COMMON IMPLEMENTATION STRATEGY FOR THE WATER FRAMEWORK DIRECTIVE (2000/60/EC)

POLICY SUMMARY

to
Guidance Document No. 7

Monitoring under the Water Framework Directive

Produced by Working Group 2.7 - Monitoring

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1. What is the purpose of the guidance document?

The **non-legally binding document** aims to guide experts and stakeholders in the design and implementation of the monitoring networks and programmes required to meet the requirements and objectives of the Water Framework Directive for all categories of waters: rivers, lakes, transitional waters, coastal waters and groundwater.

The guidance will help those who are; undertaking monitoring programmes, leading and managing experts undertaking the monitoring, using the results of monitoring for taking part in the policy making process or reporting on the results of monitoring to the EU as required by the Directive.

The guidance will help to:

- Verify the common understanding of key concepts like supporting parameters to assess ecological quality, risk, precision and confidence, surveillance, operational and investigative monitoring of surface waters, surveillance, operational and quantitative monitoring of groundwater, surface water monitoring for protected areas and other linked considerations (such as monitoring of wetlands, reference conditions, the intercalibration exercise and monitoring of heavily modified water bodies;
- Select mandatory and recommended Quality Elements (QEs) for monitoring and parameters most representative of catchment pressures for surface and groundwater. In addition information on how each QEs are currently monitored in Member States can be also found;
- Design, establish and implement monitoring programmes based on the identified objectives and required outcomes of the Directive, with emphasis on achieving acceptable levels of risk, precision and confidence; and,
- Select water bodies, monitoring sites within water bodies and sampling frequencies required for surveillance, operational, investigative and quantitative status monitoring programmes and for the monitoring of protected area.

The guidance document proposes an overall methodological approach to monitoring for the implementation of the WFD. Because of the diversity of catchment pressures, water body types, biological communities and hydromorphological and physico-chemical characteristics within the European Union, the implementation of appropriate monitoring programmes in accordance with the requirements of the Directive will vary between Member States and river basins. This proposed methodology will therefore need to be tailored to specific circumstances.

It is not the intention of the guidance to define prescriptive methods for the monitoring, assessment and classification of ecological status of surface waters, nor for the chemical and quantitative status for groundwater because:

- There are a number of existing monitoring and classification systems already in use throughout the EU that are potentially suitable for adaptation to meet the requirements of the WFD, some of which have been incorporated into National Standards;
- Individual Member States generally understand local natural variations in biological communities, hydromorphological conditions and physico-chemical variables;
- Individual Member States understand and have information on the natural hydrogeological and chemical characteristics of their aquifers and groundwater bodies;

- The level of habitat detail required varies for different indicators depending on their sensitivity to natural variation in habitat conditions; and
- There are existing international, European and national standards for a number of the required quality elements.

The guidance, therefore, provides a framework within which Member States can either use/modify their existing methods, or where no appropriate monitoring and assessment systems exists, develop new systems that will incorporate all the requirements of the WFD.

An overview of the current national monitoring best practice is also provided.

Member States must develop and adapt the methodology from this guidance document to national and regional circumstances, but in doing so should ensure that their monitoring and assessment programmes:

- Provide for an assessment on the deviation of observed conditions to those that would normally be found under reference conditions (for surface waters);
- Provide for natural and artificial physical habitat variation in surface waters;
- Account for the range of natural variability and variability arising from anthropogenic activities of all quality elements in all surface water body types, and of all parameters in groundwater bodies;
- Account for the interactions between surface waters and groundwater;
- Provide for detection of the full range of potential impacts to enable a significant classification of ecological status, and a significant classification and determination of groundwater chemical and quantitative status.

The guidance document does not focus on:

- Typology of surface water categories;
- Application of the term ‘water body’;
- Determination of reference conditions;
- Development of assessment and classification systems;
- Monitoring wetlands;
- Data analysis and reporting.

The document has been developed by an informal European working group of experts and stakeholders under the umbrella of the Common Implementation Strategy agreed by Member States and the European Commission for supporting the implementation of the Water Framework Directive. It builds on:

- The expertise and experience of the members of the working group;
- Four workshops to present, discuss and revise preliminary working documents and the guidance;
- Input and feedback from a wide range of experts and stakeholders from the Member States, Norway and the Accession Countries; and,
- Regular interactions with other relevant working groups of the Common Implementation Strategy.

2. Monitoring requirements of the Water Framework Directive

Article 8 of the Directive establishes the requirements for the monitoring of surface water status, groundwater status and protected areas. Monitoring programmes are required to establish a coherent and comprehensive overview of water status within each river basin district. The programmes have to be operational at the latest by 22 December 2006, and must be in accordance with the requirements of Annex V.

