached, taking account uncertainties in monitoring and modelling. The second is to work out what is causing the breach. The third step is to decide what can be done to improve the quality of the water.

### Issues arising from reporting compliance

The Water Framework Directive provides for a “risk-based” approach to monitoring. Some locations are judged not to be at risk because of the absence of significant discharges; the results of past monitoring; a lack of evidence of impacts; or the results of mathematical models that predict the exposure to chemicals from various sources. These sites do not need the type of chemical monitoring required for the routine assessment of compliance with standards[1]. In effect the standard is assumed to be met.

For sites at risk, the assessment of compliance uses data from monitoring. In some cases it might involve calculations using models. The data or models will always be associated with errors and uncertainty. Such errors must be quantified. The resulting uncertainty is used to calculate the confidence that a standard has been met or failed (as, for example, reported in Tables 4, 6 and 8).

The Water Framework Directive expects us to know and report these levels of confidence. As noted above, when deciding what action to take, the environment agencies look at the confidence that the standard has been failed. If there is at least 95% confidence, the agencies seek remedial action. If confidence is lower than this, the agencies seek to do more monitoring and so check if the failure is confirmed with sufficient confidence for remedial action[2].

In all this, national actions like controls on chemicals or on the use of land may be easier to justify with high confidence because of the effect of pooling hundreds of monitored sites in assessing, say, the percentage of failed sites. This irons out the uncertainties associated with single sites.

The UKTAG proposes that, in general, action to achieve compliance for Specific Pollutants does not require additional and local ecological corroboration of damage. This stance is based on the nature of the substances and risks, and the process by which the standards are set.

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[1] UKTAG Guidance on monitoring groundwater and transitional and coastal waters. www.wfduk.org/reference/assessing-status-water-environment.

[2] This caution applies to expensive or controversial action. Any agreed and available low-cost measures would always be applied, even at sites where confidence of failure was low.

**The response to failure**

There are two ways in which compliance is used to take decisions. First, the result at a particular location is used to design action for that location, such as reviewing the permit for a discharge of the substance. Second, summaries of compliance with a standard across a region or country may lead to measures, such as recommending national restrictions on the use of a chemical. Sites at risk may benefit from both types of action.

Where a standard is failed, the agencies seek to determine the cause in a systematic way. Where this reveals a problem with, for example, a single discharge, the agencies seek to tighten permit conditions subject to the Directive's considerations of cost effectiveness and disproportionate cost. Where there are several discharges, the most cost-effective approach is sought.

Where there is a mix of point sources, diffuse sources and unknown sources, further steps are taken to apportion the causes of the failure. This may involve monitoring and modelling, a consideration of cost-effectiveness and proportionate cost, and looking at the technical feasibility of securing compliance.

The environment agencies will also continue to seek to influence developments and growth in a way that manages the risks of deterioration and ensures that sustainable uses of the environment can continue and develop. They will assess the effectiveness of their efforts through compliance with the standards, and by calculating the changes in annual means and annual 95-percentiles.

The environment agencies may use biological data to inform their advice and decisions. For example, certain pesticides can give rise to particular changes in biological diversity. If such changes are confirmed, the agencies have a good idea on which substances are responsible.

**National reporting**

The rules for the Water Framework Directive state that a water body cannot be in good status if a standard for a Specific Pollutant is failed. Where such failures are at “face-value”, there is a risk (up to 50 per cent) that the failure is not true, but reflects uncertainties in monitoring. There is a similar risk that failed sites are wrongly reported to have passed. Nonetheless, for a single substance and standard, the proportions of failed waters can lead to a precise measure of the national position in terms of “percentage of failed sites”[1].

[1] Assuming the monitoring is not targeted at failed sites.

Where good status is declared as an integrated result across lots of standards (under the Directive's "one-out all-out" rule), the estimate of the national proportion of failed sites is heavily biased in a pessimistic direction.  This bias rises with increase in the number of standards.  This fact must be taken into account in the framing of national targets, and in assessing whether such targets are met.  For Specific Pollutants, this is best done through separate targets for each substance[1].  Statements such as "40 per cent of waters fail for Specific Pollutants" should be avoided.

[1] Though it is also possible to remove the bias by statistical techniques.

# CHAPTER 3: GROUNDWATER

The chapter describes the results of the UKTAG's review of its recommendations on classifying the status of bodies of groundwater [1] and on protecting groundwater from pollution [2]. The review produced recommendations on:

- threshold values for nitrate in groundwater for use in assessing threats to wetlands that depend on groundwater;
- revised threshold values for nitrate in groundwater for use in assessing risks to current and planned abstractions of water for human consumption;
- revised threshold values for nitrate, and revised generic methods, for use in assessing the risk of significant impairment of the ability of groundwater to support potential human uses;
- a revised method for deriving threshold values for groundwater for use in assessing risks to surface waters affected by groundwater;
- standards for assessing compliance with the objective to prevent or limit the inputs of pollutants into groundwater.

A breach of a threshold value indicates a risk to the chemical status of a body of groundwater and leads to further investigation aimed at confirming whether or not significant adverse impacts are present. These investigations typically involve consideration of other monitoring and the results of mathematical modelling.

The work that underpins this chapter has been subject to peer review[1]. The reviewers agreed that, to the best of their knowledge, the guidance and the consultation documents:

- incorporate the best of the current state of scientific knowledge in terms of management and understanding of the relationships between groundwater, surface water and wetlands for the hydrogeological systems encountered across the UK;
- represent a sound basis for determining the chemical status of groundwater bodies and are an improvement on the methods used for the first cycle of river basin plans;
- propose an approach to the prevent or limit objective that is transparent and consistent with the objectives of preventing or limiting the entry of hazardous and non-hazardous pollutants to groundwater.

The UKTAG also commissioned two experts[2] to review the technical report [3] that led to the recommendations on threshold values for nitrate in groundwater for use in assessing threats to wetlands. Both supported the method and techniques used to develop the proposed values.

[1] Carried out by Rob Sage (Veolia Water) and John Chilton (International Association of Hydrogeologists).
[2] Professor A J Davy from University of East Anglia and Professor M Acreman from the Centre for Ecology and Hydrology.

## NITRATE THRESHOLD VALUES FOR ASSESSING RISKS TO WETLANDS

The following recommendations apply with respect to “groundwater dependent terrestrial ecosystems” – wetlands that depend directly on groundwater. The ecological quality of these wetlands can be significantly affected by changes to the volume and quality of inflows from groundwater.

One of the criteria for the classification of a groundwater body as good or poor is whether pressures on the groundwater, such as pollution, are causing significant damage to a wetland. Each Member State is required to establish threshold values for use in assessing threats to wetlands.

Previously, the UKTAG was unable to make recommendations on suitable threshold values for this purpose because of insufficient data and an inadequate scientific understanding. To remedy this, the UKTAG’s member agencies have collected and assessed data from a wide range of wetlands. This involved looking at the condition of wetlands and the concentration of nitrate and phosphate in groundwater. The recommendations in this section are based on this work and on information from the scientific literature [3].

The UKTAG found no clear link between the concentration of phosphate in groundwater and the condition of wetlands. Consequently, it is unable recommend threshold values for phosphate at this time.

For nitrate, the UKTAG found that the relationship between nitrate concentration and the condition of the wetland varies between wetland type, and in some cases, with altitude (which acts as a proxy for the intensity of land-use). The recommended thresholds for nitrate are set out in Table 10.

**Table 10: Threshold values for nitrate in groundwater**

| | Annual mean nitrate concentration (mg/l $NO_3$) | | |
|---|---|---|---|
| Wetland type [3] | Altitude Above Ordnance Datum | | |
| | up to 175 metres | more than 175 metres | any |
| Quaking bog | 18 | 4 | |
| Wet dune | | | 13 |
| Fen (mesotrophic) and Fen Meadow | 22 | 9 | |
| Fen (oligotrophic and wetlands at tufa forming springs) | 20 | 4 | |
| Wet grassland | 26 | 9 | |
| Wet heath | 13 | 9 | |
| Peatbog and woodland on peatbog | | | 9 |
| Wetland directly irrigated by spring or seepage | | | 9 |
| Swamp (mesotrophic) and reedbed | | | 22 |
| Swamp (oligotrophic) | | | 18 |
| Wet woodland | 22 | 9 | |

**Use of the threshold values in status classification**

The UKTAG recommends that further investigation is triggered to determine whether or not a body of groundwater body should be classed as poor rather than good status when all the following conditions apply:

(a) a wetland identified as directly dependent on groundwater is significantly damaged;

(b) the characteristics of the damage are such that there is reason to believe it may be due to nitrate reaching the wetland via groundwater;

(c) the threshold value applicable to the wetland type is breached.

In practice, it is expected that the data with which to assess whether the threshold value is breached will be collected and evaluated only where conditions (a) and (b) above apply. The assessment of whether the threshold value is breached should be based on an analysis of monitoring data expected to be representative of the quality of the groundwater on which the wetland depends or, where such data are unavailable, modelled estimates of the quality of that groundwater.

The UKTAG recommends that the further investigations are site-specific and seek to establish the degree of the ecological damage and the flow and chemical pathways from the groundwater to the wetland. The work may require an ecological assessment of the wetland and a more detailed hydrogeological investigation. The level of investigation will depend on the existing ecological data and on the confidence that the available monitoring data for the groundwater are representative of the groundwater on which the wetland depends.

If the investigation confirms that the damage to a wetland is significant and that it is being caused by inputs of nitrate from the groundwater, the groundwater body should be classed as poor status. Otherwise, it should be classed as good status with respect to the effect of its nitrate content on wetlands.

