



# Water Status 2007-2009

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## **Water Framework Status Update**

based on

## **Monitoring Results 2007-2009**

Aquatic Environment Unit,

Office of Environmental Assessment

of the

Environmental Protection Agency.

Ecological Status and Chemical Status of Surface Waters

and

Chemical and Quantitative Status of Groundwaters.

Prepared in fulfilment of Articles 24 and 25 of SI 272 of 2009

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# Section 1. Introduction

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This document provides an update of status for Irish surface and groundwaters for the period 2007-2009, the first three years of the Water Framework Directive (WFD) monitoring programme.

Results are presented for each water category – groundwater, rivers, lakes, transitional and coastal waters and canals recognised by the Water Framework Directive. Each water category is reported upon separately taking the relevant quality elements required for that water category – as defined in Annex V of the WFD in §1.1 for surface waters and §2.1 for groundwaters. Insofar as possible the original phrasing and terminology of the WFD text is used when referring to quality elements in particular. Ecological status and chemical status are dealt with separately for surface waters. In the case of groundwater status chemical and quantitative status are treated separately.

The main report is essentially a set of links to more detailed information on the status results and methodologies used to defined status. Extensive use is made of hyperlinks to these supporting documents, which provide the actual surface and groundwater status results for individual waterbodies. The methodologies and results are presented in a variety of formats including maps, reports and tables. Maps and tables in GIS format compatible with those in use by the River Basin Districts (RBDs) will also be made available to the RBD GIS offices.

The report is produced in fulfilment of a requirement of Articles 24 and 25 of SI 272 of 2009 to classify waterbodies in terms of their ecological status, ecological potential as applicable and chemical status.

*“24. The Agency shall, by not later than 22 June 2011, classify in accordance with the*

*requirements of these Regulations each surface water body identified for the purposes of Article 7 of the 2003 Regulations according to its ecological status, or its ecological potential as the case may be, and its chemical status*

*25. The classification of the status for a surface water body shall be based on the results of the monitoring programmes prepared by the Agency in accordance with Article 10 of the 2003 Regulations and other relevant information, including monitoring and assessments undertaken in relation to associated protected areas.”*

The results reported here are not, however, seen as affecting the formal legal status of waterbodies already reported by the River Basin Districts in the River Basin Management Plans.

The EPA will provide regular progress reports providing a rolling three-year update on status as each year's new monitoring results become available and are analysed. The need to monitor the effectiveness or otherwise of the WFD Programmes of Measures put in place in the RBMPs is critical in order to ensure that programmes of measures are as focussed and as effective as possible. Status updates such as this will provide feedback to water managers in local authorities and other public bodies charged with implementing programmes of measures.

As the biological intercalibration exercise for surface waters is still in progress at European Level under the aegis of the ECOSTAT Working Group, some methods are not yet ready for use in the monitoring programme. These are indicated below under the appropriate heading. A target date of December 2011 is set for completion of the second round of intercalibration and a new formal EU Decision is due by late 2012. It is envisaged that new assessment methods



for all water categories will be developed during the second river basin planning cycle.

Note that this document requires internet access to access the document store of tables, maps and information regarding methods.

## Section 2. Rivers

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**Chemical Quality Elements:** Colman Concannon, Darragh Cunningham, Ray Smith, Caroline Bowden, Jean Smith, Peter Webster, Regina McGinn, Carol O'Sullivan.

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## 2.1 Rivers – Biological Quality Elements

### Rivers

#### MACROINVERTEBRATES

<b>Quality Element:</b>	<b>(Composition and Abundance of Benthic Invertebrate Fauna)</b>
<b>Method</b>	<b>EPA Quality Rating System (Q-Value)</b>
<b>Pressure</b>	Organic enrichment, toxicity, general degradation
<b>Description</b>	<p>The EPA Quality Rating System is based on the sensitivity of macroinvertebrates to pollution. It is primarily an indicator of organic enrichment – nutrient and oxygen conditions but can also indicate toxic effects (e.g. sheep dip pesticides, heavy metals).</p> <p>A broad outline of the method is given in e.g. <a href="#">Toner <i>et al.</i> Water Quality in Ireland 2001-2003</a> published by EPA, Wexford. The method is an expert system approach that assigns status based on departure of the invertebrate community from reference conditions, including both geographic/typological and temporal.</p>
<b>Reference to Method</b>	<p>Macroinvertebrate status results are included in the main river waterbody status dataset under the quality element 'Macroinvertebrates' in the <a href="#">Rivers Results Table</a>. River by river status broken down by channel length based on macroinvertebrate status is also given in <a href="#">Appendix 3.2 of Water Quality in Ireland 2007-2009</a>.</p>
<b>Results</b>	<p>A map of <a href="#">overall ecological status</a> is given for the 2007-2009 period with individual maps for each River Basin District: <a href="#">ERBD</a>, <a href="#">SERBD</a>, <a href="#">SWRBD</a>, <a href="#">WRBD</a>, <a href="#">SHRBD</a>, <a href="#">NWRBD</a>, <a href="#">NBRBD</a>. These maps are based on the one-out all-out principle combining all of the quality elements according to the combination rules given here.</p>
<b>Method</b>	<b>Freshwater Pearl Mussel Metrics</b>
<b>Pressure</b>	Siltation and eutrophication
<b>Description</b>	<p>A number of metrics were measured uniquely in <b>Freshwater Pearl Mussel (FPM)</b> SACs in the preparation of sub-basin plans for these catchments.</p> <ul style="list-style-type: none"> <li>– population abundance</li> <li>– population length frequency distribution</li> <li>– presence of juveniles as an indicator of recruitment</li> <li>– dead shells</li> </ul>

A range of environmental variables are measured and in particular,

pressures relevant to the survival of FPM were also measured:

- Degree of silt release
- Redox potential
- Algal cover
- Macrophytes

**Reference to Method**

Details of the methodology used is available in – [National Parks and Wildlife Service - Freshwater pearl mussel monitoring methods](#).

**Results**

Results are included in main [river waterbody status table](#) – Macroinvertebrates – *Margaritifera*. In general most freshwater pearl mussel populations surveyed were at moderate status as they are deemed to be at unfavourable conservation status. (This departure from reference conditions is based primarily on the lack of recent recruitment which indicates that these populations will eventually die out if measures are not taken to reduce siltation and eutrophication in these catchments.)

**Combination Rules for Quality Element Macroinvertebrates**

The EPA Quality Rating System (Q-Value) results are combined with the Freshwater Pearl Mussel assessment result on a one-out-all-out-basis – i.e. the lower status of the two assessments was used where the two metrics were available. (Not all river waterbodies will have populations of *Margaritifera*.)

## Rivers

### MACROPHYTES AND PHYTOBENTHOS

#### Quality Element: (COMPOSITION AND ABUNDANCE OF AQUATIC FLORA)

##### Method 1 Mean Trophic Rank (MTR)

**Pressure** Eutrophication

**Description** MTR scores plants based on their nutrient tolerance/sensitivity and weights them by their coverage to provide a site score indicative of nutrient conditions.

Mean Trophic Rank (Star Project methodology).

**Reference to Method** Holmes NTH, Newman JR, Chadd S, Rouen KJ, Saint L and Dawson FH (1999). [Mean Trophic Rank: A User's Manual](#). R&D Technical Report E38. Environment Agency, Bristol.

**Results** The method is still in the process of being intercalibrated and is not included in ecological status assessments. Intercalibration is due to complete in Dec 2011.

##### Method 2 Filamentous Algal Index (FAI)

**Pressure** Enrichment

**Description** Index based on filamentous algae abundance and taxonomic composition.

In development. Filamentous algae are part of the phytobenthos quality element of aquatic plants but also act as a pressure in their own right by covering the substratum and impacting on e.g. spawning gravel for salmonids. Abundance of benthic filamentous algae *Cladophora*, *Vaucheria*, *Batrochospermum* and a range of green filamentous algae *Spirogyra*, *Ulothrix*, etc., will be considered.

##### Method 3 Canonical correspondence analysis-Based Assessment System (CBAS)

**Description** CBAS: Canonical correspondence analysis-Based Assessment System. A statistical model that utilises existing survey data to calculate optima of species along different impact gradients. These optima are then used to determine diagnostic metrics that indicate the likely impacts occurring at a survey site (RepS). These metrics can then be combined to produce an Ecological Quality Ratio.

**Reference to Method** [CBAS NSSHARE Project Output](#). A more comprehensive background document on the development of CBAS is also available [Dodkins and Rippey 2007](#).