Surface waters

Annex V indicates that monitoring information from surface waters is required for:

- The classification of status. (*Note: Member States must provide a map for each river basin district in their territory illustrating the classification of the ecological and chemical status of each body of water using the colour-coding system specified by the Directive);*
- Supplementing and validating the Annex II risk assessment procedure;
- The efficient and effective design of future monitoring programmes;
- The assessment of long-term changes in natural conditions;
- The assessment of long-term changes resulting from widespread anthropogenic activity;
- Estimating pollutant loads transferred across international boundaries or discharging into seas;
- Assessing changes in status of those bodies identified as being at risk in response to the application of measures for improvement or prevention of deterioration;
- Ascertaining causes of water bodies failing to achieve environmental objectives where the reason for failure has not been identified;
- Ascertaining the magnitude and impacts of accidental pollution;
- Use in the intercalibration exercise *(Note this is not an Article 8 requirement)*;
- Assessing compliance with the standards and objectives of Protected Areas; and,
- Quantifying reference conditions (where they exist) for surface water bodies should. (*Note: this is an Annex II requirement).*

Groundwater

Annex V also indicates that monitoring information from groundwater is required for:

- Providing a reliable assessment of quantitative status of all groundwater bodies or groups of bodies; *(Note: Member States must provide maps illustrating the quantitative status of all groundwater bodies or groups of bodies using the colour-coding scheme set out in the Directive.)*
- Estimating the direction and rate of flow in groundwater bodies that cross Member States boundaries;
- Supplementing and validating the impact assessment procedure;
- Use in the assessment of long term trends both as a result of changes in natural conditions and through anthropogenic activity;

- Establishing the chemical status of all groundwater bodies or groups of bodies determined to be at risk. *(Note: Member States must provide maps illustrating the chemical status of all groundwater bodies or groups of bodies using the colour-coding scheme set out in the Directive)*;
- Establishing the presence of significant and sustained upwards trends in the concentrations of pollutants. *(Note: Member States must indicate on the maps of chemical status using a black-dot, those groundwater bodies in which there is a significant upward trend);* and,
- Assessing the reversal of such trends in the concentration of pollutants in groundwater *(Note: Member States must indicate on the maps of chemical status using a blue-dot, those groundwater bodies in which a significant upward trend has been reversed).*

Reporting

The following must be reported in the River Basin Management Plans:

- Maps of the monitoring networks;
- Maps of water status;
- An indication on the maps of the bodies of groundwater which are subject to a significant upward trend in concentration of pollutants and an indication of the bodies of groundwater in which such trends have been reversed; and,
- Estimates of the confidence and precision attained by the monitoring systems.

Types of monitoring

Three types of monitoring[1] for surface waters are described in Annex V: surveillance, operational and investigative monitoring.

For groundwater a water level monitoring network is required which will provide a reliable assessment of the quantitative status of all groundwater bodies or groups of bodies including an assessment of the available groundwater resource. It should be noted that the level network alone will not be able to achieve this assessment. In terms of groundwater chemical status, surveillance and operational monitoring are required.

These types are to be supplemented by monitoring programmes required for Protected Areas registered under Article 6. Annex V only describes requirements for Drinking Water Protected Areas in surface water and for Protected Areas for habitats and species. Member States may wish to integrate monitoring programmes established for other Protected Areas within the programmes established under the Directive. This is likely to improve the cost-effectiveness of the various programmes.

[1] *In the context of the Directive monitoring means the gathering of data and information on the status of water, and does not include the direct measurement of emissions and discharges to water. The latter is being dealt with by WG 2.1, IMPRESS*

3. Design of monitoring programmes

Monitoring is a cross-cutting activity within the Directive and as such there are important interrelationships with other Articles and Annexes of the Directive. A key Article in relation to monitoring and the design of appropriate programmes for surface waters and groundwater is Article 5, Figures 1 and 2 summarise the relationship between articles 5 and 8 for surface waters and groundwater, respectively. Article 5 requires river basin districts to be characterised and the environmental impact of human activities to be reviewed in accordance with Annex II. The first assessments must be completed by 22 December 2004. Risk assessment will be on-going as they will be required for subsequent River Basin Management Plans. The first assessments must be completed 2 years before monitoring programmes have to be operational.

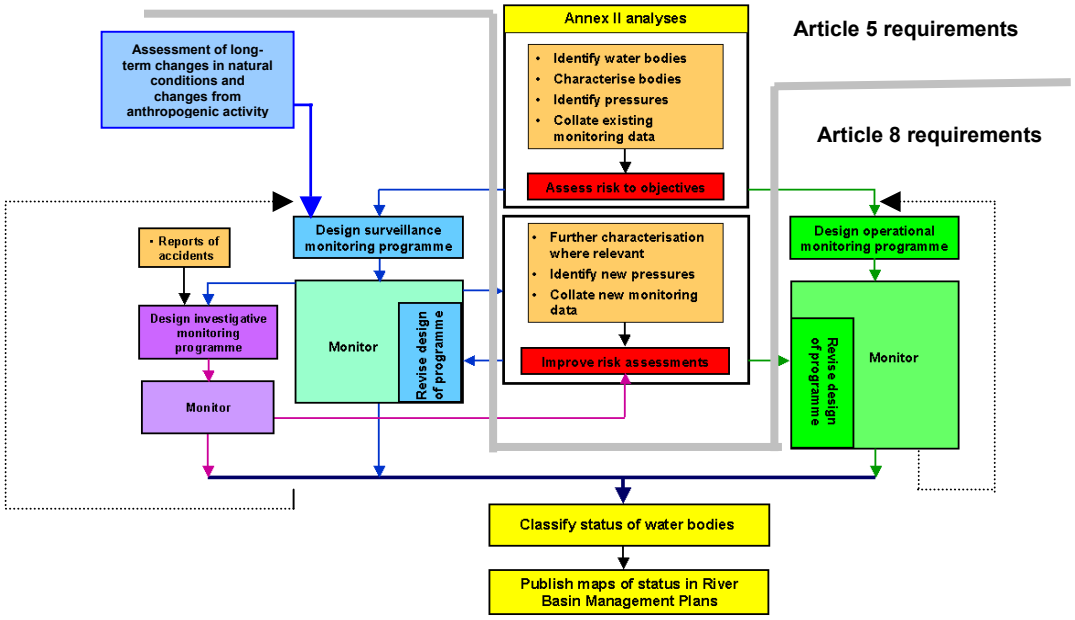

Figure 1 **Schematic diagram illustrating the relationship between Article 5 and Article 8 in the design of surface water monitoring programmes.**