The Directive requires that the confidence of classification is specified. The UKTAG recommends that high confidence of class is assigned if:

- for poor status, sufficient hydrogeological and ecological monitoring data are available to: (i) confirm that the wetland is significantly damaged; and (ii) validate a suitable conceptual model showing how nitrate in the groundwater is contributing significantly to that damage;

- for good status, (i) no groundwater dependent wetlands are identified as significantly damaged; (ii) one or more wetlands is identified as significantly damaged but no relevant threshold value is breached; or (iii) further investigation has concluded, based on agreement of all the relevant lines of evidence, that the damage to the wetlands is not significant or that nitrate from groundwater is not making a significant contribution to any damage.

In other cases, the classification decision should be assigned low confidence.

**Implications of the recommendations**

There may be many places over a body of groundwater at which the groundwater is sufficiently close to the surface of the land to create wet ground. However, for damage to a wetland to be “significant”, the wetland has to be of economic, environmental or social importance [4]. All the wetlands identified in the first cycle of river basin management planning are sites designated for their international or national importance to nature conservation (that is, Natura 2000 sites designated under the Habitats Directive, and Sites of Special Scientific Interest). The threshold values will help target action needed to achieve the objectives for these sites.

Important wetlands are typically found in upland areas and in parts of the lowlands that have not been drained for land uses, such as agriculture. Many wetland areas that once existed in lowland agricultural areas were drained to allow the land to be converted into productive farmland.

The nitrate threshold value is not expected to be being breached at many important wetland sites. If we were to re-run the 2009 classification using the new thresholds, we would expect that 5% of the groundwater bodies in England, 1% in Wales and less than 1% in Scotland would progress to the stage of further investigations.

This reflects the location of wetland sites in relation to intensive land uses. The groundwater on which a wetland depends is typically confined to the area close to the wetland. Relatively high concentrations of nitrate can occur across a large part of a body of groundwater without posing a risk to a wetland.

The identification of wetlands that depend on groundwater is part of the process of river basin management. This process requires that the characteristics of, and risks to, each body of groundwater, are assessed; and that an inventory of wetlands is established for all bodies of groundwater identified as being at risk. The assessments and the inventory are reviewed and updated every 6 years.

For the purposes of developing the threshold values, the UKTAG evaluated 180 wetland sites. In Scotland, impacts related to groundwater nitrate concentrations were suspected at around 20% of 50 sites evaluated. However, these impacts were not considered to constitute significant damage.

In England and Wales, around 25% of the 93 wetland sites that were used in the evaluation were in unfavourable condition and exceeded the relevant nitrate threshold value. These represent around 5% of the groundwater bodies in England and Wales. Several further investigations are under way to examine the relationship between nitrate pressure and wetland damage.

Where a wetland is found to be significantly damaged, action to reduce groundwater nitrate concentration is only required where it would not be disproportionately expensive. The action might typically consist of adopting best practices, including those designed to reduce losses of nutrients from farmland. The threshold values help in determining the magnitude of the reduction in concentration needed to improve the condition of the wetland. Where action is necessary, it can be designed to target the specific sources of pollution of the groundwater on which the wetland depends. A breach of the threshold value has no relevance to decisions on the designation of Nitrate Vulnerable Zones under the Nitrate Directive.

The threshold values are expected to play an important role in protecting wetlands from damage. The threshold values are recommended for use in assessing the risk posed by proposed developments which are near to wetlands and likely to increase nitrate concentrations in the groundwater on which the wetlands depend. These assessments will inform decisions on the acceptability of such developments and the steps that the developers need to take to safeguard the wetlands.

## THRESHOLD VALUES FOR ASSESSING RISKS TO USES OF GROUNDWATER

The UKTAG's previous recommendations included threshold values for assessing risks to:

- current and planned abstractions of groundwater for human consumption;
- significant impairment of the ability of groundwater to support potential human uses.

These two risks are assessed by applying the same threshold value in two different ways. The threshold value for the second purpose is designed to help assess the risk to groundwater as a potential resource for human consumption. This is the principal human use of groundwater. Protecting the potential for this use will also help protect groundwater for other human uses.

The existing threshold values were derived separately by each of the UK environment agencies following UKTAG guidance [5]. This recommended that the threshold values be derived as an annual mean that is statistically equivalent to the maximum concentration of nitrate allowed in drinking water[1] (the statistically-based option). The guidance also provided that agencies could instead set the annual mean at 75% of the maximum concentration allowed in drinking water. Differences in the threshold value between the different parts of the UK arose because of differences in the data on groundwater nitrate concentrations available to each environment agency.

[1] Council Directive 98/83/EC on the quality of water intended for human consumption.

The UKTAG has reviewed the statistically-based option for setting threshold values. As part of this review, it compared monitoring results from different types of aquifers rather than from different countries. The results showed no significant difference between the types of aquifer. The overall value for nitrate was close to the value produced by using the option of setting the annual mean at 75% of the maximum concentration allowed in drinking water standard. The UKTAG recommends that all threshold values for assessing risks to the quality of water being abstracted for human consumption and for assessing the risk of significant impairment of the ability of the groundwater to support potential human uses should be set using this latter option rather than the previously recommended statistically-based option.

The changes to the numeric values for the thresholds values for nitrate described in Table 11 below follow from this recommendation:

| **Table 11: Recommended threshold values for nitrate in groundwater** | | |
|---|---|---|
| Risk indicated by failure of the threshold in groundwater | Existing threshold | Recommended revision |
| | Annual mean concentration of nitrate (mg/l) | |
| Risk to the quality abstracted for human consumption, or intended to be abstracted.<br>Risk of significant impairment of the ability of groundwater to support human uses | 31 (Scotland)<br>42 (England & Wales)<br>37.5 (Northern Ireland) | 37.5 |

**Application to groundwater being abstracted for human consumption**

Virtually all bodies of groundwater in the UK have been identified as drinking water protected areas because they are used to provide water for human consumption. The key objective for these areas is to prevent deterioration in the quality of groundwater so as not to compromise an abstraction for human consumption. Classification of the status of a body of groundwater as good requires that this objective is being achieved.

UKTAG's previous recommendations [1] apply to the revised threshold values for assessing risks to water abstracted for human consumption. These are that, where a relevant threshold value is breached, further investigation is triggered to determine whether or not a body of groundwater body should be classed as at poor status rather than good status. Monitoring results for sites representative of the quality of groundwater being abstracted or planned to be abstracted for human uses should be used to determine whether or not the threshold value is breached.

**Implications**

The number of groundwater bodies classed as at poor status across the UK because a drinking water protected area objective has been compromised is not expected to change. This is because achievement of the objective for these areas depends on whether or not deterioration in the quality of groundwater has compromised a drinking water abstraction. The threshold value is designed to help identify potential risks and target investigations. However, compliance with the threshold is not a consideration in determining whether the protected area objective is met and hence whether the water body can be classed as good status.

In Scotland there may be a reduction in the number of abstractions in relation to which a further investigation is triggered on the basis of a breach of the threshold value. In England and Wales there may be an increase. However, the implications are expected to be minimal. Investigations are also driven by other indications of deterioration in water quality, such as trends detected by providers of public water supplies.

**Application to assess impacts on the groundwater resource**

Spatially extensive pollution of groundwater can both compromise existing uses of groundwater and impair the ability of groundwater to support abstractions for human consumption and other uses in the future. Classification of a body of groundwater as good status requires that its ability to support human uses has not been significantly impaired.

UKTAG's previous recommendations apply to the revised threshold value for nitrate. These are that, where a threshold value is breached at one or more monitoring points, further investigation is triggered to determine whether or not a body of groundwater body should be classed as at poor status rather than good status. Monitoring data from sites representative of groundwater quality over an appropriate spatial extent of the body of groundwater should be used to determine whether the threshold is breached.

The UKTAG has also reviewed its previous recommendation on the further investigations required where any threshold value for assessing risks to a groundwater body's ability to support human uses is breached. The existing recommendation is that a body of groundwater should not be classed as good status if the average of all the monitoring results from all the monitoring points representative of the risk to the quality of the groundwater exceeds the threshold value. This criterion is designed to assess whether the cumulative effect on groundwater quality of a large number of small inputs of pollutants is resulting in a breach of a threshold value over a wide area[1].

On the basis of its review, the UKTAG recommends that its existing recommendation on the further investigations is amended and supplemented as follows. These new recommendations are intended to be applied to all investigations triggered by a breach of a relevant threshold value:

[1] For example, in the form of diffuse pollution associated with general use of the land.

- irrespective of whether the existing criterion for classification as poor status is met, the body of groundwater should be classed as good rather than poor if the concentration of the pollutant to which the threshold value applies does not exceed the maximum concentration allowed for it in drinking water in at least one sample from an appropriately representative monitoring point;

- the body of groundwater should not be classed as good status if (i) the threshold values is exceeded across any plume of pollutants extending for over 2 square kilometres or more; and (ii) the maximum concentration allowed in drinking water for any of the pollutants in the plume is exceeded in at least part of the plume.

The revision to the existing criterion recommended in point (a) above is designed to help confirm that the pollution is sufficiently severe to compromise the potential of the body of groundwater to support human uses. The second criterion is designed to take account of spatially extensive impacts arising from individual sources of pollution, such as large contaminated land sites. The investigation is expected to involve the use of modelling and monitoring information to predict and validate the severity and extent of the plume.

**Implications**

Change in the nitrate threshold value: Most nitrate problems arise from the cumulative impact of lots of diffuse sources, in particular from agriculture. Nitrate from agriculture is managed under the Nitrates Directive. Two approaches apply. In Northern Ireland actions to reduce nitrate pollution are taken across the whole territory. In the rest of the UK, discrete areas, called Nitrate Vulnerable Zones are identified. Action programmes to reduce nitrate pollution are applied within these zones.

The UKTAG's recommended revision to the nitrate threshold value will have no impact on the designation of Nitrate Vulnerable Zones (NVZ) in Wales, England or Scotland.