**Results** Not in use as of yet – under consideration for future surveys.

<b>Method 4</b>	<b>Macrophyte Index System (MIS)</b>
<b>Pressure</b>	Organic Pollution
<b>Description</b>	Based on the sensitivities of indicator macrophyte species to organic pollution.
<b>Reference to Method</b>	Caffrey J.M. 1987. <a href="#">Macrophytes as indicators of organic pollution in Irish rivers.</a>
<b>Results</b>	Not in use as of yet – under consideration for future surveys.
<b>Method 5</b>	<b>River Trophic Diatom Index - RTDI</b>
<b>Pressure</b>	Responds to enrichment pressure – eutrophication.
<b>Description</b>	Based on the sensitivities of indicator diatom species to enrichment pressure – eutrophication.
<b>Reference to Method</b>	The method is based on a revision of the Trophic Diatom Index (Kelly <i>et al.</i> 2001) with further details of the metric calculation and species sensitivity scores at . Phase 1 intercalibration at a European Level has been completed and the relevant EQR values for High and Good status are included in the <a href="#">formal decision</a> and <a href="#">Irish Regulations</a> SI 272 of 2009 (see Table 8, Schedule 5). Further harmonisation of member status boundary values is ongoing and will be completed by the end of 2011. Diatoms are collected primarily at the surveillance monitoring sites.
<b>Results</b>	Results for rivers surveyed to date are included in the <a href="#">Rivers Results Table.</a>
<b>Combination Rules for Aquatic Flora</b>	Combination of diatoms and the other aquatic plant quality elements is currently on a one-out-all-out basis but intercalibration is still under way to complete the macrophyte and possibly filamentous algal status and averaging or other weighting may be used.

## Rivers

### FISH

**Quality Element:** (COMPOSITION, ABUNDANCE AND AGE STRUCTURE OF FISH FAUNA)

**Method 1** Fish versus EPA Quality Rating System and Expert opinion

**Pressure** Mainly enrichment but habitat degradation is also considered.

**Description** Sites are assigned status based on the composition and abundance of indicator species metrics (total salmonids and salmonids 1+ and older) in various catchment size classes in relation to water quality. Habitat and connectivity were included in the assessment. The ratio of salmonids versus tolerant fish species was also assessed to achieve a final status classification.

**Reference to Method** Kelly, F.L., Champ, T., McDonnell, N., Kelly-Quinn, M., Harrison, S., Arbuthnott, A., Giller, P., Joy, M., McCarthy, K., Cullen, P., Harrod, C., Jordan, P., Griffiths, D. and Rosell, R. (2007) [Investigation of the Relationship between Fish stocks, Ecological Quality Ratings \(Q-values\), Environmental Factors and Degree of Eutrophication. \(2000-MS-4-M1\) Final Report](#). Prepared for the Environmental Protection Agency. Summary Report: [ERTDI Report 73](#).

**Results** Results are shown in [Fish Results Table](#) giving location of monitoring sites and overall water body status for the 2008-2009 WFD fish monitoring programme.

**Method 2** Fisheries Classification Scheme 2 (Ireland)

**Pressure** Enrichment, general habitat degradation and connectivity

FCS2 Ireland is a geostatistical model based on Bayesian probabilities – predicts fish at sites based on site typology, presence of downstream barriers, water quality, etc.

**Description** For a single species within a site, the calculated EQR is based upon the probabilistic comparison of observed fish counts with expected (predicted) fish counts made under reference conditions (un-impacted). The EQR for multiple species and sites are then combined to give a single EQR with which to classify a water body.

The output is an Ecological Quality Ratio (EQR) between 1 and 0, with five class boundaries defined along this range, corresponding with the five ecological status classes of High, Good, Moderate, Poor and Bad.

**Reference to** SNIFFER, 2011 [River Fish Classification Tool](#): Science Work. Phase 3

<b>Method</b>	Report. The method is in the process of intercalibration at EU level and should be included in the next formal EU intercalibration decision.
<b>Results</b>	This method has not yet been used to assign formal status.
<b>Combination Rules for Fish</b>	Fish results are combined with other biological quality elements on a one-out all-out basis.
<b>Further Details:</b>	Contact: Dr Fiona Kelly, Inland Fisheries Ireland. Fiona.Kelly@fisheriesireland.ie



## 2.2 Rivers - Chemical and Physico-Chemical Elements Supporting the Biological Elements

### Rivers

<b>Quality Element:</b>	<b>GENERAL CONDITIONS - OXYGENATION AND NUTRIENT CONDITIONS</b>
<b>Method</b>	<b>Oxygenation and Nutrient Conditions ('Organic Enrichment')</b> Ortho-phosphate, Nitrate, Total Ammonia, BOD, Dissolved Oxygen
<b>Description</b>	Classify into Good or Moderate-or-poorer – based on being <b>99%</b> confident that relevant EQS in <a href="#">SI 272 of 2009</a> are exceeded (Table 9, Schedule 5). 'Passes' are not classified as High.
<b>Reference to Method</b>	A 'benefit of the doubt' approach to compliance with standards is taken in assessing compliance with the environmental quality standards (EQS) for phosphate, biochemical oxygen demand, and total ammonia set out in SI 272 of 2009. The method is described in more detail: <a href="#">Compliance Rules for River Chemistry Determinands</a> .
<b>Results</b>	National results are shown in <a href="#">Appendix 3.3</a> of Water Quality in Ireland 2007-2009. Average concentrations for PO <sub>4</sub> , BOD, NH <sub>3</sub> and NO <sub>3</sub> within hydrometric areas are mapped in <a href="#">Fig 3.8 of WQII 2007-2009</a> (page 55) with thresholds that match those used by the European Environment Agency WISE river maps. The overall pass/fail results for the good/moderate boundary are also mapped in <a href="#">Fig 3.7 of Water Quality in Ireland 2007-2009</a> . In general sites that are classified as moderate or less using the above procedure will also have moderate, poor or bad ecological status based on the biological quality elements.
<b>Combination Rules for Oxygenation and Nutrient Conditions</b>	Half or more of the parameters measured (PO <sub>4</sub> , NO <sub>3</sub> , NH <sub>3</sub> , BOD) must fail before a site is failed under supporting general physico-chemical conditions. For these determinands both mean and 95%ile must fail. Oxygen is combined with these on a one-out all-out basis.
<b>Quality Element</b>	<b>GENERAL CONDITIONS - ACIDIFICATION STATUS</b>
<b>Method</b>	<b>pH</b>
<b>Description</b>	Comparison of pH with EQS value ranges
<b>Reference to Method</b>	Face-value assessment against pH with the following ranges for soft water 4.5 < pH < 9.0 and hard water 6.0 < pH < 9.0 where hard water is > 100mg/l CaCO <sub>3</sub> and soft water is ≤100 mg/l CaCO <sub>3</sub> . See Table 9 of Schedule 5 of <a href="#">SI 272 of 2009</a> (European Communities Environmental Objectives (Surface Waters) Regulations 2009).

**Results** National results are shown in [Appendix 3.3](#) of Water Quality in Ireland 2007-2009.

**Quality Element:** **GENERAL CONDITIONS - THERMAL CONDITIONS**

**Method** **Temperature**

**Description** In situ temperature measurement – against standard in [SI 272 of 2009](#) (Table 9 of Schedule 5) – ‘Not greater than a 1.5°C rise in ambient temperature outside the mixing zone’

**Reference to Method** Face value comparison with standard.

**Results** National results are shown in [Appendix 3.3](#) of Water Quality in Ireland 2007-2009. No fails were recorded at WFD monitoring sites for thermal conditions.

**Quality Element:** **GENERAL CONDITIONS - SALINITY**

**Method** **Conductivity Measurement or Chloride**

**Description** High conductivity may indicate transitional water conditions. High chloride may also indicate point source discharges such as municipal wastewater treatment plants.

**Reference to Method** Standard method using meter or laboratory methods

**Results** National results are shown in [Appendix 3.3](#) of Water Quality in Ireland 2007-2009.

**Overall Combination Rule for General Conditions.** The individual supporting physico-chemical quality elements are judged as described above and the lowest status result then determines the final status for the site or waterbody on a one-out all-out basis.

## 2.3 Rivers – Specific Pollutants

### Rivers

**Quality Element:** **SPECIFIC POLLUTANTS**

**Method** **All priority substances plus other pollutant substances discharged in significant quantities**

**Description** Comparison of specific pollutants with EQS as set out in [Table 10 of SI 272 of 2009](#) using annual averages or maximum allowable concentrations. MACS are assessed on a 95%ile basis – i.e. 95% of measurements must be below the MAC. Annual average EQS values are assessed on a face value basis.