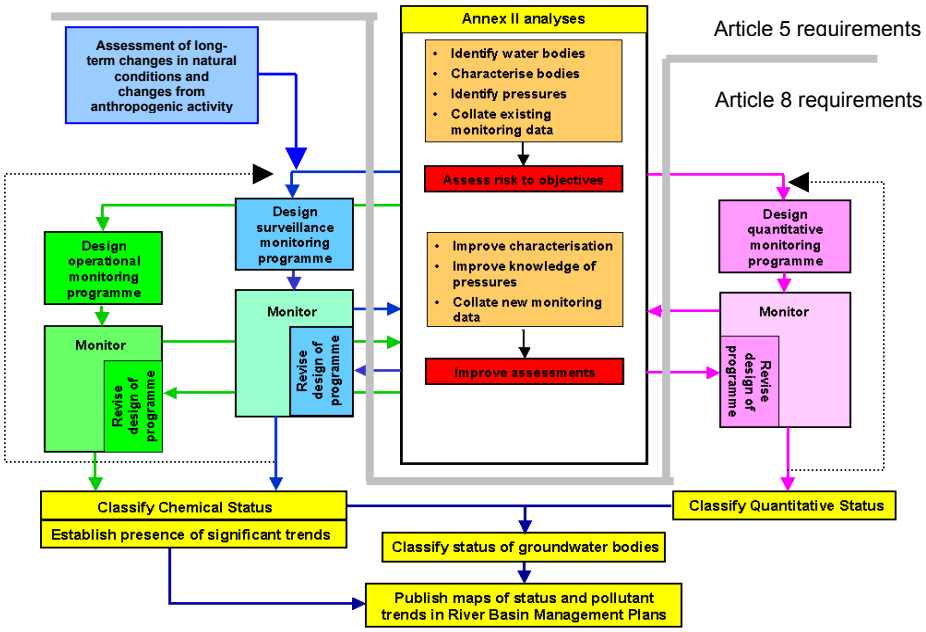

Figure 2 **Schematic diagram illustrating the relationship between Article 5 and Article 8 in the design of groundwater monitoring programmes**

Thus the Annex II risk assessments play a key role in the initial design and subsequent revision of the monitoring programmes required by the Directive.

Surface waters

Annex II describes a process by which surface water bodies are identified, categorised and then typified according to one of two systems A or B given in section 1.2 of the Annex. Type-specific reference conditions have to be identified for each surface water body type. It is the type specific reference conditions from each surface water body type that the monitoring results will be compared with to give an assessment of the status of a water body categorised in the water body type. Information on the type and magnitude of the significant anthropogenic pressures to which the surface water bodies in each river basin district are subject has to be collected and maintained. There must then be an assessment of the susceptibility of the surface water status of bodies to the pressures identified, and of the likelihood that surface water bodies within the river basin district will fail to meet the environmental quality objectives set under Article 4. This assessment will use any available existing monitoring data: the extent of existing data will vary greatly from country to country. Also expert judgement and /or modelling approach (i.e. risk assessment) can be used. For the first assessment there will not be data arising from the Article 8 monitoring programmes as they do not have to be operational until the end of 2006: data should be available for subsequent assessments for future RBMPs. However, many countries already have extensive monitoring programmes.

The Directive introduces a flexible hierarchical system for monitoring the very many different types of water body across Europe reflecting the fact that natural physical and geological conditions and anthropogenic pressures vary greatly across Europe. Because of this a monitoring system designed for one part of Europe may not be entirely applicable in another. The Directive seeks ways of harmonising the results of monitoring systems and ecological

assessments rather than imposing a common ecological quality assessment system in each country.

There is flexibility in terms of monitoring frequencies reflecting that some determinands and quality elements (in terms of surface waters) will be more variable than others. Member States can also plan their monitoring programmes and resources so that not all the selected quality elements have to be monitored every year at every station. This should ensure the situation does not occur where countries have to monitor for chemical substances even though they are known not to be present in the catchment, except where validation of the risk assessments is required. In short, cost-effective and targeted monitoring programmes can be designed.

An important aspect in the design of monitoring programmes is quantifying the temporal and spatial variability of quality elements and the parameters indicative of the quality elements in the surface water bodies being considered. Those that are very variable may require more sampling (and hence cost) than those that are more stable or predictable. Alternatively variability might be reduced or managed by an appropriate targeted or stratified sampling programme which collects data in a limited but well-defined sampling window.