The number of groundwater bodies assessed as poor status in Scotland because of widespread pollution by nitrates is expected to decrease. UKTAG estimates that less than 5% of groundwater bodies are expected to change status. In England and Wales, the number of groundwater bodies assessed as poor status because of widespread pollution by nitrates is expected to increase. UKTAG estimates that less than 5% of groundwater bodies are expected to change status. For Northern Ireland, the threshold value has not changed and consequently changes to water body classifications are not expected.

Changes to further investigation criteria: The UKTAG has undertaken an initial analysis of the effect of the new criteria recommended for the further investigations. The first of its two recommendations was that, for classification as poor status, at least one sample from a relevant monitoring point must breach the maximum concentration allowed in drinking water. The analysis concluded that this criterion is highly likely to be met where the average of all monitoring results breaches the threshold value. Consequently, the UKTAG expects this criterion to have no impact, or at most a negligible impact, on the classification of water bodies.

The criteria for the extent of plumes of pollutants are expected to lead to additional water bodies being classed as poor status. Further analysis is needed to determine how many. A significant proportion of the water bodies in which there are extensive plumes will already be classed as poor status for other reasons. Extensive pollutant plumes result from large point sources, including contaminated land. Reducing the extent of a plume involves stopping or limiting further inputs from these sources. Such action is already the focus of other legislation, including legislation on the remediation of contaminated land. The reflection of the impact of large pollutant plumes in status classifications may help inform decisions on priorities for action under other legislation. However, it is not expected to result in a change to the measures required.

## THRESHOLD VALUES FOR RISKS TO ASSOCIATED SURFACE WATERS

A significant proportion of flow in some rivers can come from groundwater. The ecological quality of such rivers can be harmed by changes to the volume and quality of the groundwater inflows.

One of the criteria for the classification of a groundwater body as good or poor is whether pressures on groundwater, such as pollution, are leading to significant damage to the ecological quality of a river, lake, estuary or coastal water. Each Member State is required to establish threshold values for groundwater for use in assessing this threat. The threshold values are designed to identify risks and so target further investigations. The latter are used to decide whether or not the groundwater body meets the criteria for classification as good or poor. A body is classed as poor status where:

- An environmental standard for good for a pollutant in an associated surface water body is breached; and
- The concentrations of the pollutant in the surface water resulting solely from anthropogenic inputs via groundwater represents at least 50% of the value of the environmental standard.

The UKTAG has reviewed its recommended method for calculating the threshold values. The review concluded that the existing method can produce thresholds that fail to identify significant risks. To improve the identification of risks requiring further investigation, the UKTAG recommends that the method for deriving thresholds is revised as follows:

| **Existing threshold** | **Recommended threshold** |
|---|---|
| surface water standard ÷ dilution factor | 0.5 x (surface water standard ÷ dilution factor) |
| Notes: The "dilution factor" is taken to be the fraction of the average annual river flow derived from groundwater inflows. It can be estimated from established hydrological indices such as the baseflow index, or from the ratio of catchment groundwater recharge to effective precipitation. | |

Groundwater inflows can occur as obvious point sources (for example, from resurgences of mine water) and these can contribute to breaches of environmental standards in the surface water. In such cases, the UKTAG continues to recommend that assessments are based on a comparison of surface water quality upstream and downstream of the groundwater inflows. Threshold values in groundwater are not required for such assessments.

### Implications

The recommended revision is expected to result in an increase in the number of groundwater bodies identified as requiring further investigation. It will not affect the outcome of these investigations, as the criteria for classification as good or poor status remain the same. However, the likely overall effect is that more water bodies at significant risk will be investigated and so more bodies will be identified as poor status.

In particular, the number of investigations relating to phosphate concentrations in groundwater from diffuse sources and small point sources is likely to increase. There may also be an increase in the number of further investigations relating to ammonia and some metals.

In Scotland, the effect is expected to be minimal. This is because no relevant threats to surface waters were identified in the first round of river basin planning. In Northern Ireland, the revised method for deriving threshold values has already been introduced into the classification process. The recommendation will have the greatest effect in England and Wales, probably for phosphorus and certain metals. An assessment of the impact on the number of further investigations will be made once the changes in surface water standards recommended elsewhere in this consultation have been reflected in updated assessments for surface waters.

## PREVENT OR LIMIT THE INPUT OF POLLUTANTS INTO GROUNDWATER

If uncontrolled, individual inputs of pollutants into groundwater can cause local problems. The accumulated effect of these can lead to a deterioration of the status of bodies of groundwater. The Directive includes the objectives of preventing the input of hazardous substances[1] into groundwater and limiting inputs of other pollutants so as to avoid deterioration and significant and sustained upward trends in the concentrations of pollutants. These objectives are elaborated in Directive 2006/118/EC on the protection of groundwater against pollution and deterioration. The standards described in this section are recommended for use in designing measures to achieve these objectives and assessing whether the measures have been effective.

### Recommended approach for hazardous substances

Standards for hazardous substances in groundwater are used to help assess whether or not measures to prevent inputs from identified sources have been successful. They are based on the “limits of quantification” achieved routinely by competent laboratories and are applied at the water table.

[1] These are substances or groups of substances that are toxic, persistent and liable to bio-accumulate or which give rise to an equivalent level of concern.

The approach was first introduced to implement an earlier Directive, 80/68/EEC, on the protection of groundwater against pollution caused by certain dangerous substances. This also has an objective of preventing the introduction into groundwater of listed hazardous substances.

The UKTAG recommends that the approach to setting and applying standards for hazardous substances established under Directive 80/68/EEC is also used to implement the Water Framework Directive's objective of preventing inputs of hazardous substances.

The standards recommended by the UKTAG for hazardous substances in groundwater are listed in Table 12. Most have already been subject to public consultation[1] in England and Wales [6]. Whilst they are also used across the UK, up until now, no definitive UK list has been published.

The standards are recommended for use in assessing:

- the risk of inputs posed by proposed new developments, such as new landfill sites;
- whether or not existing activities and contaminated land with the potential to cause inputs are doing so.

In the latter case, a breach of a standard in a sample of groundwater may result in a requirement for extra controls on the source of the pollutant input unless an exemption is applicable. The criteria for exemption are set out in Article 6 of Directive 2006/118/EC[2]. These include consideration of whether preventing inputs would require disproportionately costly measures to remove quantities of pollutants from, or otherwise control their percolation in, contaminated ground or subsoil.

Where there is a significant risk of inputs of a hazardous substance not listed in Table 12, UKTAG recommends that the agency derives and applies a standard based on the routine “limit of quantification” for the substance achieved by a competent laboratory.

**Implications**

All activities on or in the ground with the potential to cause inputs of hazardous substances into groundwater will continue to be subject to the same restrictions as currently apply under the control regime established to implement Directive 80/68/EEC.

The Water Framework Directive's requirements also apply to contaminated land sources of pollution. The standards are expected to be used to help in identifying on-going inputs of hazardous substances from these sources and the measures needed to prevent them. Actions currently taken with respect to contaminated land are not always sufficient to prevent inputs of hazardous substances. Additional remediation may be needed in some cases to remove the source of the inputs or to otherwise prevent the pollutants from percolating into groundwater. However, land remediation can be very expensive.

[1] For the purpose of these consultations, the standards were referred to as ”minimum reporting values”.
[2] Groundwater Daughter Directive to the Water Framework Directive - 2006/118/EC

This is why Directive 2006/118/EC provides for an exemption where preventing further inputs would require “disproportionately costly measures” to remove quantities of pollutants from, or otherwise control their percolation in, contaminated ground or subsoil.

**Table 12: Recommended standards for hazardous substances[a]**

| Substance | Standard (µg/l) |
|---|---|
| 1,1,1-trichloroethane | 0.1 |
| 1,1,2-trichloroethane | 0.1 |
| 1,2,4-trichlorobenzene | 0.01 |
| 1,2-dichloroethane | 1 |
| 2,4-dichlorophenol (2,4-DP) | 0.1 |
| 2-chlorophenol | 0.1 |
| 4-chloro-3-methylphenol | 0.1 |
| Aldrin | 0.003 |
| Atrazine | 0.03 |
| Azinphos ethyl | 0.02 |
| Azinphos methyl | 0.001 |
| Benzene | 1 |
| Cadmium | 0.1 |
| Carbon tetrachloride (tetrachloromethane) | 0.1 |
| Chlorfenvinphos | 0.001 |
| Chloroform | 0.1 |
| Chloronitrotoluene [b] | 1 |
| DDT [c] | 0.002 |
| Demeton | 0.05 |
| Diazinon | 0.001 |
| Dieldrin | 0.003 |
| Dimethoate | 0.01 |
| Endosulfan [d] | 0.005 |
| Endrin | 0.003 |
| Fenitrothion | 0.001 |
| Fenthion | 0.01 |
| Hexachlorobenzene (HCB) | 0.001 |
| Hexachlorobutadiene (HCBD) | 0.005 |
| Hexachlorocyclohexane (lindane / γ-HCH) | 0.001 |
| Isodrin | 0.003 |
| Malathion | 0.001 |
| Mercury compounds | 0.01 |
| Mevinphos | 0.005 |
| Parathion | 0.01 |
| Parathion-methyl | 0.015 |
| Polychlorinated biphenyls (PCBs) [e] | 0.001 |
| Pentachlorophenol (PCP) | 0.1 |
| Permethrin [f] | 0.001 |
| Simazine | 0.03 |
| Tetrachloroethylene | 0.1 |
| Toluene | 4 |
| Trifluralin | 0.01 |
| Tributyltin oxide (TBTO) [g] | 0.001 |
| Trichloroethylene | 0.1 |
| Triphenyltin oxide (TPTO) [g] | 0.001 |

| Table 12: Recommended standards for hazardous substances[a] | |
|---|---|
| **Substance** | **Standard (µg/l)** |
| Xylene [h] | 3 |

Notes:

a. Standards based upon Minimum Reporting Values (MRV) published by the Environment Agency [7]
b. The standard applies to each of the following individual chloronitrotoluene compounds: 2,4-chloronitrotoluene; 2,5-chloronitrotoluene; 2,6-chloronitrotoluene; 4,2-chloronitrotoluene; 4,3-chloronitrotoluene.
c. The standard applies to the following DDT compounds or breakdown products: o,p-DDT; p,p-DDT; o,p-DDE; p,p-DDE; o,p-TDE; p,p-TDE.
d. The standard applies to α-Endosulfan.
e. The standard applies to each individual polychlorinated biphenyl (PCB) congener.
f. The standard applies to the cis- and trans- isomers of permethrin.
g. These specific compounds are listed as hazardous by Joint Agency Groundwater Directive Advisory Group (JAGDAG). They are examples of ‘tributyltin compounds’ and ‘triphenyltin compounds’.
h. The standard applies to o-xylene and m+p-xylene.