**Reference to Method** Table 10 of Schedule 5 of [SI 272 of 2009](#).

**Results** A small number of exceedances were noted in the surveillance and operational monitoring for 2007-2009. These are shown in the [Rivers Results Table](#) under the quality element: 'SpecificPollutants'. Note that not all of the specific pollutants are measured at all monitoring sites.

## 2.4 Rivers – Hydromorphological elements supporting the biological elements

### Rivers

**Quality Element:** **HYDROMORPHOLOGY**

**Method** **Rapid Hydromorphology Assessment Technique (RHAT)**

**Description** This method assesses a range of hydromorphological features and combines these into a score indicating departure from reference conditions. In general, it is used to decide if sites that would be of high status based on other quality elements should be downgraded to good status or not. It is not used to provide assessments of status lower than this. If hydromorphological pressures are significant they will have an impact on one or more of the biological quality elements and the status of the affected quality elements will reflect this – e.g. dredging, dams affecting fish migration, etc.

**Reference to Method** [RHAT Training Manual 2009](#).

**Results** Results are shown under quality element 'Hydromorphology' in the [rivers results table](#) for ecological status.

## Section 3. Lakes

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Chemical Quality Elements: Colman Concannon, Darragh Cunningham, Ray Smith, Caroline Bowden, Regina McGinn, Carol O'Sullivan.

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## 3.1 Lakes – Biological quality elements

### Lakes

<b>Quality Element:</b>	<b>MACROPHYTES AND PHYTOBENTHOS - (COMPOSITION AND ABUNDANCE OF OTHER AQUATIC FLORA)</b>
<b>Method</b>	<b>Free Macrophyte Index</b>
<b>Pressure</b>	Enrichment
<b>Description</b>	<p>Multimetric Index responding to enrichment. The metrics comprising the index cover the parameters; taxonomic composition and abundance as outlined for macrophytes in the WFD. The metric scores are averaged and expressed as an index score which has a corresponding EQR. The EQR ranges from 0 to 1 representing bad to high status.</p>
<b>Reference to Method</b>	<p>Free, G., Little, R., Tierney, D., Donnelly, K. and Caroni, R., 2007. <a href="#">A reference based typology and ecological assessment system for Irish lakes. Preliminary investigations</a>. EPA, Wexford. The method has also been published as a UK <a href="#">TAG methodology</a> (see UKTAG Lakes Assessment Methods Macrophytes and Phytobenthos Macrophytes (Free Index) - published by Water Framework Directive - United Kingdom Technical Advisory Group (WFD-UKTAG).</p>
<b>Results</b>	The individual lake results are given in the <a href="#">Lakes Status results table</a> .
<b>Method</b>	<b>Lake Trophic Diatom Index – LTDI</b>
<b>Pressure</b>	Enrichment
<b>Description</b>	Responds to enrichment pressure – eutrophication.
<b>Reference to Method</b>	Lakes phytobenthos method: <a href="#">Lake Trophic Diatom Index (LTDI)</a> .
<b>Results</b>	<p>None reported until harmonisation of status class boundaries post intercalibration.</p>
<b>Combination Rules for Aquatic Flora</b>	<p>To be finalised – diatoms are used as a proxy of the entire phytobenthos for the aquatic plant quality element listed in Annex V of the Water Framework Directive. The combined quality element 'Macrophytes and phytobenthos' will be reported for the surveillance monitoring network using a combination rule (e.g. minimum of the reported metrics) while incorporating information from the confidence estimates from the individual sub-metric scores when assigning status for a particular lake.</p>

## Lakes

<b>Quality Element:</b>	<b>PHYTOPLANKTON - (COMPOSITION, ABUNDANCE AND BIOMASS OF PHYTOPLANKTON)</b>
<b>Method 1</b>	<b>Chlorophyll <i>a</i></b>
<b>Pressure</b>	Enrichment
<b>Description</b>	Average of chlorophyll <i>a</i> . Measure of phytoplankton biomass as concentration of chlorophyll in µg/l averaged over the 3 year period. Chlorophyll <i>a</i> increases with increasing enrichment.
<b>Reference to Method</b>	Standards are set out in Table 8 of Schedule 5 of <a href="#">SI 272 of 2009</a> . Comparisons are done on a face value basis taking into account seasonal and other factors indicated in Table 8 as referenced above.
<b>Results</b>	See <a href="#">Lakes Status results table</a> .
<b>Method 2</b>	<b>Irish Phytoplankton Index (IPI)</b>
<b>Pressure</b>	Enrichment
<b>Description</b>	The <b>Irish Phytoplankton Index</b> (IPI) is based on the abundances of planktonic algae in response to enrichment. Nine algal indicator taxa were chosen due to their significant positive increase in abundance with elevated total phosphorous concentration. The nine taxon scores are averaged with a score for sample chlorophyll <i>a</i> to give the overall IPI assessment.
<b>Reference to Method</b>	Free, G., Little, R., Tierney, D., Donnelly, K. and Caroni, R., 2007. <a href="#">A reference based typology and ecological assessment system for Irish lakes. Preliminary investigations</a> . EPA, Wexford.
<b>Results</b>	Only chlorophyll <i>a</i> has been intercalibrated at the time of publication of this report (June 2011). No phytoplankton-based results are yet available – this awaits final intercalibration.
<b>Combination Rules for Phytoplankton</b>	A method for joining the two phytoplankton metrics has been developed and is currently in the intercalibration process.

## Lakes

### Quality Element:

### INVERTEBRATES - (COMPOSITION AND ABUNDANCE OF BENTHIC INVERTEBRATE FAUNA)

#### Method 1

#### Chironomid Pupal Exuvial Technique (CPET)

##### Pressure

General pressures – including enrichment

##### Description

Monitoring has been undertaken for chironomid exuviae (CPET).and data collected but a method has not yet been formally adopted. Monitoring has included shoreline sampling of macroinvertebrates, profundal samples and collection of chironomid exuviae (CPET).

##### Reference to Method

UK TAG DOCUMENT

##### Results

Not available

#### Method 2

#### Stony Shore Invertebrates,

##### Pressure

General pressures – including enrichment

##### Description

Monitoring has been undertaken and data collected but a method has not yet been formally adopted.

##### Reference to Method

Not available

##### Results

Not available

#### Method

#### Profundal Invertebrates

##### Pressure

General pressures – including enrichment

##### Description

Monitoring has been undertaken and data collected but a method has not yet been formally adopted.

##### Reference to Method

Not available

##### Results

Not available

### Quality Element:

### Invertebrates (Zebra Mussels)

#### Method

The presence of zebra mussels (*Dreissena polymorpha*) is used in the overall assessment of ecological status.

#### Description

If *Dreissena* is found to be present – typically they become very abundant very quickly once they enter a lake – then a lake cannot be regarded as being of high status and is downgraded to good status even if other quality elements are indicative of high status.

#### Reference to Method

This document



**Results**

Lakes downgraded due to presence of invasive species such as zebra mussels are indicated in the lakes results if applicable. See [Lakes Status results table](#).

**Combination Rules  
for  
Macroinvertebrates**

To be decided when methods are completed.

## Lakes

**Quality Element:** **FISH - (COMPOSITION, ABUNDANCE AND AGE STRUCTURE OF FISH FAUNA)**

**Method 1** **FIL (Fish in Lakes classification tool)**

**Pressure** Mainly Enrichment

**Description** A preliminary ecological classification tool for fish in lakes was developed during the NSSHARE project. This tool (FIL) was used to objectively assign lakes to ecological status classes based on fish species composition, abundance and age structure relationships with total phosphorus (Kelly et al., 2008). Expert opinion was also used on some occasions where known pressures such as non-native species introductions, serve to downgrade the status of a lake. For example, a high status lake cannot contain any non-native fish species.

**Reference to Method** Kelly, F.L., Harrison, A., Connor, L., Allen, M., Rosell, R. and Champ, T. (2008) [North South Shared Aquatic Resource \(NS SHARE\) Lakes Project: Fish in Lakes, Task 6.9: Classification Tool for Fish in Lakes. Final Report.](#) Additional datasets are included as [appendices](#) to the above report including bathymetric maps. See also [www.wfdfish.ie](http://www.wfdfish.ie) the dedicated website for fish monitoring under the WFD.