Groundwater

Article 17 requires the Commission to come forward with a proposal for a daughter directive on groundwater by the end of 2002. Among other things, this proposal may include further criteria for assessing good groundwater chemical status and for the identification of trends. This may have implications for the design of the monitoring programmes described in the guidance document.

The monitoring programmes for groundwater should be designed on the basis of the results of the Annex II characterisation and risk assessment procedure. Guidance on characterisation and risk assessment for bodies and groups of bodies of groundwater can be found in the documents prepared by CIS Working Group 2.1 IMPRESS. The results of the assessments should provide the necessary information on, and understanding of, the groundwater system and the potential effects of human activities on it with which to design the monitoring programmes. In particular, monitoring programme design will require:

- Estimated boundaries of all bodies of groundwater;
- Information on the natural characteristics, and a conceptual understanding, of all bodies or groups of bodies of groundwater;
- Information on how bodies may be grouped because of similar hydrogeological characteristics and therefore similar responses to the identified pressures;
- Identification of those bodies, or groups of bodies, of groundwater at risk of failing to achieve Directive's objectives, including the reasons why those are considered to be at risk; and,
- Information on (a) the level of confidence in the risk assessments (e.g. in the conceptual understanding of the groundwater system, the identification of pressures, etc), and (b) what monitoring data would be required to validate the risk assessments.

To ensure the targeted and cost-effective development of the groundwater monitoring programmes, this information and understanding should serve as the basis for identifying:

- The bodies, or groups of bodies relevant to each monitoring programme;

- The appropriate monitoring sites in those bodies, or groups of bodies;
- The appropriate parameters for monitoring at each site; and
- The monitoring frequencies for those parameters at each site

A conceptual model/understanding represents the current understanding of the groundwater system based on information on its natural characteristics and the pressures on it. Monitoring should provide the information needed to test the model/understanding and, where necessary, improve it so that an appropriate level of confidence can be achieved in the prediction and assessment of groundwater problems. Designing the monitoring programmes on the basis of conceptual models/understandings ensures that the programmes will be appropriate to the hydrogeological characteristics of the body, or group of bodies, of groundwater and, where relevant, to the behaviour of pollutants in the groundwater system. For example, monitoring quantitative or chemical status in a low permeability fractured medium will require a different strategy (in terms of what to measure, where and when) than would monitoring quantitative or chemical status in a high permeability inter-granular flow medium.

Different types of environmental objectives applicable to groundwater bodies will demand different environmental outcomes. They may therefore require different monitoring strategies to provide the information needed to assess their achievement. However, the design of the monitoring programme should always be based on an appropriate conceptual model/understanding. For example, objectives requiring the protection of associated surface water bodies, directly dependent terrestrial ecosystems, drinking water abstraction points or other legitimate uses from point sources of pollution might require monitoring in the predicted flow path between the source and one of the receptors listed above whereas monitoring data to assess objectives for general groundwater quality could be provided by more dispersed monitoring depending on the conceptual model/understanding of the distribution of pollutants in the groundwater.

Key principles:

The design and operation of groundwater monitoring programmes should be informed by:

- **The objectives applying to the body;**
- **The characteristics of the groundwater body, or group of bodies;**
- **The existing level of understanding (i.e. the confidence in the conceptual model/understanding) of the particular groundwater system;**
- **The type, extent and range of the pressures on the body, or group of bodies;**
- **The confidence in the assessment of risk from pressures on the body, or group of bodies; and**
- **The level of confidence required in the assessment of risk.**

4. What water bodies should be monitored?

The Water Framework Directive covers **all** waters[2] including inland waters (surface water and groundwater) and transitional and coastal waters up to one sea mile (and for the chemical status also territorial waters which may extend to 12 sea miles) from the territorial baseline of a Member State independent of the size and the characteristics[3].

The objective of monitoring is to establish a coherent and comprehensive overview of water status within each River Basin District and must permit the classification of all surface water bodies into one of five classes[4] and groundwater into one of two classes[5].

The success of the Directive in achieving this purpose and its related objectives will be mainly measured by the status of "water bodies". "Water bodies" are therefore the units that will be used for reporting and assessing compliance with the Directive's principal environmental objectives. However, it should be emphasised that the identification of a "water body" is a tool not an objective in itself. The definition and identification of water bodies within river basins, catchments and sub-catchments is therefore a key consideration in the design of monitoring programmes. The Commission and Member States has developed horizontal guidance on water bodies.

The 'water body' should be a coherent sub-unit in the river basin (district) to which the environmental objectives of the Directive must apply[6]. Hence the main purpose of identifying 'water bodies' is to enable the status to be accurately described and compared to environmental objectives.

Thus the purpose of delineating water bodies is to provide for an accurate description of the status of surface water and groundwater and provide a sound basis for management of the water environment. The number of water bodies required in monitoring programmes will, therefore, be strongly dependent on the degree of variation in the status of the water environment as well as on the extent and characteristics of surface waters in a Member State's territory (e.g. number of lakes, whether the State has a coast, etc). Where there are numerous and significant differences in status, water bodies will be equally numerous to reflect those differences. Where status is similar, water bodies will tend to be larger and therefore fewer in number. The scale of monitoring programmes will be dependent to some degree on the numbers of water bodies – or more accurately on the extent of, and variability in, impacts on the water environment.