**Recommended approach for non-hazardous pollutants**

Standards for non-hazardous pollutants in groundwater are used to help assess the extent to which inputs to groundwater need to be limited to ensure that they do not cause deterioration or a significant and sustained upward trend in the concentrations of pollutants in groundwater. Deterioration is said to occur where increases in concentration cause significant adverse impacts on surface waters, wetlands, or on existing uses and potential future uses of groundwater. Trends are “significant” if they would result in such adverse impacts unless preventative action were taken.

This section covers standards for protecting the ability of groundwater to support future uses. Existing UKTAG guidance explains the approach taken to protect surface waters and abstractions for human consumption. The threshold values for wetlands described in an earlier section of this chapter are recommended for use in protecting wetlands from inputs of pollutant.

UKTAG recommends that the ability of groundwater to support other uses is protected by applying standards derived from those required to protect water used for human consumption. The standards would normally apply at a distance of 50 metres from the source of the inputs in the direction of groundwater flow. This distance may be extended up to a maximum of 250 metres where there other constraints on the future development of the local groundwater resource.

Inputs of pollutants can limit the potential for economically productive uses of groundwater in the area concerned. They also add to the cumulative impact on the groundwater body. Where a body of groundwater's ability to support potential human uses becomes significantly impaired over a wide area, the body is classed as poor status. Controlling inputs from each source helps prevent such deterioration in status.

Limits on discharges and other point source inputs are calculated taking into account both the standard and the capacity for dilution and attenuation between the source and the point at which the standard applies. More information on the process can be found in the UKTAG's technical guidance on setting regulatory standards in groundwater [2].

If the relevant standard for a pollutant is breached in any sample, extra controls on the input may be required unless one or more of the following applies:

- a sequence of measured concentrations in the groundwater shows an improving trend as a result of action taken at the site;
- the breach is shown to be short term. Evidence here includes a check that the estimate of the annual 95-percentile does not exceed the standard with statistical confidence[1];
- it is demonstrated that concentrations are elevated by other sources of pollution. In such a case the standards applied may be elevated to avoid penalising one site because of pollution from a neighbour[2]; or
- an exemption is applicable in accordance with the criteria set out in the Groundwater Directive[3].

The UKTAG recommends that the appropriate standard for a pollutant is selected as follows:

(a) a national drinking water standard for the pollutant established under domestic legislation, including legislation implementing the Drinking Water Directive;
(b) if no standard is available via (a), a standard specified in World Health Organisation (WHO) Guidelines for Drinking Water Quality;
(c) if no standard is available via (a) or (b), a standard established following peer review by a national authority in another country;
(d) if no suitable standard is available via any of the above, an operational value adopted by the agencies based on the best available scientific information on the pollutant concerned.

### Implications

The approach recommended is the same as that put in place to implement the Directive 80/68/EEC on the protection of groundwater from pollution by Dangerous Substances. It has been used for many years throughout the UK as part of agreeing compliance values and conditions on permits and licences for landfills, discharges to ground, and other activities that need to be controlled in order to protect groundwater.

All activities on or in the ground with the potential to cause pollution of groundwater will be subject to the same restrictions as currently apply under the control regime established to implement Directive 80/68/EEC and under the legislation for remediating contaminated land.

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[1] The degree of additional sampling depends on the required level of confidence which in turn depends on site specific variability, and on the costs of the action being proposed. For example, where it is clear that groundwater quality does not vary, this may require one or two additional samples.
[2] The degree of adjustment will depend on the extent of natural attenuation expected in the groundwater at the site.
[3] Article 6 of the Groundwater Daughter Directive to the Water Framework Directive - 2006/118/EC.

# CHAPTER 4: ALIEN SPECIES

This Chapter describes the UKTAG's proposed revisions to its recommendations on alien species. An alien species is defined by the International Union for Conservation of Nature and Natural Resources as a species introduced “outside its normal past or present distribution”. “Invasive” alien species are those which “threaten ecosystems, habitats or species with environmental or socio-economic harm” [1].

## Alien species and classification

UKTAG's existing guidance places alien species in Great Britain on one of three lists – high impact, low impact, or unknown impact - in relation to the risks they pose to the water environment. (A separate list containing only high-impact species has been compiled for Northern Ireland and the Republic of Ireland.)[1]

The effect on the ecological quality of waters in which a high impact alien species is established is expected to be more than very minor. This means the waters cannot be classed as in high ecological status. They are instead classified as good, moderate, poor or bad status, depending on the extent and severity of the impact of the species on the structure and functioning of the ecosystem [2].

The UKTAG recommends that decisions on the appropriate listing for an alien species are based on the results of risk assessments[1] coordinated by the Great Britain Non-native Species Secretariat (GBNNSS) [3].

To facilitate this, the UKTAG is recommending adding a list of moderate impact alien species to its existing lists. This is because the GBNNSS risk assessments differentiate moderate impacts from high and low impacts. The listings are intended to help prioritise efforts to monitor and assess risks; prevent or contain introductions; and attempt eradication.

The GBNNSS has completed a number of risk assessments since the UKTAG published its original recommendations. Table 13 describes the changes to the UKTAG lists that would follow from taking account of these results.

The UKTAG is also proposing to develop an 'alert' list. This will cover alien species that are not yet present in Great Britain but have the potential to be introduced. Ireland has already developed an 'amber list' for this purpose. The aim is to provide greater readiness for future invasions.

Table 14 is the revised high impact list[2], taking account of the revisions described in Table 13. An assessment on common carp by GBNNSS is under way. Its listing will be reviewed when this is complete.

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[1] Risk assessments are reviewed if substantive new evidence comes to light.
[2] The full list (including that for Northern Ireland and the Republic of Ireland) can be obtained from the UKTAG website: http://www.wfduk.org/sites/default/files/Media/Characterisation%20of%20the%20water%20environment/Classification%20of%20Alien%20species_Final_010709.pdf

| Table 13: Revisions to the UKTAG listings of alien species | | |
|---|---|---|
| **Species** | **From** | **To** |
| [1]Canadian pondweed (*Elodea canadensis*) | High | Moderate |
| [1]Nuttall's pondweed (*Elodea nuttallii*) | High | Moderate |
| Pacific oyster (*Crassostrea gigas*) | High | Moderate |
| Marbled crayfish (*Procambarus* spp.) | High | Moderate |
| Spiny cheeked crayfish (*Orconectes limosus*) | High | Moderate |
| *Crangonyx pseudogracilis* (a freshwater amphipod) | High | Low |
| Japanese weed (*Sargassum muticum*) | High | Low |
| [2]Quagga mussel (*Dreissena bugensis*) | High | Candidate for new alert list |
| [3]Pikeperch (*Sander lucioperca*) | Unknown | Moderate |
| Jenkins' spire shell (*Potamopyrgus antipodarum*) | Unknown | Moderate |
| *Caprella mutica (*a marine amphipod) | Unknown | Moderate |
| Noble crayfish (*Astacus astacus*) | Unknown | Low |
| Narrow-clawed (Turkish) crayfish *(Astacus leptodactylus*) | Unknown | Low |
| American lobster (*Homarus americanus*) | - | Moderate |
| Water hyacinth (*Eichhornia crassipes*) | - | Low |

| Table 14: High impact species in Great Britain | |
|---|---|
| **Freshwater plants** | species with updated risk assessments by GBNNSS |
| Australian swamp stonecrop (*Crassula helmsii*) | yes |
| Floating pennywort (*Hydrocotyle ranunculoides*) | yes |
| Water fern (*Azolla filiculoides*) | yes |
| Water fern (*Azolla caroliniana*) | no |
| Parrot's feather (*Myriophyllum aquaticum*) | yes |
| Curly water-thyme (*Lagarosiphon major*) | yes |
| Water primrose (*Ludwigia grandiflora*) | yes |
| | |
| **Freshwater animals** | |
| North American signal crayfish (*Pacifastacus leniusculus*) | yes |
| Freshwater amphipod (*Dikerogammarus villosus*) | yes |
| Mysid crustacean (*Hemimysis anomola*) | no |
| Zebra mussel (*Dreissena polymorpha*) | yes |
| Common carp (*Cyprinus carpio*) | no |
| Topmouth gudgeon (*Pseudorasbora parva*) | yes |
| Goldfish (*Carassius auratus*) | no |
| Red swamp crayfish (Procambarus clarkii) | yes |
| | |
| **Coastal and transitional water species** | |
| Common cord-grass, Townsend's grass or ricegrass (*Spartina anglica*) | no |
| Chinese mitten crab (*Eriocheir sinensis*) | yes |

[1] This can be confirmed once the risk assessments are approved by the Great Britain Programme Board.
[2] This has not been recorded in the UK.
[3] On the basis of expert judgement.

| | |
|---|---|
| Slipper limpet (*Crepidula fornicata*) | no |
| Leathery sea squirt (*Styela clava*) | no |
| American oyster drill (*Urosalpinx cinerea*) | no |
| Colonial tunicate (non-native *Didemnum* spp.) | yes |
| Marine tubeworm (*Ficopomatus enigmaticus*) | no |
| | |
| **Bankside alien plants** | |
| Japanese knotweed (*Fallopia japonica*) | yes |
| Himalayan balsam (*Impatiens glandulifera*) | no |
| Giant hogweed (*Heracleum mantegazzianum*) | no |
| Rhododendron (*Rhododendron ponticum*) | no |
| Giant knotweed (*Fallopia sachalensis*) | yes |
| Japanese knotweed and Giant knotweed hybrid (*Fallopia x bohemica*) | no |

**'Locally absent' species**

Some species that are native in parts of the country can take on the characteristics of alien invasive species when they are moved to another part of the country. These are called 'locally absent'[1]. One example is ruffe – a freshwater fish, native to Britain but not to Scotland. In the early 1980s it was recorded in Loch Lomond; it is thought to have been introduced by anglers. The population rose exponentially and caused serious damage to native species, including rare species important for conservation.