**Results** Fish classification for lakes results – See [Lakes Status results table.](#)

**Method 2** **Fish in Lakes Classification Tool 2 (FIL2)**

**Description** Lakes are classified into four lake types based on alkalinity and maximum depth for use in the FIL classification tool. Each lake is assigned an ecological status based on an anthropogenic pressure gradient using total phosphorus and chlorophyll as stressors. The FIL2 classification tool then uses discriminant analysis to develop classification rules for each of the four lake types based on 13 fish metrics, including Total BPUE (total biomass per unit effort) of all fish species, BPUE of native fish species and the percentage biomass of perch. A separate model (using the same metrics) is then used to generate Ecological Quality Ratios (EQRs) for each lake.

Model outputs include quantitative EQR values with associated 95% confidence intervals and qualitative impact class category according to the EQR value.

**Reference to Method** Allen, M. and Rosell, R. (2011) Classification tool for Fish in Lakes. Final Report Commissioned by Inland Fisheries Ireland.

Kelly, F.L., Allen, M., Harrison, A., Connor, L. and Rosell, R. (in prep) A Classification Tool for Fish in Lakes in Ireland.

**Precision and Confidence of method** Model outputs include quantitative EQR values with associated 95% confidence intervals

<b>Results</b>	The method has been intercalibrated and will be used to assess fish in lakes on future surveys.
<b>Combination Rules for Fish</b>	Fish are combined with the other biological quality elements on a one-out all-out basis meaning that the lowest status found defines the overall status for the waterbody.
<b>Further Details:</b>	Contact: Fiona Kelly, Inland Fisheries Ireland. Fiona.Kelly@fisheriesireland.ie

## 3.2 LAKES – Chemical and physico-chemical elements supporting the biological elements

### Lakes

**Quality Element:** **GENERAL CONDITIONS - OXYGENATION CONDITIONS**

**Method** **95%ile of Dissolved Oxygen Percent Saturation**

**Description** Assignment of moderate status for dissolved oxygen was based on the 95%ile as described in [SI 272 of 2009](#) (Table 9, Schedule 5) but the waterbody must fail on at least 5 sampling occasions over the 3 year period.

**Reference to Method** The upper and lower thresholds are laid out in Table 9, Schedule 5 of [SI 272 of 2009](#).

**Results** See table of ecological status results for lakes.

**Quality Element:** **GENERAL CONDITIONS - NUTRIENT CONDITIONS**

**Method 1** **Average Total Phosphorus**

**Description** Provisional EQS of 10 and 25 µg/l for the high/good and good/moderate boundaries were applied to the average total phosphorus over the 3 year period.

**Reference to Method** Provisional

**Results** See [Lakes Status results table](#).

**Method 2** **Total Ammonia**

**Description** For a lake to be assigned high status, both the mean and 95%ile values must be in agreement. If the mean and the 95%ile did not agree then the status was based on the lower of the 2 statistics for example, the mean value placed a lake in good status but the 95%ile placed it in moderate status, therefore for ammonium the lake was considered to be in moderate status.

**Reference to Method** See Table 9, Schedule 5 of [SI 272 of 2009](#).

**Results** See [Lakes Status results table](#).

**Combination Rules for Oxygenation Conditions** One out all out

## Lakes

**Quality Element:** **GENERAL CONDITIONS - ACIDIFICATION STATUS (PH)**

**Method** **pH**

**Description** Comparison of maximum and minimum pH with EQS as set out in SI 272

**Reference to Method** See Table 9, Schedule 5 of [SI 272 of 2009](#).

**Results** See [Lakes Status results table](#).

**Quality Element:** **GENERAL CONDITIONS - THERMAL CONDITIONS**

**Method** **Temperature °C**

**Description** Comparison of average temperature with EQS as set out in SI 272

**Reference to Method** See Table 9, Schedule 5 of [SI 272 of 2009](#).

**Results** See [Lakes Status results table](#).

**Quality Element:** **TRANSPARENCY**

**Method** **Secchi Disk**

**Description** Measurement of light absorption/reflectance within lake surface water as an indication of phytoplankton, humic content or suspended inorganic particulate matter affecting light penetration to benthic macrophytes and water column primary producers.

**Reference to Method** Standard method. This quality element does not yet have an EQS established.

**Results** Results have not been published.

## Lakes

**Quality Element:** **GENERAL CONDITIONS - SALINITY**

**Method** **Conductivity Measurement or Chloride**

**Description** High conductivity may indicate transitional water conditions. There are no known direct discharges to Irish lakes that would impact salinity. Brackish lagoons and coastal lakes are treated under transitional waters.

**Reference to Method** Standard method using meter or laboratory methods

**Results** Results have not been published.

**Overall** The individual supporting physico-chemical quality elements are

**Combination  
Rule for General  
Conditions.**

judged as described above and the lowest status result then determines the final status for the site or waterbody on a one-out all-out basis.

## 3.3 Lakes – Specific Pollutants

### Lakes

<b>Quality Element:</b>	<b>SPECIFIC POLLUTANTS</b>
<b>Method</b>	<b>All priority substances plus other pollutant substances discharged in significant quantities</b>
<b>Description</b>	Comparison of specific pollutants with EQS as set out in <a href="#">Table 10 of SI 272 of 2009</a> using annual averages or maximum allowable concentrations. MACS are assessed on a 95%ile basis – i.e. 95% of measurements must be below the MAC. Annual average EQS values are assessed on a face value basis.
<b>Reference to Method</b>	See Table 10, Schedule 5 of <a href="#">SI 272 of 2009</a> .
<b>Results</b>	See <a href="#">Lakes Status results table</a> . One lake failed on chemical status – an tSeisigh which exceeded the benzo[a]-pyrene MAC-EQS.
<b>Overall Combination Rule for Specific Pollutants.</b>	Exceedances for specific pollutants are combined with other quality elements determining ecological status on a one-out all-out basis. Exceedances result in an ecological status of 'moderate or less'. Biological quality elements may then rate such a waterbody to moderate, poor or bad if data are available.

## 3.4 Lakes – Hydromorphological elements supporting the biological elements

### Lakes

**Quality Element:** **HYDROMORPHOLOGICAL ELEMENTS**

**Method** **LHS (Lake Habitat Survey)/MImAS**

**Description** Structure of lake shore, quantity and dynamics of water flow (partial)  
10 habitat plots located evenly along the perimeter of the lake are surveyed for various characteristics such as vegetation type, physical modifications and naturalness. The outlet is assessed and whether or not there is an abstraction is noted. The information collated is used to calculate the MImAS score which determines the status class.

**Reference to Method** J.S. Rowan 2008 [Development of Lake-MImAS as a Decision-Support Tool for Managing Hydromorphological Alterations to Lakes](#). SNIFFER. 65pp.

**Results** Hydromorphological results are shown in the [Lakes Status results table](#).

**Method** **Lake Residence Time and Lake Depth Variation**

**Description** Residence time and depth are calculated from detailed bathymetric maps of individual lakes which provides accurate lake volume. The volume of inflowing water is calculated using data from the EPA hydrometric network.

**Reference to Method** A number of reports on the results of bathymetric surveys have been produced.

**Results** Detailed results of residence time are not yet available. Turnover times will be used in Vollenweider-type modelling to calculate individual lake total phosphorus loadings in order to compare actual with reference conditions loading. More detailed depth measurements will also assist in updating lake typology and assigning types to lakes that have not yet been typed.

**Method** **Quantity and dynamics of water flow**

**Description** The volume of inflowing water is calculated using data from the EPA hydrometric network. A number of key lakes have lake level gauges providing continuous measurement of lake levels.

**Reference to Method** The EPA hydrometric programme uses a range of standard methods. More details on the [EPA Hydrometric Programme](#) is available on the EPA Website.



**Results**

Detailed results of lake levels and water flow through lakes are not yet collated specifically for lakes. The EPA publishes [Surface Water Levels and Flows](#) from which results for individual lakes can be determined.

**Combination  
Rules for this QE**

Hydromorphological elements are used to downgrade sites that may be regarded as high status by the combined assessments of the other quality elements sites to good status. More complex relationships also exist between hydrometric aspects and other quality elements such as nutrient loading to lakes.

## Section 4. Transitional Waters

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Biological Quality Elements: Shane O'Boyle<sup>3</sup>, Robert Wilkes, Georgina McDermott, Tone Noklegaard, Fiona Kelly

Chemical Quality Elements: Colman Concannon, Darragh Cunningham, Ray Smith, Caroline Bowden, Regina McGinn, Carol O'Sullivan.