Surface water bodies or bodies of groundwater may each be grouped for monitoring purposes as long as the monitoring of sufficient indicative or representative water bodies in the sub-groups of surface water or groundwater bodies provides for an acceptable level of confidence and precision in the results of monitoring, and in particular the classification of water body status.

Monitoring stations may not be needed in each and every water body. Member States will have to ensure that enough individual water bodies of each water body type or grouping are monitored. They will also have to determine how many stations are required in each

[2] *Taken from horizontal guidance on the application of the term "water body", version 8.0*
[3] *Articles 2 (1), (2) and (3)*
[4] *Annex V 1.3*
[5] *Annex V 2.2.4 and 2.4.5*
[6] *Taken from horizontal guidance on the application of the term "water body", version 8.0.*

individual water body to determine its ecological (surface water) chemical (surface water and groundwater) and quantitative (groundwater) status. This process of selecting water bodies and monitoring stations should entail statistical assessment techniques, and should ensure that the overview of water status has an acceptable level of confidence and precision.

The size typology given in Annex II (System A) implies that rivers with catchment areas greater than 10 km^2 and (b) lakes greater than 0.5 km^2 in surface area are water bodies that fall under the requirements of the Directive and might need to be included within the water status assessment and monitoring. Surface waters below the System A typology size thresholds could be Protected Areas, be important to the ecology of the river basin as a whole (e.g. important spawning and breeding grounds), or be subject to pressures that have significant consequences elsewhere in the river basin district. In the System B typology no such size limits are implied, though the typology used must achieve at least the same degree of differentiation as would be achieved using System A. Member States may thus wish or need to include small water bodies within the monitoring and assessment requirements of the Directive.

In practice Member States will determine the size of water body that needs to be included in monitoring programmes. It will depend on the nature (natural and anthropogenic) of each River Basin District being characterised and the attainment of the objective to provide a coherent and comprehensive overview of water status within the River Basin District.

The Directive also stipulates that surveillance monitoring of surface waters should be carried out at points where:

- The rate of water flow is significant within the river basin district as a whole; including points on large rivers where the catchment is greater than 2 500 km^2;
- The volume of water present is significant within the river basin district, including large lakes and reservoirs;
- Significant bodies of water cross a Member State boundary;
- Sites are identified under the Information Exchange Decision 77/795/EEC; and,
- At such other sites as are required to estimate the pollutant load which is transferred across Member States boundaries, and which is transferred into the marine environment.

Groundwater bodies within which groundwater flows across Member States boundaries are also to be included in groundwater level and chemical status monitoring programmes.

Protected Areas

There are additional monitoring requirements for protected areas[7]. Protected Areas include bodies of surface water and groundwater used for the abstraction of drinking water and habitat and species protection areas identified under the Birds Directive or the Habitats Directive. Thus for the former areas monitoring sites must be designated in bodies of surface water which provide more than 100 m^3 a day as an average. For groundwater there appear to be no additional monitoring requirements.

[7] *Annex V.1.3.5*

Wetlands

Wetlands are not defined as a separate water category or water body type within the Directive. There are, however, explicit references to wetlands within the Directive[8]. The inclusion of wetlands in the monitoring requirements of the Directive is a matter of discussion between Members States, NGOs and other stakeholders. As a result the EEB and WWF prepared a draft paper regarding wetlands and WFD. It was presented at the Strategic Co-ordination Group (SCG) (30.09.02 - 01.10.02) meeting in order to determine what actions are required**.** At this meeting it was agreed that the SCG should take the issue of wetlands under the umbrella of the CIS and to prepare a 'horizontal guidance' within 2003 (refer to Guidance on Wetlands - currently under preparation).

5. Quality elements "supporting" the biological elements

The Directive specifies quality elements for the classification of ecological status[9] that include hydromorphological, chemical and phisico-chemicalelements supporting the biological elements. For surveillance monitoring parameters indicative of all the biological, hydromorphological and all general and specific physico-chemical quality elements are required to be monitored. For operational monitoring, the parameters used should be those indicative of the biological and hydromorphological quality elements most sensitive to the pressures to which the body is subject, and all priority substances discharged and other substances discharged in significant quantities. The ecological status classification[10] of a body of water is to be represented by the lower of the values for the biological and physico-chemical monitoring results for the relevant quality elements classified in accordance with the normative definitions[11].

Supporting means that the values of the physicochemical and hydromorphological quality elements are such as to support a biological community of a certain ecological status, as this recognises the fact that biological communities are products of their physical and chemical environment. The latter 2 aspects fundamentally determine the type of water body and habitat, and hence the type specific biological community. It is not intended that these supporting elements can be used as surrogates for the biological elements in surveillance and operational monitoring. The monitoring or assessment of the physical and physicochemical quality elements will support the interpretation assessment and classification of the results arising from the monitoring of the biological quality elements.

Key Principal

The use of non-biological indicators for estimating the condition of a biological quality element may complement the use of biological indicators but it cannot replace it. Without comprehensive knowledge of all the pressures on a water body and their combined biological effects, direct measures of the condition of the biological quality elements using biological indicators will always be necessary to validate any biological impacts suggested by non-biological indicators.