The UKTAG is currently exploring whether there is sufficient information to reliably identify areas of the UK in which different species of freshwater fish would be "locally absent" in the natural environment. It is also considering whether there is enough information to assess the likely impact of introductions of species into such areas. At this stage, it is not possible to make recommendations, though a list of possibilities is available [4].

The UKTAG would welcome information about locally absent species of fish, including information about adverse effects where they have been introduced to areas outside their natural range.

## FEEDBACK

Views and information are welcomed on:

- the UKTAG's recommendation to base its listings of alien species on the results of risk assessments carried out by the GBNNSS;
- the idea that 'locally absent' species can have a 'high impact' [2], and information on impacts caused by the introduction of "locally absent" fish;

[1] These do not include species whose distribution may move as a result of climate change, as this is considered to be a natural aspect of population dispersal.

- the creation of an 'alert' list;
- alien species not yet listed that may pose a significant risk to the water environment, and the reasons for this view.

# CHAPTER 5: RIVER FLOWS

This chapter proposes changes to the UKTAG's recommendations on standards for river flows [1,2]. The standards affected are those dealing with modifications to medium and high flows.

UKTAG's current recommendations were designed to help:

- assess the risk of deterioration in ecological status that is posed by proposed changes to river flows (for example, through new abstractions);
- estimate the status of rivers already subject to flow alterations in cases where no suitable biological methods are available to assess directly the impact on ecological quality [3];
- inform investigations into the potential causes of biological damage. This is done by comparing the degree of alteration to river flows with the results of assessments of ecological quality.

The UKTAG reconsidered its previous recommendations in response to the experience of using its standards, and because of requests for a review by water users such as hydropower companies. Under certain circumstances, the member agencies of the UKTAG were finding that some of the standards appeared to over-estimate the severity of adverse impacts [4, 5].

The review looked at scientific developments since the UKTAG made its first recommendations in 2007. It was informed by a number of projects.

The standards are expressed as the percentage of the natural flow that may be abstracted without a significant risk of damage to the ecology of rivers. Different percentages apply depending on the flow, with higher percentages used for higher flows.

## FINDINGS OF THE REVIEW

The UKTAG concluded that there is no new quantitative information that can be used to refine the standards for low flows [6]. Consequently, the UKTAG proposes no changes to its current recommendations on standards for low flows.

Low flows are defined as flows that are smaller than the flow exceeded for 95% of the time[1]. This is labelled, Q95. If we imagine the natural river, with no abstractions and discharges, the flow that would be exceeded for 95% of the time is called the Qn95.

[1] In other words, for 347 days per year on average.

As river flow increases from very low levels, there is an increase in the extent and suitability of in stream habitats for species. This increase in the value of the habitat[1] for some species may not begin to level off until flows are higher than the Qn95 [7]. There is also evidence that invertebrates living on the bottom of rivers[2] are impacted where flows are reduced below Qn95. The Dried-Up research project [8] found evidence of significant impacts when summer Qn95 flows are reduced by between 10 and 30%[3]. This finding broadly agrees with the existing low flow standards for good status.

In contrast, the UKTAG did conclude that there is a need to revise its recommendations on flow standards for medium and high flows. Much of the evidence for this change comes from sites where low flows are maintained, but medium and higher flows are abstracted.

For a site to be assigned bad ecological status, severe adverse ecological impacts should be present[4]. These severe impacts are not being found at sites predicted to be at bad status using the standards for medium and high flows in cases where low flows are largely unaffected.

The methods of biological classification previously recommended by the UKTAG and applicable across the UK are not specifically designed to detect the ecological effects of alterations to flow; they show limited sensitivity to such impacts. Even so, if severe impacts are present, it is expected that these methods would provide some indication of impact. In a project which sought to verify limits and conditions set on the managed flows downstream of impoundments [5], no evidence was found of a relationship between the flow sensitive LIFE score[5] and the degree of flow impact at high flows (Q5[6]). The project found some evidence of reduced variability in LIFE scores downstream of impoundments, but no clear indication of the major or severe impacts that would be associated with poor and bad ecological status.

## ECOLOGICAL RESPONSES TO CHANGES TO MID AND HIGH FLOWS

Published studies show that effects on aquatic organisms can result from changes to mid and higher flows [5,7,8]. However, the available evidence does not suggest that these effects can be sufficiently severe on their own to lead to bad ecological status.

[1] For example where impact is expressed in terms of features such as the habitat space measured by “wetted width” .
[2] As measured by the flow-sensitive LIFE score.
[3] The study showed a deviation of around 0.5 standard deviations from reference condition LIFE score.
[4] Typically, this will mean that large portions of the biological communities normally present under undisturbed conditions are absent.
[5] A special form of biological index designed to be sensitive to changes in river flow.
[6] Flows exceeded 5% of the time.

### Mid flows

The ecological impacts caused by reductions in mid range flows are expected to be a loss in habitat space and a prolonging of periods of low flows. These effects will tend to lead to a shift in aquatic plant and animal communities from those favouring flowing water to those preferring stiller water. Reductions in mid range flows increase the typical duration of episodes of low flow at which river conditions become less favourable to a varied aquatic ecology. Unfavourable conditions in extended low flow events can include higher temperatures, decreased dissolved oxygen and reduced habitat space.

The UKTAG advises that these effects can be sufficient to cause the ecological status to be poor[1]. The recovery time following exceptional periods of low flow can extend over a number of years, particularly for the recovery of species diversity [9].

With a reduction of 60% of mid flows it can be shown that extreme episodes of low flow such as those which, under natural conditions have a 1 in 20 year return period, can increase their frequency to a return period of once a year. It is likely that, with such a frequency, ecological recovery becomes compromised, and a change in the character of the biological communities will result.

The duration of periods of low flow increases gradually as mid flows (flows above Qn90[2]) are reduced. Reductions greater than 60% appear to lead to a substantially increased rate of extension to the durations of periods of low flow.

The sensitivity of a river to extended periods of low flows is likely to depend on the characteristics of that river. There is some evidence that rivers with large contributions from groundwater to their flows are more sensitive than flashier types with limited groundwater contributions to their flows. Recent work has noted a difference in the response of macro-invertebrates between upland and lowland rivers, with bigger effects caused by extended low flows in lowland rivers [8]. However, at this time, the UKTAG considers the scientific understanding to be insufficient to differentiate the relative sensitivity of different types of river to extended low flows. Consequently, the UKTAG's proposals for revised standards apply to all river types.

### High flows

The ecological processes affected by reductions in high flows typically revolve around loss of stream energy and, in turn, reduced mobility of the bed load and increased deposition of sediment. Added to this, reductions in high flows can affect habitats by their impact on the connectivity between the river and its floodplain.

[1] At poor status, there will typically be major alterations to the composition and abundance of aquatic plants and animals such that the biological communities present differ substantially from those normally found under undisturbed conditions.
[2] The natural flow exceeded for 10% of the time.

Reductions in the frequency of high flow events, and changes in their timing, will also have an impact on migratory fish, with disrupted cues for migration, and impacts on spawning habitats. The UKTAG is not confident that the ecological effects of changes to high flows can be sufficiently severe on their own to result in a worse status than moderate. In practice, changes to high flows are normally accompanied by large changes to mid range flows.

## RECOMMENDATIONS FOR MID AND HIGH FLOW STANDARDS

The UKTAG's recommendations are summarised in the Tables 15 and 16. The results are that:

- On days when flow would naturally be greater than the Qn90, proposed abstractions that leave the equivalent of at least a poor status Qn90 flow in the river would not be expected to cause deterioration to worse than poor status.

- On days when flow would naturally be greater than Qn60, proposed abstractions that leave the equivalent of at least a moderate status Qn60 flow in the river would not be expected to cause deterioration to worse than moderate status.