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<sup>3</sup> Corresponding Author: [s.o'boyle@epa.ie](mailto:s.o'boyle@epa.ie)

## 4.1 Transitional Waters – Biological quality elements

### Transitional Waters

<b>Quality Element:</b>	<b>COMPOSITION AND ABUNDANCE OF MACROALGAE AND ANGIOSPERMS</b>
<b>Method 1:</b>	<b>Opportunistic Macroalgal Growth (OGA)</b>
<b>Pressure</b>	Responds to increase in nutrient pressures Assessment of ABUNDANCE of opportunistic Macroalgae.
<b>Description</b>	Multi-metric tool that measures the spatial extent, coverage and biomass of opportunistic macroalgal accumulations. Degradation in ecological status measured by increase in biomass and cover of opportunist species.
<b>Reference to Method</b>	C.M. Scanlan, J. Foden, E. Wells, M.A. Best 2007. <a href="#">The monitoring of opportunistic macroalgal blooms for the Water Framework Directive</a> . <i>Marine Pollution Bulletin</i> . <b>55</b> , 136 – 150.
<b>Results</b>	See <a href="#">TraC results table</a> .
<b>Method 2:</b>	<b>Intertidal Seagrass (SG)</b>
<b>Pressure</b>	Tool responds to hydro-morphological or nutrient pressures. Assessment of composition and abundance of intertidal seagrasses.
<b>Description</b>	Degradation in ecological status measured by reduction in spatial extent and density of seagrass beds or through loss of diversity.
<b>Reference to Method</b>	Re J. Foden and D.J. de Jong (2007). <a href="#">Assessment metrics for littoral seagrass under the European Water Framework Directive; outcomes of UK intercalibration with the Netherlands</a> . <i>Hydrobiologia</i> , <b>583</b> (1): 383-383.
<b>Results</b>	See <a href="#">TraC results table</a> .
<b>Combination Rules for this QE</b>	Classification based on 'one out, all out' method or lowest classification for each of the above methods.

## Transitional Waters

<b>Quality Element:</b>	<b>COMPOSITION, ABUNDANCE AND BIOMASS OF PHYTOPLANKTON</b>
<b>Method 1:</b>	<b>Chlorophyll</b>
<b>Pressure</b>	Responds to eutrophication pressure. Assessment of Phytoplankton <b>abundance and biomass</b> using 90 <sup>th</sup> percentile and median chlorophyll concentrations.
<b>Description</b>	Degradation in ecological status measured by increase in chlorophyll concentrations assessed against a salinity related threshold.
<b>Reference to Method</b>	EPA Water Quality in Ireland 2007-2009
<b>Results</b>	See <a href="#">TraC results table</a> .
<b>Method 2:</b>	<b>Elevated Phytoplankton taxa cell counts</b>
<b>Pressure</b>	Tool responds to eutrophication pressure. Assessment of Composition and abundance of phytoplankton. Cell counts of single phytoplankton taxa above a certain salinity corrected threshold. Degradation in ecological status measured by number of cells counts above a salinity corrected threshold.
<b>Description</b>	
<b>Reference to Method</b>	Still under development in Transitional Waters.
<b>Results</b>	See <a href="#">TraC results table</a> .
<b>Combination Rules for this QE</b>	Classification for phytoplankton is based on the average of the two methods above.

## Transitional Waters

<b>Quality Element:</b>	<b>COMPOSITION AND ABUNDANCE OF BENTHIC INVERTEBRATE FAUNA</b>
<b>Method:</b>	<b>Infaunal Quality Index (IQI)</b>
<b>Pressure</b>	The tool responds to organic enrichment
<b>Description</b>	<p>This multimetric has been developed by the UK-Ireland Benthic Invertebrate subgroup of the UK-Ireland Marine Task Team.</p> <p>The IQI describes ecological status based on the composition and abundance of soft sediment infaunal communities.</p>
<b>Reference to Method</b>	See Page 119 of <a href="#">Water Framework Directive Monitoring Programme</a> .
<b>Results</b>	See <a href="#">TraC results table</a> .

## Transitional Waters

**Quality Element:** **COMPOSITION AND ABUNDANCE OF FISH FAUNA**

**Method:** **Transitional Fish Classification Index (TFCI)**

**Pressure** General degradation

This multimetric has been developed by the UK-Ireland Fish subgroup of the UK-Ireland Marine Task Team.

This multimetric ecological classification tool has been developed by the UK-Ireland Fish subgroup of the UK-Ireland Marine Task Team.

**Description**

The TFCI assigns ecological status based on the composition and abundance of the fish community in a transitional water body, compared with the fish community expected under reference or undisturbed conditions.

The number of 'indicator species' such as salmon, trout and shad is also used as a metric in the classification tool.

**Reference to Method**

<http://www.wfdfish.ie/>.

See [TraC results table](#).

**Results**

More detailed fish results for transitional waters are available on [www.wfdfish.ie](http://www.wfdfish.ie) for [2008](#), [2009](#) and [2010](#).

**Further Details:**

Contact Dr Fiona Kelly, Inland Fisheries Ireland.  
[Fiona.Kelly@fisheriesireland.ie](mailto:Fiona.Kelly@fisheriesireland.ie)

## 4.2 Transitional waters - Chemical and physico-chemical elements supporting the biological elements

### Transitional Waters

<b>CHEMICAL AND PHYSICO-CHEMICAL ELEMENTS SUPPORTING THE BIOLOGICAL ELEMENTS</b>	
<b>Quality Element:</b>	<b>General Conditions – Nutrient Conditions</b>
<b>Method 1:</b>	<b>Molybdate Reactive Phosphorus (MRP)</b>
<b>Description</b>	MRP concentration assessed against a salinity corrected threshold.
<b>Reference to Method</b>	Face value comparison with standards set out in Schedule 5, Table 9 of <a href="#">SI 272 of 2009</a> .
<b>Results</b>	See <a href="#">TraC results table</a> .
<b>Quality Element</b>	<b>General Conditions – Oxygenation Conditions</b>
<b>Method 1.</b>	<b>Dissolved Oxygen (DO)</b>
<b>Description</b>	DO concentration assessed against salinity corrected thresholds for undersaturation and supersaturation.
<b>Reference to Method</b>	Face value comparison with standards set out in Schedule 5, Table 9 of <a href="#">SI 272 of 2009</a> .
<b>Results</b>	See <a href="#">TraC results table</a> .
<b>Method 2</b>	<b>Biological Oxygen Demand (BOD)</b>
<b>Description</b>	95 <sup>th</sup> Percentile of BOD concentration must be below 4mg/l.
<b>Reference to Method</b>	Face value comparison with standards set out in Schedule 5, Table 9 of <a href="#">SI 272 of 2009</a> .
<b>Results</b>	See <a href="#">TraC results table</a> .
<b>Quality Element:</b>	<b>GENERAL CONDITIONS - THERMAL CONDITIONS, TRANSPARENCY, SALINITY</b>
<b>Method</b>	<b>Temperature °C, Secchi Disk, Conductivity/Salinity meter</b>
<b>Description</b>	There are no EQS set directly for these particular supporting QEs in

transitional waters as of yet. Salinity, however, is crucial in underpinning the nutrient standards, for example.

**Reference to  
Method**

General standard methods. No EQS set but salinity used in e.g. assessing status based on nitrogen standards.

**Results**

Results have not been formally published but datasets are available. Additional transitional waters datasets are available from <http://www.marinedataonline.ie>.



## 4.3 Transitional Waters – Hydromorphological Elements Supporting the Biological Elements

### Transitional Waters

**Quality Element:** **HYDROMORPHOLOGICAL ELEMENTS SUPPORTING THE BIOLOGICAL ELEMENTS**

**Method 1:** **Transitional and Coastal Waters Morphology Impact Assessment System (MimAS)**

In the absence of environmental standards for morphology, Morphological Condition Limits (MCLs) were developed to help quantify the risk that a new morphological alteration could impair achievement of the ecological objectives of the WFD:

- Description**
- MCLs are expressed in terms of % capacity used within a water body,
  - Defined for 3 TraC zones: hydrodynamic; intertidal; subtidal,
  - High = 5%; Good = 15%,
  - MImAS can provide risk-based information to inform decisions,
  - Predict where a deterioration in status is likely, identifying where regulatory exemption tests are required to determine if work should proceed on the basis of over-riding public interest / social / economic factors.