[8] *e.g. Article 1(a), Preamble (8), (23)*
[9] *Annex V.1.1*
[10] *Annex V.1.4.2*
[11] *Annex V.1.2*

6. Risk, precision and confidence

Risk[12] and confidence[13] are words used in Annex II[14] (in terms of risk of failing environmental objectives, and confidence in the values of reference conditions), and risk, confidence and also precision[15] are words used in Annex V[16] (design of monitoring programmes). Their interpretation will affect the scale and extent of the monitoring required to assess status at any particular time and changes in status with time. What is considered to be "acceptable", "adequate" and "sufficient" levels of precision and confidence, and a "significant" risk, will determine aspects such as the:

- Number of water bodies included in the various types of monitoring;
- Number of stations that will be required to assess the status of each water body; and,
- Frequency at which parameters indicative of surface water quality elements will have to be monitored.

Choosing levels of precision and confidence will set limits on how much uncertainty (arising from natural and anthropogenic variability) can be tolerated in the results of monitoring programmes. In terms of monitoring for the Directive, it will be necessary to estimate the status of water bodies and in particular to identify those that are not of good status or good ecological potential or are deteriorating in status. Thus status will have to be estimated from the sampled data. This estimate will almost always differ from the true value (i.e. the status which would be calculated if all water bodies were monitored and sampled continuously for all components that define quality).

The level of acceptable risk will affect the amount of monitoring required to estimate a water body's status. In general terms, the lower the risk of misclassification desired, the more monitoring (and hence costs) required to assess the status of a water body. It is likely that there will have to be a balance between the costs of monitoring against the risk of a water body being misclassified. Misclassification implies that measures to improve status could be inefficiently and inappropriately targeted. It should also be borne in mind that in general the cost of measures for improvement in water status would be orders of magnitude greater than the costs of monitoring. The extra costs of monitoring to reduce the risk of misclassification might therefore be justified in terms of ensuring that decisions to spend larger sums of money required for improvements are based on reliable information on status. Further, from an economics point of view, stronger criteria should be applied to avoid a situation where water bodies fulfilling the objective are misjudged and new measures applied. Also it should be noted that for surface water surveillance monitoring, and all groundwater monitoring, sufficient monitoring should be done to validate risk assessments and test assumptions made.

The Directive does not specify the levels of precision and confidence required from monitoring programmes and status assessments. This perhaps recognises that achievement of too rigorous precision and confidence requirements would entail a much-increased level of monitoring for some, if not all, Member States.

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[12] At the simplest level, a risk can be thought of as the chance of an event happening. It has two aspects: the chance, and the event that might happen. These are conventionally called the probability and the consequence.
[13] The probability (expressed as a percentage) that the answer obtained (e.g. by the monitoring programme) does in fact lie within calculated and quoted limits, or within the desired or designed precision.
[14] Annex II.1.1.5, 2.1 and 1.3
[15] The discrepancy between the answer (e.g. a mean) given by the monitoring and sampling programme and the true value.
[16] Annex V 1.3, 2.3 and 2.4

Key Principal

The actual precision and confidence levels achieved should enable meaningful assessments of status in time and space to be made. Member States will have to quote these levels in RBMPs and will thus be open to scrutiny and comment by others. This should serve to highlight any obvious deficiencies or inadequacies in the future.

The starting point for many Member States will probably be an assessment of existing stations and samples to see what level of precision and confidence can be achieved by those resources. It is likely that this will have to be an iterative process with modification and revision of monitoring programmes to achieve levels of precision and confidence that allow meaningful assessments and classification.

It is also likely that Member States will use expert judgement to some extent in assessing the risk of misclassification. For example in the case of a misclassifying bodies "at risk" the persons responsible for making the decision to implement expensive measures will clearly secure their decisions by further assessments before implementing the measures. In the case of misclassifying bodies as "not being at risk" there will be much local experience and expert judgement (by water managers or public persons) to doubt the monitoring results and assessment and look for further clarification.

7. What parameters and quality elements should be monitored?

Surveillance monitoring of surface waters

Member States must monitor at least for a period of a year for parameters indicative of all biological, hydromorphological and general physico-chemical quality elements. The relevant quality elements for each type of water are given in Annex V.1.1 and V.1.2.

The Directive indicates that monitoring of the biological quality elements must be at an appropriate taxonomic level to achieve adequate confidence and precision in the classification of the quality elements. This applies equally to the three types of surface water monitoring.

Those priority list substances discharged into the river basin or sub-basins must be monitored. Other pollutants[17] also need to be monitored if they are discharged in significant quantities in the river basin or sub-basin. No definition of ‘significance’ is given but quantities that could compromise the achievement of one of the Directive’s objectives are clearly significant, and as examples, one might assume that a discharge that impacted a Protected Area, or caused exceedence of any national standard set under Annex V 1.2.6 of the Directive or caused a biological or ecotoxicological effect in a water body would be expected to be significant.

Operational monitoring of surface waters

Member States are required to monitor for those biological and hydromorphological quality elements most sensitive to the pressures to which the body or bodies are subject. For example, if organic pollution is a significant pressure on a river then benthic invertebrates might be the most sensitive and appropriate indicator of that pressure. Thus in the absence of other pressures, aquatic flora and fish populations may not need to be monitored in those

[17] *Annex VIII*

bodies of water. However, the monitoring and assessment system must still be based on the concept of ecological status and not just reflect degrees of organic pollution without comparison to the appropriate reference conditions. This is because its ecological status must be defined.