**Table 15: Recommended revisions to the "moderate" standards for river flows**

| | Permitted maximum abstraction per day as a proportion of natural flow | | | |
|---|---|---|---|---|
| | At daily flows (Qn) from Qn60 up to Qn5 | | At daily flows (Qn) greater than Qn90 and less than Qn60 | |
| River Type | Existing standards | **Proposed revision** | Existing standards | **Proposed revision** |
| A1 | 60% of Qn | Qn less 40% of Qn60 | 50 - 55 % of Qn | 60% of $Q_n$ |
| A2 (downstream), B1, B2, C1, D1 | 55% of Qn | Qn less 40% of Qn60 | 45 - 50 % of Qn | 60% of $Q_n$ |
| A2 (headwaters), C2, D2 | 50% of $Q_n$ | Qn less 40% of Qn60 | 40 - 45 % of Qn | 60% of $Q_n$ |
| No changes are proposed to the existing standards for daily flows from Qn95 and up to Qn90 and for daily flows less than Qn95 | | | | |

| Table 16: Recommended revisions to the “poor” standards for river flows | | | | |
|---|---|---|---|---|
| | Permitted maximum abstraction per day as a proportion of natural flow | | | |
| | At daily flows (Qn) from Qn60 up to Qn5 | | At daily flows (Qn) greater than Qn90 and less than Qn60 | |
| River Type | Existing standards | **Proposed revision** | Existing standards | **Proposed revision** |
| A1 | 85% of $Q_n$ | $Q_n$ less 25% of $Q_{90}$ | 75 - 80% of Qn | $Q_n$ less 25% of $Q_{90}$ |
| A2 (downstream), B1, B2, C1, D1 | 80% of $Q_n$ | $Q_n$ less 30% of $Q_{90}$ | 70 - 75% of Qn | $Q_n$ less 30% of $Q_{90}$ |
| A2 (headwaters), C2, D2 | 75% of $Q_n$ | $Q_n$ less 35% of $Q_{90}$ | 65 - 70% of Qn | $Q_n$ less 35% of $Q_{90}$ |
| No changes are proposed to the existing standards for daily flows from Qn95 up to Qn90 and for daily flows less than Qn95 | | | | |

## IMPLICATIONS OF THE PROPOSALS

### Risk assessment

Standards for river flow help assess the risk of deterioration posed by proposed new abstractions or increases in existing abstractions. The changes to the standards are expected to affect risk assessments for developments that propose to abstract a large proportion of mid and high flows but which leave low flows largely unaffected.

Proposals that, using the existing standards, would be assessed as likely to cause deterioration to bad status, may be assessed as risking deterioration to moderate or, at worse, poor, on the basis of the revised standards.

The revisions are also expected to result in fewer proposals being assessed as likely to cause deterioration to poor. This is because the revised standard for the moderate-poor boundary for mid flows is less stringent than it was in the UKTAG's previous recommendations.

From a regulatory perspective, the revisions mean that some proposals will either:

- not be considered to pose a risk that would previously have been assessed as likely to cause deterioration; or
- be assessed as likely to cause a deterioration that is less severe than previously.

Proposed developments that are expected to cause deterioration can go ahead if they meet the criteria for exemption from the Directive's objective of preventing deterioration of status. These criteria involve a consideration of the positive and negative consequences of such proposals. Information on the severity of the likely deterioration helps in understanding the negative consequences. With the new standards, the process of weighing up positive and negative consequences will be less complicated.

**Classification**

The UKTAG has previously recommended that river flow standards can be used in the classification of ecological status in cases where suitable biological methods are not available for the direct assessment of ecological impacts.

The UKTAG is developing indicators of the ecological impacts of flow alterations. The aim is to enable all parts of the UK, as a minimum, to identify major effects on ecological quality that result from changes to the river flow regime. This will ensure that no part of the UK has to rely on river flow standards to classify sites as poor or bad ecological status. A consultation on these indicators is planned for later in 2012.

The UKTAG has also set priorities for the development of methods of ecological assessment that could differentiate sites affected by hydromorphological alterations into high, good and moderate status, as well as poor and bad status. The first of these is expected to be available in a few years' time.

Currently only SEPA relies on river flow standards to inform classifications of ecological status. This is because the biological methods available to SEPA are insufficiently sensitive to the effects of alterations to river flows. The main effects of the proposed revisions to the flow standards, and of the introduction of ecological indicators, will be on the classification of rivers affected by abstractions for the generation of hydropower, or on rivers abstracted for water storage schemes for public water supply. The effect is likely to be that a better class is assigned to around 30% of all river water bodies in Scotland currently classed as poor, and to 20% of those classed as bad.

The UKTAG maintains its existing recommendation that requiring costly action is not appropriate for waters classified as moderate status on the basis of river flows unless there is corroborating evidence of ecological damage.

# CHAPTER 6: WATER LEVELS IN LAKES

The UKTAG's recommendations on standards for water levels in lakes were designed to help:

- assess the risk of deterioration in the ecological status of lakes posed by future abstractions;
- estimate the ecological status of lakes already subject to changes in levels in cases where no biological methods are available to assess the impact on ecology [1].

The original standards were based on expert views on the degree of change in the natural variation in levels expected to pose a significant risk of ecological damage [2]. They were converted into corresponding changes in a lake's natural outflow. This was done using a simple hydraulic equation to estimate the reduction in a lake's natural inflows that would give rise to the level change. The inflow criteria were then converted to outflow standards to try to account for lake water storage effects[1].

The UKTAG undertook a review in response to experience of using the standards. The standards were predicting large changes in impact from very small changes in water level. For example, in some lakes, the difference between good and bad status could result from a 10 centimetre change in water level [3].

The review concluded that the standards were overestimating the risk posed by small changes in water levels and that they were failing to differentiate between slight, moderate, major and severe impacts (that is – between good, moderate, poor and bad status). One reason for this was the assumptions made in translating the changes in natural levels into standards defined in terms of lake outflows.

The ecological quality of lakes can be significantly affected by changes to the quality and extent of shallow water through which sunlight can penetrate to the lake bed. This is because this habitat, known as the littoral zone [4], is particularly productive ecologically, supporting rooted plants and bottom-living algae. The depth to which light penetrates depends on the clarity of the water but generally falls into the range from 1 to 10 metres. The depth of light penetration in peaty lakes is typically much less than in clear water lakes.

Lowering the water levels in lakes can change the area of the littoral zone and as well as other lake habitats. It can also change the quality of the habitat by increasing the extent of very shallow areas exposed to the erosive effects of wave action.

[1] Low flows in lake outflows are typically elevated compared with low flows in lake inflows. This is because of the lake storage effect. This results in changes to outflows lagging behind changes in inflows.

The shape of the lake (its bathymetry) has a significant bearing on the impact of a change in level. In deep, steep-sided lakes, the area of the littoral zone and other lake habitats is not significantly affected by relatively large changes in water level. The main effect in these lakes is likely to be on the interaction between the lake and surrounding terrestrial habitats and feeder streams. In shallow, gently shelved lakes, small reductions in level can have a significant effect on the area and quality of different lake habitats.

The existing standards were designed with these same impacts in mind. The use of type-specific standards was an attempt to account for variation in the area of lake habitat affected by a given abstraction. Tighter standards apply to shallow, shelving basin types of lake than to deep, steep-sided lakes.

The UKTAG recommends replacing the existing standards with standards specified directly in terms of changes in the area of lake habitat. This avoids the problems that stemmed from attempts to reflect the impacts in terms of changes to lake outflows. The proposed standards are as follows:

<table>
<tr><th colspan="4">Table 17: Standards for the effect of water level changes on lake surface area</th></tr>
<tr><td colspan="4">Daily maximum percentage reductions in lake surface area in 99 percent of days in any year</td></tr>
<tr><td>High</td><td>Good</td><td>Moderate</td><td>Poor</td></tr>
<tr><td>1</td><td>5</td><td>10</td><td>20</td></tr>
<tr><td colspan="4">Lake surface area means, for any day, (a) the area under the reference conditions of the lake's surface that would overly water from the shore out to 10 metres deeper than the depth to which light penetration to the lake bed would be sufficient, under those conditions, to enable the growth of rooted plants or bottom-living algae; or (b), if the deepest part of the lake is shallower than this, the whole area of the lake's surface, under reference conditions.<br><br>Reference conditions means the absence of any abstractions or discharges[1] that could affect the surface area of the lake. For the purposes of setting a maximum allowable abstraction, it is recommended that reference conditions should be representative of the current standard UK Meteorological Office climate reference period (currently 1981 to 2010)<br><br>In the absence of field data to the contrary, the depth to which light penetration to the lake bed is sufficient to enable the growth of rooted plants or bottom-living algae may be taken to be 5 metres for lakes with the geological sub-type of "peat" and 10 metres for all other lake types. A lake is considered to have the sub-type of “peat” where (i) its mean water colour is more than 90 hazen units; or (ii), where information on colour is unavailable, more than 75 % of the soils of its catchment area are comprised of peat.</td></tr>
</table>

[1] For lakes designated as heavily modified for water storage, "reference conditions" may be taken to mean the regime as (a) altered by the use for which the lake has been designated; and (b) with all mitigation measures that can be put in place without a significant adverse impact on the use or the wider environment.

## USING OF THE STANDARDS

To use the standards it will be necessary to estimate the area of the lake habitat in the absence of impacts from the use of water resources (for example , abstractions of water). This will be achieved by modelling the lake levels using measured or modelled values for the natural inflows to the lake[1].

Compliance will be assessed by the modelling of natural and influenced lake levels, and by using bathymetry to assess corresponding changes in the area of the lake habitat. The abstractions will comply if the thresholds in Table 17 are not exceeded for more than 1% of days in any period of 12 months.

In order to set a maximum allowable abstraction for licence conditions, it is necessary to estimate the numbers of days that abstractions would not exceed the percentage changes in Table 17. This involves determining the quantity of water that can be abstracted without breaching the standards across the range of typical climatic conditions. The UKTAG recommends using the current 30 year period defined by the UK Meteorological Office as the basis for determining typical climatic conditions. The period is updated by Meteorological Office every 10 years.

## PEER REVIEW

As part of the development of these standards, a peer review was undertaken by:

- Professor Kenneth Irvine, Chair of Aquatic Ecosystems UNESCO-IHE, Netherlands
- Dr. John Rowan, Reader in Physical Geography, School of the Environment - Geography, University of Dundee

The move to more lake specific standards (based upon bathymetry and lake level regimes) was welcomed by the reviewers as a step in the right direction. The reviewers went on to suggest that standards for lake levels should ideally take account of factors such as differences in the sensitivity of species (including within-year sensitivity); the rate of level changes; finer-scale differences in the sensitivities of habitats within lakes; and connectivity between the lake and its shore. However, the reviewers did not identify a means of reflecting these factors in standards. The reviewers recommended that ongoing research into these factors is brought into a future review of lake standards by the UKTAG.