**Reference to Method** The [MImAS](#) method is used.

**Results** See [TraC results table](#).

### Transitional Waters

**Quality Element:** **HYDROMORPHOLOGICAL ELEMENTS SUPPORTING THE BIOLOGICAL ELEMENTS -**

**Method 2:** **Morphological Conditions and Tidal Regime**

A range of hydromorphological quality elements are listed in Annex V of the WFD:

Morphological conditions:

- Description**
- depth variation,
  - quantity, structure and substrate of the bed,
  - structure of the intertidal zone;

Tidal regime:

freshwater flow,  
wave exposure.

Some of these quality elements are included under the MImAS method above. Others are covered by a range of surveys undertaken primarily by the Marine Institute. A series of tide gauges and wave buoys are in place around the coast. The bathymetric mapping of the shallow <50m seabed is currently under way. Hydrometric flow data provide information on freshwater inputs to transitional waters.

**Reference to  
Method**

In development.

**Results**

Various relevant datasets are available via  
<http://www.marinedataonline.ie>.

## 4.4 Transitional waters – Specific Pollutants

### Transitional Waters

**Quality Element:** **SPECIFIC POLLUTANTS**

**Method:** **All priority substances plus other pollutant substances discharged in significant quantities**

**An assessment of dangerous substances in Water Framework Directive Transitional and Coastal Waters: 2007 – 2009**

- a. Review, selection and collation of MI datasets and external data
- b. Review and collation of appropriate tools and in particular assessment criteria for classification at good-moderate boundary
- c. Assessment process

**Description**

- i. Data extraction, binning according to water body, and normalization where appropriate
- ii. Classification according to good status and less than good status for parameter matrix combinations according to WFD water bodies
- iii. An assessment of the confidence of this assessment
- iv. An assessment of temporal trends for various parameters
- v. An expert commentary on the above and considering inter alia data available for substances where assessment criteria could not be identified and other information (such as biological).

**Reference to Method**

- Table 10 of Schedule 5 of [SI 272 of 2009](#).
- [An assessment of dangerous substances in Water Framework Directive Transitional and Coastal Waters: 2007 – 2009: A report by the Marine Institute for the Environmental Protection Agency, October 2010](#)

**Results**

See [TraC results table](#).

## Section 5. Coastal Waters

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Biological Quality Elements: Shane O'Boyle<sup>4</sup>, Robert Wilkes, Georgina McDermott, Tone Nokleggaard, Fiona Kelly

Chemical Quality Elements: Colman Concannon, Darragh Cunningham, Ray Smith, Caroline Bowden, Regina McGinn, Carol O'Sullivan.

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<sup>4</sup> Corresponding Author: [s.o'boyle@epa.ie](mailto:s.o'boyle@epa.ie)

## 5.1 Coastal Waters – Biological Quality Elements

### Coastal Waters

<b>Quality Element:</b>	<b>COMPOSITION AND ABUNDANCE OF MACROALGAE AND ANGIOSPERMS</b>
<b>Method 1:</b>	<b>Reduced Species List (RSL)</b>
<b>Pressure</b>	<p>Tool responds to morphological impacts, hazardous substance and increased nutrient pressures.</p> <p>Assessment of COMPOSITION of rocky shore macroalgae.</p>
<b>Description</b>	Multi-metric tool to assess species richness and community structure of attached rocky shore macroalgae. Degradation in ecological status measured by changes in species numbers and composition.
<b>Reference to Method</b>	<a href="#">E. Wells, M. Wilkinson, P. Wood and C. Scanlan, 2007. The use of macroalgae species richness and composition on intertidal rocky seashores in the assessment of ecological quality under the European Water Framework Directive. Marine Pollution Bulletin. 55, 151 – 161.</a>
<b>Results</b>	See <a href="#">TraC results table</a> .
<b>Method 2:</b>	<b>Opportunistic Macroalgal Growth (OGA)</b>
<b>Pressure</b>	<p>Tool responds to increase in nutrient pressures.</p> <p>Assessment of ABUNDANCE of opportunistic Macroalgae.</p>
<b>Description</b>	Multi-metric tool that measures the spatial extent, coverage and biomass of opportunistic macroalgal accumulations . Degradation in ecological status measured by increase in biomass and cover of opportunist species.
<b>Reference to Method</b>	<a href="#">C.M. Scanlan, J. Foden, E. Wells and M.A. Best , 2007. The monitoring of opportunistic macroalgal blooms for the water framework directive . Marine Pollution Bulletin. 55, 162 – 171.</a>
<b>Results</b>	See <a href="#">TraC results table</a> .
<b>Method 3:</b>	<b>Intertidal Seagrass (SG)</b>
<b>Pressure</b>	<p>Tool responds to hydro-morphological or nutrient pressures.</p> <p>Assessment of composition and abundance of intertidal seagrasses.</p>
<b>Description</b>	Degradation in ecological status measured by reduction in spatial extent and density of seagrass beds or through loss of diversity.
<b>Reference to</b>	Re J. Foden and D.J. de Jong (2007). <a href="#">Assessment metrics for littoral</a>

<b>Method</b>	<a href="#">seagrass under the European Water Framework Directive; outcomes of UK intercalibration with the Netherlands.</a> <i>Hydrobiologia</i> , <b>583</b> (1): 383-383
<b>Results</b>	See <a href="#">TraC results table</a> .
<b>Combination Rules for this QE</b>	Classification based on 'one out, all out' method or lowest classification for each tool.

## Coastal Waters

### Quality Element:

### COMPOSITION, ABUNDANCE AND BIOMASS OF PHYTOPLANKTON

#### Method 1:

#### Chlorophyll

##### Pressure

Tool responds to eutrophication pressure.

Assessment of Phytoplankton **abundance and biomass** using 90<sup>th</sup> percentile and median chlorophyll concentrations.

##### Description

Degradation in ecological status measured by increase in chlorophyll concentrations assessed against a salinity related threshold.

##### Reference to Method

See [Chapter 5 of Water Quality in Ireland 2007-2009](#).

##### Results

See [TraC results table](#).

#### Method 2:

#### Elevated Phytoplankton taxa cell counts

##### Pressure

Tool responds to eutrophication pressure.

Assessment of Composition and abundance of phytoplankton. Cell counts of single phytoplankton taxa above a certain salinity corrected threshold. Degradation in ecological status measured by number of cells counts above a salinity corrected threshold.

##### Description

##### Reference to Method

METRIC report: <http://coe.epa.ie/safer/iso19115/display?isoID=40>

##### Results

See [TraC results table](#).

### Combination Rules for this QE

Classification based on the average of the two methods.

**Coastal Waters**

**Quality Element:** **COMPOSITION AND ABUNDANCE OF BENTHIC INVERTEBRATE FAUNA**

**Method:** **Infaunal Quality Index (IQI)**

**Pressure** The tool responds to organic enrichment.

**Description** This multimetric has been developed by the UK-Ireland Benthic Invertebrate subgroup of the UK-Ireland Marine Task Team.  
The IQI describes ecological status based on the composition and abundance of soft sediment infaunal communities.

**Reference to Method** [Water Framework Directive Monitoring Programme.](#)

**Results** See [TraC results table](#).



## 5.2 Coastal Waters - Chemical and physico-chemical elements supporting the biological elements

### Coastal Waters

<b>Quality Element:</b>	<b>GENERAL CONDITIONS - NUTRIENT CONDITIONS</b>
<b>Method:</b>	<b>Dissolved Inorganic Nitrogen (DIN)</b>
<b>Description</b>	DIN concentration assessed against a salinity corrected threshold.
<b>Reference to Method</b>	Face value comparison with standards set out in Schedule 5, Table 9 of <a href="#">SI 272 of 2009</a> .
<b>Results</b>	See <a href="#">TraC results table</a> .

### Coastal Waters

<b>Quality Element</b>	<b>GENERAL CONDITIONS - OXYGEN CONDITIONS</b>
<b>Method:</b>	<b>Dissolved Oxygen (DO)</b>
<b>Description</b>	DO concentration assessed against salinity corrected thresholds for undersaturation and supersaturation.
<b>Reference to Method</b>	Face value comparison with standards set out in Schedule 5, Table 9 of <a href="#">SI 272 of 2009</a> .
<b>Results</b>	See <a href="#">TraC results table</a> .