If a body is not identified as being at risk because of discharges of priority substances or other pollutants, no operational monitoring for these substances is required. A pollutant is defined[18] as 'any substance liable to cause pollution in particular those listed in Annex VIII'. As such nutrients and substances that have an unfavourable influence on the oxygen balance must also be considered as well as metals and organic micropollutants. Operational monitoring must use parameters relevant to the assessment of the effects of the pressures placing the body at risk.

Investigative monitoring of surface waters

Investigative monitoring[19] may also be required in specified cases. These are given as:

- Where the reason for any exceedences (of Environmental Objectives) is unknown;
- Where surveillance monitoring indicates that the objectives set under Article 4 for a body of water are not likely to be achieved and operational monitoring has not already been established, in order to ascertain the causes of a water body or water bodies failing to achieve the environmental objectives; or
- To ascertain the magnitude and impacts of accidental pollution.

The results of the monitoring would then be used to inform the establishment of a programme of measures for the achievement of the environmental objectives and specific measures necessary to remedy the effects of accidental pollution.

Investigative monitoring will thus be designed to the specific case or problem being investigated. In some cases it will be more intensive in terms of monitoring frequencies and focused on particular water bodies or parts of water bodies, and on relevant quality elements.

International monitoring standards

The Directive also indicates that the monitoring of type parameters for surface waters should conform to appropriate international standards (such as those developed by CEN and ISO) which should ensure the provision of data of an equivalent scientific quality and comparability.

Groundwater quantitative status

The most appropriate parameters to monitor quantitative status will depend on the conceptual model/understanding of the groundwater system. For example, spring flows or even base-flows in rivers may be more appropriate than the use of boreholes in low permeability fractured media or where the risks of failing to achieve good quantitative status are low and information from the surface water monitoring network can adequately validate this assessment.

[18] *Article 2.31*
[19] *Annex V.1.3.3*

Groundwater chemical status and trends

Where surveillance monitoring is required, the Directive requires that a core set of parameters be monitored. These parameters are oxygen content, pH value, conductivity, nitrate and ammonium.

Other monitored parameters for both surveillance and operational monitoring must be selected on the basis of (a) the purpose of the monitoring programme, (b) the identified pressures and (c) the risk assessments made using a suitable conceptual model/understanding of the groundwater system and the fate and behaviour of pollutants in it. For example, suites of parameters commonly associated with certain types of pressures have been identified in the guidance document (e.g gas works: PAH, Phenol, hydrocarbons, etc). Parameters indicative of the pollutants that are liable to be present can be used to ensure cost-effective monitoring. Other chemical parameters may need to be sampled for quality assurance purposes. For example, measuring the concentrations of major ions in a water sample so that an ion balance can be used as a check that the water analysis results are representative of the sampled groundwater should be considered as a routine quality assurance procedure.

8. How often should monitoring be undertaken?

Surface waters

The Directive allows Member States to tailor monitoring frequencies according to the conditions and variability within their own waters. These are likely to differ greatly from determinand to determinand, from water body type to water body type, from area to area and from country to country, recognising that a frequency adequate in one country may not be so in another. However, the key is to ensure that a reliable assessment of the status of all water bodies can be achieved, and the reliability of that assessment in terms of confidence and precision must be provided.

Annex V[20] provides tabulated guidelines in terms of the minimum monitoring frequencies for all the quality elements. The suggested minimum frequencies are generally lower than currently applied in some countries. More frequent samples will be necessary to obtain sufficient precision in supplementing and validating Annex II assessments in many cases. Less frequent samples for the general physicochemical quality elements are permissible if technically justified and based on expert judgement. In addition, not all quality elements need to be monitored during the same year, there can be phased monitoring from year to year as long as all are monitored at least once over a year during the lifetime of the RBMP.

There is also an additional clause in Annex V that allows Member States to only undertake surveillance monitoring in specific water bodies once every three river basin management plans (RBMPs) (i.e. once in 18 years) when that body has reached good status and when there is no evidence that impacts on that body have changed.

In terms of operational monitoring Member States are required to determine monitoring frequencies that will provide a reliable assessment of the status of the relevant quality element. The same guidance given on minimum monitoring frequencies for surveillance monitoring is also used for operational monitoring. Again more frequent monitoring will mostly likely be necessary in many cases, but also less frequent monitoring is justified when based on technical knowledge and expert judgement.

[20] *Annex V.1.3.4*

Member States can also amend their operational monitoring programmes (particularly the monitoring frequency) during the duration of a RBMP where an impact is found not to be significant or the relevant pressure is removed, and the ecological status is no longer less than good.

Monitoring frequencies are also given for certain Drinking Water Protected Areas[21] and relate to the size of the population that the Protected Area serves – the greater the population the greater the frequency.

Groundwater quantitative status

The most appropriate monitoring frequency will depend on the conceptual model/understanding of the groundwater system and the nature of the pressures on the system. The frequency chosen should allow short-term and long-term level variations within the groundwater body to be detected. For example, for formations in which the natural temporal variability of groundwater level is high or in which the response to pressures is rapid, more frequent monitoring will be required than will be the case for bodies of groundwater that are relatively unresponsive to short-term variations in precipitation or pressures. Where monitoring is designed to pick up seasonal or annual variations, the timing of monitoring should be standardised from year to year.