The reviewers felt that accounting for the additional sensitivity of peaty lakes was important and could be achieved as proposed by the UKTAG. They recommended that the sizes of zones should be measured on a site by site basis using, for example, a Secchi disc to determine the light penetrating zone, or surveys of habitat. This recommendation is reflected in the proposed standards, but since the data may not always be available, a standard set of zone definitions has been developed.

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[1] A research project commissioned by SEPA has shown it is possible to use inflows transposed from data from a nearby gauging station [5].

The reviewers were clear that the standards should take no account of any notional ‘gains’ in habitat. Such gains might occur for the submerged areas that fall into a habitat zone as a result of an impact. The standards proposed here only take account of losses to habitat.

Both reviewers indicated that effects of climate change should be accommodated. By explicitly linking reference conditions to a 30-year period that will be updated each decade, the UKTAG suggests that any impacts of a changing climate will be included.

**IMPLICATIONS**

For most shallow lakes, the proposed standard for good equates to a water level change of between 20 cm and 50 cm. This corresponds closely with the criteria for good on which the existing standards were based [2]. These criteria translated into reductions in levels of up to about 40 centimetres. For deep, steep-sided lakes, the recommended standard for good can translate into reductions in levels up to around 1.5 metres.

The application of the recommended standards requires information on bathymetry and on the variation in the levels. Both may be derived from modelling or monitoring. Where the information is not already available, the UKTAG recommends applying the existing outflow standards as part of a screening step to decide if it is necessary to obtain extra information. . The outflow standards are tighter than the standard for good status in Table 17 and if the existing standards are met there will be high confidence that these water bodies meet at least good status. If they are not breached, neither will the recommended surface area standards.

Most lakes subject to major alterations to their water levels serve as reservoirs for public water supply or for hydropower generation, or have done so in the past. Most have been designated as heavily modified water bodies under the Water Framework Directive. The proposed standards may be used to help assess the risk of deterioration of the ecological potential of these water bodies that would result from further abstractions or from modifications to the existing operating regimes.

The revised standards are expected to better reflect significant risks to the ecological quality of lakes. The existing standards overestimate the risks.

One of the expected consequences of replacing the existing standards is that fewer proposed new abstractions will be assessed as likely to cause deterioration. More water could be abstracted before the standards are breached.

Proposed developments expected to cause deterioration must meet the criteria for exemption from the Directive's objective of preventing deterioration of status. These criteria involve a consideration of the positive and negative consequences of such proposals. Information on the severity of the likely deterioration helps in understanding the negative consequences.

The standards may be used to help classify where no suitable biological methods are available with which to assess directly the impact of changes in lake levels. Currently, Scotland relies on the existing lake level standards to inform classification. If the new standards were to be applied, there would be a small reduction in the number of lakes classed as worse than good and, of those that are worse than, considerably fewer would be classed as poor and bad.

# CHAPTER 7: INTERMITTENT DISCHARGES

In its first report the UKTAG set out standards for rivers for Biochemical Oxygen Demand (BOD), dissolved oxygen and ammonia [1]. Such standards are used, for example, to assess the need for further action on discharges from sewage treatment works.

In support of these standards the UKTAG also recommended [1] the continued use of standards that help design works to improve intermittent discharges to rivers that can occur in wet weather [2]. These include unsatisfactory discharges from combined sewer overflows, and discharges from storm tanks.

### Fundamental Intermittent Standards

A review by the Water Research Centre [3] has confirmed that the standards known as Fundamental Intermittent Standards need not be changed. They can continue to be used in support of plans to achieve good status. The standards are listed in Tables 18 and 19.

The Fundamental Intermittent Standards provide values for dissolved oxygen and for a type of ammonia known as un-ionised ammonia. Concentrations of this form of ammonia are linked directly to causes actual damage to fish. Un-ionised ammonia is a tiny part of the total concentration of ammonia and is particularly toxic.

The Fundamental Intermittent Standards refer to events of particular frequency and duration and are generally used with mathematical models that deal with the effect and probability of storms.

| **Table 18: Fundamental intermittent standards for Dissolved Oxygen** | | | |
|---|---|---|---|
| **Ecosystem suitable for a sustainable salmonid fishery** | | | |
| **Return period** | **Dissolved oxygen concentration (mg/l)** | | |
| | **1 hour** | **6 hours** | **24 hours** |
| 1 month | 5.0 | 5.5 | 6.0 |
| 3 months | 4.5 | 5.0 | 5.5 |
| 1 year | 4.0 | 4.5 | 5.0 |
| **Ecosystem suitable for a sustainable cyprinid fishery** | | | |
| **Return period** | **Dissolved oxygen concentration (mg/l)** | | |
| | **1 hour** | **6 hours** | **24 hours** |
| 1 month | 4.0 | 5.0 | 5.5 |
| 3 months | 3.5 | 4.5 | 5.0 |
| 1 year | 3.0 | 4.0 | 4.5 |

| |
|---|
| The above limits apply when the concurrent concentration of un-ionised ammonia concentration is below 0.02 mg/l. The following correction factors apply at higher concurrent un-ionised ammonia concentrations:<br>Where the un-ionised ammonia lies between 0.02-0.15 mg NH3-N/l: the correction factor is an addition of (0.97 x log (mg NH3-N/l) + 3.8) mg $O_2$/litre. For concentrations that exceed 0.15 mg NH3-N/l, the correction factor is +2 mg $O_2$/litre.<br>A correction factor of 3 mg $O_2$/l is added for salmonid spawning grounds. |

| **Table 19: Fundamental intermittent standards for Un-ionised Ammonia** | | | |
|---|---|---|---|
| **Ecosystem suitable for a sustainable salmonid fishery** | | | |
| **Return period** | **Un-ionised Ammonia concentration (mg $NH_3$-N/l)** | | |
| | **1 hour** | **6 hours** | **24 hours** |
| 1 month | 0.065 | 0.025 | 0.018 |
| 3 months | 0.095 | 0.035 | 0.025 |
| 1 year | 0.105 | 0.040 | 0.030 |
| **Ecosystem suitable for a sustainable cyprinid fishery** | | | |
| **Return period** | **Un-ionised Ammonia concentration (mg $NH_3$-N /l)** | | |
| | **1 hour** | **6 hours** | **24 hours** |
| 1 month | 0.150 | 0.075 | 0.030 |
| 3 months | 0.225 | 0.125 | 0.050 |
| 1 year | 0.250 | 0.150 | 0.065 |
| The above limits apply when the concentration of dissolved oxygen is above 5 mg/l. At lower concurrent concentrations of dissolved oxygen the following correction factor applies:<br>For Dissolved Oxygen less than 5 mg/l DO, multiply the standard by 0.0126 and the concentration of Dissolved Oxygen in mg $O_2$/litre, C, raised to the power of 2.72, that is, 0.0126 $C^{2.72}$. | | | |
| The standards also assume that the concurrent pH is greater than 7 and temperature is greater than 5 degrees C. For lower pH and temperatures the following correction factors apply:<br>Where the pH is less than 7, multiply the standard by 0.0003 and by the value of the pH, p, raised to the power of 4.17, that is: 0.0003 $p^{4.17}$. Where the temperature is less than 5 degrees Centigrade, multiply this correction factor by a further 0.5. | | | |

**99-percentile Standards**

The calculation of levels of dissolved oxygen and un-ionised ammonia downstream of discharge requires good data on the physical and chemical processes in the river. The results for un-ionised ammonia are sensitive to errors in pH – a change of 1% in pH causes a 10% change in the concentration of unionised ammonia.

This issue has meant that another family of standards is used instead of or as well as the Fundamental Intermittent Standards. These are the 99-percentile Standards for BOD, Total Ammonia and Un-ionised Ammonia.

The calculations for the 99-percentile Standards for BOD and Total Ammonia are less vulnerable to data and assumptions and the outcomes are strongly correlated with damage linked to dissolved oxygen and un-ionised ammonia.

The existing 99-percentile standards were derived from the 90-percentile standards used before the Water Framework Directive to define classes of rivers known as River Ecosystem (RE) Classes. The 90-percentiles for River Ecosystem (RE) were adjusted slightly for the new Directive and its typologies[1]. Table 20 shows the typologies:

**Table 20: Types of river to which standards apply**

| Altitude | Alkalinity (as mg/l CaCO3) | | | | |
|---|---|---|---|---|---|
| | Less than 10 | 10 to 50 | 50 to 100 | 100 to 200 | Over 200 |
| Over 80 metres | Type 1 | Type 2 | Type 3 | Type 5 | Type 7 |
| Under 80 metres | | | Type 4 | Type 6 | |

Table 21 and 22 sets out the new values for the Water Framework Directive, and provides the old values for comparison.

**Table 21: 99 percentile standards for BOD**

| Status | Types of river | Old objective | Biochemical Oxygen Demand | |
|---|---|---|---|---|
| | | | 90-percentile | 99 percentile |
| | | RE1 | 2.5 | 5.0 |
| High | 1, 2, 4 and 6 | | 3.0 | 7.0 |
| High | 3, 5 and 7 | RE2 | 4.0 | 9.0 |
| Good | 1, 2, 4 and 6 | | | |
| Good | 3, 5 and 7 | | 5.0 | 11.0 |
| Moderate | 1, 2, 4 and 6 | RE3 | 6.0 | 14.0 |
| Moderate | 3, 5 and 7 | | 6.5 | 14.0 |
| Poor | 1, 2, 4 and 6 | | 7.5 | 16.0 |
| | | RE4 | 8.0 | 19.0 |
| Poor | 3, 5 and 7 | | 9.0 | 19.0 |
| | | RE5 | 15.0 | 30.0 |

[1] The types are described and set out in the River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2009; The Scotland River Basin District (Surface Water Typology, Environmental Standards, Condition Limits and Groundwater Threshold Values) Directions 2009; and The Solway Tweed River Basin District (Surface Water Typology, Environmental Standards, Condition Limits and Groundwater Threshold Values) (Scotland) Directions 2009.