## 5.3 Coastal Waters - Hydromorphological elements supporting the biological elements

### Coastal Waters

**Quality Element:** **MORPHOLOGICAL CONDITIONS AND TIDAL REGIME**

**Method 1:** **Transitional and Coastal Morphology Impact Assessment System (MImAS)**

In the absence of Environmental Standards for morphology, Morphological Condition Limits (MCLs) were developed to help quantify the risk that a new morphological alteration could impair achievement of the ecological objectives of the WFD

### Description

- MCLs are expressed in terms of % capacity used within a water body
- Defined for 3 TraC zones: hydrodynamic; intertidal; subtidal
- High = 5%; Good = 15%
- MImAS can provide risk-based information to inform decisions
- Predict where a deterioration in status is likely, identifying where regulatory exemption tests are required to determine if work should proceed on the basis of over-riding public interest / social / economic factors

### Reference to Method

[MImAS](#).

### Results

See [TraC results table](#).

### Coastal Waters

**Quality Element:** **HYDROMORPHOLOGICAL ELEMENTS SUPPORTING THE BIOLOGICAL ELEMENTS -**

**Method 2:** **Morphological Conditions and Tidal Regime**

A range of hydromorphological quality elements are listed in Annex V of the WFD:

Morphological conditions:

### Description

depth variation,  
structure and substrate of coastal the bed,  
structure of the intertidal zone;

Tidal regime:

direction of dominant currents  
wave exposure.

Some of these quality elements are included under the MImAS method above. Others are covered by a range of surveys undertaken primarily by the Marine Institute. A series of tide gauges and wave buoys are in place around the coast. The bathymetric mapping of the shallow <50m seabed is currently under way. Hydrometric flow data provide information on freshwater inputs to transitional waters.

**Reference to  
Method**

In development.

**Results**

Various relevant datasets are available via  
<http://www.marinedataonline.ie>.

## 5.4 Coastal waters – Specific Pollutants

### Coastal Waters

**Quality Element:** **SPECIFIC POLLUTANTS**

**Method:** **All priority substances plus other pollutant substances discharged in significant quantities**

An assessment of dangerous substances in Water Framework Directive Transitional and Coastal Waters: 2007 – 2009.

- a. Review, selection and collation of MI datasets and external data.
- b. Review and collation of appropriate tools and in particular assessment criteria for classification at good-moderate boundary.
- c. Assessment process:

### Description

- i. Data extraction, binning according to water body, and normalization where appropriate
- ii. Classification according to good status and less than good status for parameter matrix combinations according to WFD water bodies
- iii. An assessment of the confidence of this assessment
- iv. An assessment of temporal trends for various parameters
- v. An expert commentary on the above and considering inter alia data available for substances where assessment criteria could not be identified and other information (such as biological).

### Reference to Method

- Face value comparison against standards set out in Schedule 5, Table 10 of [SI 272 of 2009](#).
- [An assessment of dangerous substances in Water Framework Directive Transitional and Coastal Waters: 2007 – 2009](#): A report by the Marine Institute for the Environmental Protection Agency, October 2010

### Results

See [TraC results table](#).

### Combination Rules for Specific Pollutants

Specific pollutants are combined on a one-out all-out basis with the other quality elements determining ecological status.

## Section 6. Artificial and Heavily Modified Waterbodies

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D. Tierney, S. O'Boyle, J. Caffrey.

## 6.1 Artificial Waterbodies - Canals

### Canals

<b>Quality Element:</b>	<b>MACROINVERTEBRATES AND SUPPORTING PHYSICO-CHEMICAL ELEMENTS</b>
<b>Method:</b>	Macroinvertebrates and a range of supporting physico-chemical quality elements were assessed in Irish Canals
<b>Description</b>	Water quality monitoring was carried out in on Canals during the 2007-2009 period with water samples collected at a total of 42 sites.
<b>Reference to Method</b>	Details of approach and surrogate standards used in classification are contained in <a href="#">Chapter 3 of Water Quality in Ireland 2007-2009</a> , pages 66-69. Further work is required to finalise the assessment of ecological potential in Irish canals.
<b>Results</b>	Details of the results are contained in <a href="#">Chapter 3 of Water Quality in Ireland 2007-2009</a> , pages 66-69.

## 6.2 Heavily Modified Waterbodies – Lakes and Reservoirs

### HMWB

<b>Quality Element:</b>	<b>BIOLOGICAL QUALITY ELEMENTS AND SUPPORTING PHYSICO-CHEMICAL ELEMENTS</b>
<b>Method:</b>	<b>As outlined for lakes</b>
<b>Description</b>	A number of lakes or reservoirs were classified as heavily modified waterbodies. They are listed in the lakes status table and their ecological potential is assessed with natural lakes.
<b>Reference to Method</b>	If the outcome of the biological quality elements and the physico-chemical quality elements was not considered to be comprised by the modifications to the waterbody then the lower of the two was considered to be ecological potential.
<b>Results</b>	Details of the results are contained in the <a href="#">Lakes Status table</a> .
<b>Combination Rules for HMWBs</b>	The quality elements are combined in a similar fashion to that for the natural lake quality elements.

## 6.2 Heavily Modified Waterbodies – Transitional and Coastal Waters.

### HMWB

<b>Quality Element:</b>	<b>BIOLOGICAL QUALITY ELEMENTS AND SUPPORTING PHYSICO-CHEMICAL ELEMENTS</b>
<b>Method:</b>	<b>As outlined for transitional and coastal waters</b>
<b>Description</b>	A number of transitional and coastal waters were classified as heavily modified waterbodies. They are listed in the <a href="#">MImAS status results</a> table and their ecological potential is assessed with natural waters.
<b>Reference to Method</b>	If the outcome of the biological quality elements and the physico-chemical quality elements was not considered to be comprised by the modifications to the waterbody then the lower of the two was considered to be ecological potential.
<b>Results</b>	Details of the results are contained in <a href="#">Transitional and Coastal Water Status table</a> .
<b>Combination Rules for HMWBs</b>	The quality elements are combined in a similar fashion to that for the quality elements used to assess natural TraC waters.



# Section 7. Surface Water Chemical Status

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Colman Concannon<sup>5</sup>, Darragh Cunningham, Ray Smith, Caroline Bowden, Regina McGinn, Carol O'Sullivan.

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## 7.1 Surface Water Chemical Status

### Priority Substances (including priority hazardous substances) measured in surface waters.

**Rivers, Lakes, Transitional, Coastal and Territorial Waters.**

**Quality Element:** **PRIORITY SUBSTANCES**

**Method:** **Priority Substances and Priority Hazardous Substances**

**Description** Good or Failing to achieve good as set out in Table 11 of SI 272

**Reference to Method** Comparison of measured concentrations of priority substances in water with EQS as set out in [Table 11 and Table 12 of SI 272 of 2009](#) using annual averages or maximum allowable concentrations as specified. MACS are assessed on a 95%ile basis – i.e. 95% of measurements must be below the MAC. Annual average EQS values are assessed on a face value basis.

**Results** Results are set out in the [Table of Priority Substances Exceedances](#) for rivers. A map showing the locations of the exceedances is shown for [rivers nationally](#) on a site by site basis indicating each RBD in which the exceedances occur. [Chemical status at a waterbody level](#) within the RBDs is also depicted. Waterbodies not shown were not monitored.

Exceedances are mapped for [lakes nationally](#) and individually for : [EARBD](#), [SERBD](#), [SWRBD](#), [WRBD](#), [SHIRBD](#), [NWIRBD](#), [NBIRBD](#), for [transitional and coastal waters nationally](#) and for each RBD separately: [EARBD](#), [SERBD](#), [SWRBD](#), [WRBD](#), [SHIRBD](#), [NWIRBD](#), [NBIRBD](#).

**Combination Rules for this QE** Chemical status is combined with Ecological Status to produce 'Surface Water Status' which is the poorer of the two. ([WFD §2.17.](#))

# 8.1 Groundwater Status and Trend Assessments

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Matthew Craig<sup>6</sup>, Anthony Mannix and Donal Daly

An [introduction and summary](#) provide background to the groundwater status and trend assessments undertaken. A more detailed [description of the methodology](#) is also available.

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## 8.2 Groundwater – Chemical Status Tests

### Groundwater

#### Test:

#### Saline Intrusion

#### Description

Status, and the presence of an intrusion of poor quality water into the groundwater body, is determined through an assessment of trends in Electrical Conductivity or other indicator substances. The test is designed to detect the presence of an intrusion that is induced by the abstraction of groundwater.

#### Criteria

Threshold Values are exceeded and there is either a significant and sustained rising trend in one or more key determinands at relevant monitoring points or there is an existing significant impact on a point of abstraction as a consequence of an intrusion.