Groundwater chemical status

The conceptual model/understanding of the groundwater system and the understanding of the fate and behaviour of pollutants within it, and the aspect of the model being tested should determine the appropriate frequency of monitoring. The guidance document provides examples of frequencies that Member States have found appropriate in a number of hydrogeological circumstances and in relation to different pollutant behaviours.

No minimum duration for the groundwater chemical status surveillance programme is specified. For the first river basin planning period, Member States that already have extensive groundwater monitoring networks may only need a short period of surveillance monitoring to help design their operational monitoring programmes whereas Member States whose existing networks are more limited may require more information from surveillance programmes before the design of their operational programmes can be completed.

Surveillance monitoring is only specified in the Directive for bodies at risk or which cross a boundary between Member States. However, to adequately supplement and validate the Annex II risk assessment procedure, validation monitoring will also be needed for bodies, or groups of bodies, not identified as being at risk. The amount and frequency of monitoring undertaken for these bodies, or groups of bodies, must be sufficient to enable Member States to be adequately confident that the bodies are at good status and that there are no significant and sustained upward trends.

[21] *Annex V.1.3.5*

9. Linkages with other CIS Working Groups

As previously described monitoring is cross-cutting activity within the requirements of the Directive and as such there are many linkages and inter-relationships with other CIS Working Groups and Expert Advisory Fora. Some of the main linkages are listed below:

1. Working Group on Pressures and Impacts (IMPRESS) (2.1) provides further guidance on Annex II risk assessments and, for example, on the selection of chemicals for inclusion in monitoring programmes (WFD CIS Guidance Document No. 3);
2. There are linkages with Working Group (2.2) on heavily modified water bodies in terms of the selection of appropriate quality elements for the monitoring and assessment of heavily modified and artificial water bodies (WFD CIS Guidance Document No. 4);
3. Monitoring results are to be used for the classification of ecological and chemical; status of surface water bodies. There are therefore linkages with Working Groups 2.3 on reference conditions for inland surface waters (REFCOND) and 2.4 on typology and classification of transitional and coastal waters. In addition, reference conditions may be determined by the monitoring of existing high status water bodies (WFD CIS Guidance Document No. 10);
4. The intercalibration exercise will involve monitoring. The monitoring guidance may, therefore need to be modified to reflect conclusions Working Group 2.5 on intercalibration (WFD CIS Guidance Document No. 6);.
5. Working Group (WG 2.8) on tools on assessment and classification of groundwater which has dealt with, and reported on, statistical methods for groundwater trend analysis (WFD CIS Guidance Document No. 9);
6. The Expert Group on the Analysis and Monitoring of Priority Substances established by EAF on Priority Substances will also be considering the monitoring, and assessment of compliance, of Priority Substances and Priority Hazardous Substances in terms of the Directive. This specific guidance will need to be incorporated into the monitoring guidance document in the future.
7.

10. Conclusions and outlook

1. The guidance document provides a common understanding on the monitoring requirements of the Water Framework Directive. Guidance and principles generic to all water categories are provided as well as more specific guidance on groundwater, rivers, lakes, transitional waters and coastal waters. This is largely based on current best practice in Member States and Norway. In addition, details of current monitoring practices in Member States and Norway are also given with details of national experts that could provide additional assistance.
2. The guidance document proposes an overall pragmatic approach. Because of the diversity of circumstances within the European Union, Member States may apply this guidance in a flexible way to answer problems that will vary from one river basin to the next. This proposed guidance will therefore need to be tailored to specific circumstances. However, these adaptations should be justified and should be reported in a transparent way.

3. It is recommended that the Commission considers establishing a drafting group to further develop horizontal guidance on the classification of ecological status of surface waters particularly in relation to Annex V.1.4.2 and Annex V.1.2. This is to do with the interpretation of the normative definition of good ecological status in terms of the physico-chemical quality elements, and the role of physicochemical and hydromorphological quality elements as supporting the biological quality elements. This issue is also of relevance to Working Groups 2.3 on reference conditions for inland surface waters (REFCOND) and 2.4 on typology and classification of transitional and coastal waters.
4. The Article 17 Groundwater Directive may establish additional criteria for the assessment of groundwater status. This guidance may need to be updated once such criteria have been established.
5. Additional monitoring is required for drinking water abstraction points and habitat and species protection areas. However the register or registers of protected areas also includes areas designated as bathing waters under Directive 76/160/EEC, as vulnerable zones under Directive 91/676/EEC and areas as sensitive under Directive 91/271/EEC. These latter Directives also have monitoring and reporting requirements. The EAF on Reporting is considering not only the reporting required under the WFD but also existing reporting requirements with the aim of 'streamlining' the reporting process. The Working Group on Monitoring also recommends that ways of integrating, rationalising and streamlining the monitoring requirements under the other Directives should also be considered in future work that might revise this draft guidance document.
6. It is recommended that appropriate standards are developed as a matter of priority and urgency for those aspects of monitoring for which there are no internationally agreed standards or techniques/methods.
7. It is anticipated that the guidance can be further developed by work undertaken in the next phase of the Common Implementation Strategy, for example, by the development of further horizontal guidance on some aspects, and in the light of experience gained during the pilot basin testing phase.