<table>
<tr><th colspan="6">Table 22: 99 percentile standards for Ammonia</th></tr>
<tr><th rowspan="2">Type of standard</th><th rowspan="2">Types of river</th><th rowspan="2">Old objective</th><th colspan="2">Total Ammonia (mg/l)</th><th>Un-ionised ammonia (mg/l)</th></tr>
<tr><th>90-percentile</th><th colspan="2">99-percentile</th></tr>
<tr><td>High</td><td>1, 2, 4 and 6</td><td></td><td>0.2</td><td>0.5</td><td>0.04</td></tr>
<tr><td></td><td></td><td>RE1</td><td>0.25</td><td>0.6</td><td>0.04</td></tr>
<tr><td>High</td><td>3, 5 and 7</td><td></td><td rowspan="2">0.3</td><td rowspan="2">0.7</td><td rowspan="2">0.04</td></tr>
<tr><td>Good</td><td>1, 2, 4 and 6</td><td></td></tr>
<tr><td>Good</td><td>3, 5 and 7</td><td>RE2</td><td>0.6</td><td>1.5</td><td>0.04</td></tr>
<tr><td>Moderate</td><td>1,2,4 and 6</td><td></td><td>0.75</td><td>1.8</td><td>0.04</td></tr>
<tr><td>Moderate</td><td>1,3,5 and 7</td><td></td><td rowspan="2">1.1</td><td rowspan="2">2.6</td><td rowspan="2">0.04</td></tr>
<tr><td>Poor</td><td>1,2,4 and 6</td><td></td></tr>
<tr><td></td><td></td><td>RE3</td><td>1.3</td><td>3.0</td><td>0.04</td></tr>
<tr><td>Poor</td><td>1,3,5 and 7</td><td>RE4</td><td>2.5</td><td>6.0</td><td>-</td></tr>
<tr><td></td><td></td><td>RE5</td><td>9.0</td><td>25.0</td><td>-</td></tr>
</table>

**Implications**

The implications are tied to the changes in the objectives from the now defunct classes under River Ecosystem to the status classes under the Water Framework Directive.

91% of 40,000 kilometres of rivers in England and Wales met their objectives under River Ecosystem for BOD, dissolved oxygen and ammonia. For the objectives under the Water Framework Directive, the corresponding figure is around 90% of 50,000 kilometres. This indicates that 1000 to 2000 more kilometres may be in need of action in the form of tighter controls on sewage effluents and to any intermittent discharges to the same rivers.

The figures of 91 and 90% have been corrected for the pessimistic bias under the classification used with the one-out all-out rule the Water Framework Directive. This rule changes the 90% to 85%. If we to take action only when there is 95% confidence of failure of the standard, the effect of the change to the Water Framework Directive remains limited to 1000 to 2000 kilometres of river.

# CHAPTER 8: STANDARDS FOR ACIDIFICATION IN RIVERS

Anthropogenic acidification is caused by emissions to the atmosphere of sulphur dioxide and oxides of nitrogen. These are released as a result of the combustion of fossil fuels. The gases undergo oxidation to form sulphuric acid and nitric acid, respectively. The acids are then deposited, either in rain or snow, or when particles or gases stick to the ground, plants or other surfaces.

Base cations[1] in soils, such as calcium, potassium and manganese, act as a natural buffer against acidity. The acidification of rivers and lakes occurs in areas which have limited buffering capacity, such as land with thin soils that overlay granite rock. Forests can enhance the deposition of acid pollutants from the atmosphere because of the greater air turbulence caused by their rough canopies. The way forests are planned, designed and managed influences the risk of them contributing to acidification.

Action taken under a series of treaties dating from the 1980s and 1990s has led to significant reductions in emissions of acid pollutants from power stations and industry. Despite this, acidification remains an issue, particularly in upland western parts of Scotland and Wales, where rainfall is high, soils are generally base poor, and significant conifer plantations exist.

The UKTAG has developed recommendations on standards for acidification in rivers [1]. The standards are for pH and a parameter called the Acid Neutralising Capacity (ANC)[2]. The first of these acts as a surrogate for “labile aluminium”, which is believed to provide the toxicity which shapes biological communities at low pH. The ANC is a direct measure of longer-term anthropogenic acidification.

Dissolved Organic Carbon (DOC) plays an important role in determining the damage to waters prone to acidification. A value of 10mg/l of DOC is used as a threshold to distinguish “clear” and “humic” waters[3] in the biological method that is used to describe the impact of acid pressures in rivers [2]. The UKTAG proposes that this value is used as a threshold to develop separate standards for each type of water.

The UKTAG's existing recommendations on standards for pH are set as the annual 5 or 10-percentile for acidification, and the annual 95-percentile for alkalinity. The studies that underpin this review have demonstrated strong correlations between the annual mean and the biological data. Consequently, it is proposed that the new standards are defined as annual mean values.

[1] Base cations are the most prevalent, exchangeable and weak acid cations in the soil.
[2] As calculated by the Cantrell method.
[3] Humic material provides the brown staining of water in peat catchments and is derived from the oxidation of peat.

The pH boundary for good and moderate is placed at the start of increases in concentrations of labile aluminium – a point at which significant damage starts to be observed in biological communities.  For ANC, the boundary between high and good is set above the point at which concentrations of labile aluminium begin to elevate. The other boundaries are positioned at appropriate places on the gradient of labile aluminium.  The poor-bad boundary is placed just below maximum concentrations of labile aluminium[1] [2].

Under most instances, the proposed standards provide the same class as the class suggested by the biological data.  Where there is disagreement it is most commonly by only one class. There is a slight bias towards a lower class for biology.  This might be expected because the biological data provides an integrated record, and the chemical records describe the conditions at the times of sampling – the biology may be shaped by extreme events not picked up in chemical samples that were taken.

As noted above, the ANC and pH fulfil different roles in describing the impact of acidification. ANC provides an indication of buffering capacity that is useful in the context of national and international management of acid deposition; it forms the basis of approaches based on critical loads, forestry plantings and the modelling of scenarios for the impact of acid deposition. The pH is a measure of overall acidity and is strongly correlated with the concentrations of labile aluminium. However, it does not help distinguish between natural and anthropogenic acidification.

### Comparison of current and proposed standards for acidification

To help with the comparison, the current percentile standards have also been shown in Table 23 as estimates of the corresponding annual means[2].  The new standards are tighter for clear waters but laxer for humic waters.

**Table 23: Comparison of current and proposed standards for pH and ANC**

| Class | Current standards[3] | | Proposed standards | | | |
|---|---|---|---|---|---|---|
| | All waters | | Clear waters | | Humic waters | |
| | pH | | pH | ANC | pH | ANC |
| | | (indicative mean) | (annual mean) | | | |
| High | 6.0 (  5-percentile) | 5.79 | 6.60 | 80 | 5.10 | 80 |
| Good | 5.2 (10-percentile) | 5.37 | 5.95 | 40 | 4.55 | 50 |
| Moderate | 4.7 (10-percentile) | 4.91 | 5.44 | 15 | 4.22 | 10 |
| Poor | 4.2 (10-percentile) | 4.43 | 4.89 | -10 | 4.03 | 5 |

[1] Covering most concentrations of dissolved organic carbon.
[2] Using data on typical values of the standard deviation and assuming a normal distribution and a coefficient of variation of 0.075, the average for Welsh rivers.
[3] The current standards for high status also include a test set to protect against elevated pH – an annual 95-percentile of 9.  No change is proposed for this.

An assessment using water-bodies in Scotland shows that the proposed standards produce broadly similar results in classification. The UKTAG believes that this outcome would be replicated across the UK where acidification pressures exist.

Movement of water-bodies between classes is shown in Tables 24a and 24b. In 267 clear waters there would be 15 downgrades and 9 upgrades following the use of the new standards in classification. In 37 humic waters there would be 1 down-grade and 16 upgrades. The net outcome is an upgrade for humic waters and a downgrade for clear waters.

**Table 24a: Movements in class in clear waters as a result of new standards**

| | | Proposed standards for clear waters | | | | | |
|---|---|---|---|---|---|---|---|
| | | **High** | **Good** | **Moderate** | **Poor** | **Bad** | Totals |
| Current standards | **High** | 229 | 13 | | | | 242 |
| | **Good** | 7 | 12 | 2 | | | 21 |
| | **Moderate** | | 1 | 2 | | | 3 |
| | **Poor** | | | 1 | 0 | | 1 |
| | **Bad** | | | | | 0 | 0 |
| | Totals | 236 | 26 | 5 | 0 | 0 | 267 |

**Table 24b: Movements in class in humic waters as a result of new standards**

| | | Proposed standards for humic waters | | | | | |
|---|---|---|---|---|---|---|---|
| | | **High** | **Good** | **Moderate** | **Poor** | **Bad** | Totals |
| Current standards | **High** | 20 | | 1 | | | 21 |
| | **Good** | 8 | | | | | 8 |
| | **Moderate** | 6 | | | | | 6 |
| | **Poor** | 1 | 1 | | | | 2 |
| | **Bad** | | | | | | 0 |
| | Totals | 35 | 1 | 1 | 0 | 0 | 37 |

**Implications**

The issues that will be affected by failure of the standards are the control of power stations that use fossil fuel. Most of the necessary controls are already in place through other drivers. There is also the adoption of policy on land-use that directs appropriate forestry in sensitive areas – areas that have a naturally low buffering against acid events.

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