**Note:** This test mirrors the Quantitative saline intrusion test as it is dependent on **chemical impact** caused by groundwater abstraction.

#### Standards/Threshold Values

Threshold Values are set at the upper limit of the natural background range for key determinands. Threshold Values are only used in combination with trend assessment(s). Threshold Values have only been derived for pollutants that are indicative of saline (or other) intrusions.

- Electrical Conductivity = 800  $\mu\text{S}/\text{cm}$
- Chloride = 24 mg/l

#### Results

This element is one of five that are used to determine chemical status ([see Map 1](#)). Groundwater bodies are at Poor Status in relation to saline intrusion. See [Groundwater Results Table](#).

#### Test:

#### Surface Water

#### Description

Status is determined through a combination of surface water classification results and an assessment of chemical inputs from groundwater bodies into surface water bodies. The surface water bodies can comprise rivers, standing waters and transitional waters. The test is designed to determine whether the contribution from groundwater quality to surface water quality, or any consequent impact on surface water ecology, is sufficient to threaten the WFD objectives for these associated water bodies.

#### Criteria

An associated surface water body does not meet its objectives because of diffuse pressures, Threshold Values are exceeded and groundwater contributes at least 50% of the load that would

breach the relevant surface water standard.

Threshold Values are surface water quality standards adjusted by dilution and, where appropriate, attenuation factors. The Threshold Values have been based on the EQS for the associated surface water receptor.

**Standards/Threshold Values**

- Molybdate Reactive Phosphorus (as P) = 35 µg/l (based on River EQS)
- Ammonium (as N) = 65 µg/l (based on River EQS)

**Results**

This element is one of five that are used to determine chemical status ([see Map 1](#)). 95 groundwater bodies are at Poor Status in relation to the impact of groundwater quality on surface waters. See [Groundwater Results Table](#).

**Test:**

**Groundwater Dependent Terrestrial Ecosystems**

**Description**

Status is determined through a combination of Groundwater Dependent Terrestrial Ecosystems (GWDTE) assessments to determine ecological damage and an assessment of chemical inputs from groundwater bodies into GWDTEs. The test is designed to determine whether the contribution from groundwater quality to GWDTEs and consequent impact on GWDTE ecology is sufficient to threaten the WFD objectives for these associated GWDTEs.

**Criteria**

The ecology of an associated GWDTE is damaged due to the chemical contribution from the groundwater body, Threshold Values are exceeded and groundwater loading is sufficient to cause a breach of the relevant GWDTE quality standard.

**Standards/Threshold Values**

Threshold Values are wetland quality standards or action values adjusted by dilution and, where appropriate, attenuation factors.

**Results**

Due to the lack of information on trigger action values for GWDTEs, the GWDTE ecological/chemical assessment could not be undertaken. This assessment will be undertaken in the 2<sup>nd</sup> River Basin planning cycle. Therefore no groundwater bodies are at Poor Status in relation to the impact of groundwater quality on GWDTE ([see Map 1](#)). See [Groundwater Results Table](#).

**Test:**

**Drinking Water**

**Description**

Good chemical status requires an assessment, at the point of abstraction for water intended for human consumption, of whether there is deterioration in groundwater quality due to

anthropogenic influences that could lead to an increase in purification treatment. **Note:** the stated aim of the Drinking Water Protected Area (DWPA) objective in the WFD is to provide the necessary protection to avoid deterioration in water quality in order to reduce the need for purification treatment. This has been interpreted as a minimum requirement to prevent deterioration in groundwater quality at the point of abstraction for drinking water supply.

## Criteria

There is a significant and sustained rising trend in one or more key determinands at the point of abstraction and Threshold Values are exceeded.

## Standards/Threshold Values

Threshold Values are an appropriate percentage of Drinking Water Standards or any other requirement to ensure that drinking water is free from contamination that could constitute a danger to human health (in accordance with the Drinking Water Directive). Threshold Values have been derived for the following pollutants:

- Nitrate (as NO<sub>3</sub>) = 37.5 mg/l
- Ammonium (as N) = 175 µg/l
- Electrical Conductivity = 1,875 µS/cm
- Nitrite (as NO<sub>2</sub>) = 375 µg/l
- Chloride = 187.5 mg/l
- Sulphate = 187.5 mg/l
- Sodium = 150 mg/l
- Boron = 750 µg/l
- Individual Pesticides = 0.075 µg/l
- Total Pesticides = 0.375 µg/l

## Results

This element is one of five that are used to determine chemical status ([see Map 1](#)). No groundwater bodies are at Poor Status in relation to the impact of groundwater quality on Drinking Water . See [Groundwater Results Table](#).

## Test:

### General Chemical

Status is determined through an assessment of the areal extent of a groundwater body exceeding a Threshold Value for a pollutant. It is only conducted for determinands for which:

## Description

- an EU prescribed standard is set; or
- the risk characterisation process has indicated that pollutants may cause significant impairment of human uses of groundwater.

## Criteria

Threshold Values are exceeded at individual monitoring points, and a representative aggregation of the monitoring data at the groundwater body scale indicates that there is a significant environmental risk or a significant impairment of human uses of the groundwater body.

Threshold Values are an appropriate percentage of the EU prescribed standards for nitrates and pesticides or a use-related standard that is appropriate for existing or planned use of the groundwater body. Threshold Values have been derived for the following pollutants:

## Standards/Threshold Values

- Nitrate (as NO<sub>3</sub>) = 37.5 mg/l
- Ammonium (as N) = 175 µg/l
- Electrical Conductivity = 1,875 µS/cm
- Nitrite (as NO<sub>2</sub>) = 375 µg/l
- Chloride = 187.5 mg/l
- Sulphate = 187.5 mg/l
- Sodium = 150 mg/l
- Boron = 750 µg/l
- Individual Pesticides = 0.075 µg/l
- Total Pesticides = 0.375 µg/l
- Chromium = 37.5 µg/l
- Arsenic = 7.5 µg/l
- Lead = 18.75 µg/l
- Nickel = 15 µg/l
- Mercury = 0.75 µg/l
- Cadmium = 3.75 µg/l
- Copper = 1500 µg/l
- Aluminium = 150 µg/l
- Cyanide = 37.5 µg/l
- 1,2-Dichloroethane = 2.25 µg/l
- Vinyl Chloride = 0.375 µg/l
- Total Tetrachloroethene & Trichloroethene = 7.5 µg/l
- Benzene = 0.75 µg/l
- Benzo(alpha)pyrene = 7.5 ng/l
- Total Polycyclic Aromatic Hydrocarbons = 0.075 µg/l
- Total Trihalomethanes = 75 µg/l

## Results

This element is one of five that are used to determine chemical status ([see Map 1](#)). Eight groundwater bodies are at Poor Status in relation to the widespread impact of pollution on groundwater quality. See [Groundwater Results Table](#).



## 8.3 Groundwater – Quantitative Status Tests

### Groundwater

#### Test:

#### Saline Intrusion

#### Description

Status, and the presence of an intrusion of poor quality water into the groundwater body, is determined through an assessment of trends in Electrical Conductivity or other indicator substances. The test is designed to detect the presence of an intrusion that is induced by the abstraction of groundwater.

#### Criteria

Threshold Values are exceeded and there is either a significant and sustained rising trend in one or more key determinands at relevant monitoring points or there is an existing significant impact on a point of abstraction as a consequence of an intrusion.

**Note:** This test mirrors the chemical saline intrusion test as it is dependent on chemical impact caused by **groundwater abstraction**.

#### Standards/Threshold Values

Threshold Values are set at the upper limit of the natural background range for key determinands. Threshold Values are only used in combination with trend assessment(s). Threshold Values have only been derived for pollutants that are indicative of saline (or other) intrusions.

- Electrical Conductivity = 800  $\mu\text{S}/\text{cm}$
- Chloride = 24 mg/l

#### Results

This element is one of four that are used to determine quantitative status ([see Map 2](#)). No groundwater bodies are at Poor Status in relation to saline intrusion. See [Groundwater Results Table](#).

#### Test:

#### Surface Water

#### Description

Status is determined through a combination of surface water classification results and an assessment of the potential impact of groundwater abstraction on the flow required to support surface water ecology. The surface water bodies can comprise rivers, standing waters, and transitional waters.

#### Criteria

The ecology of an associated surface water body is damaged due to groundwater abstraction(s) impacting the groundwater flow from the groundwater body to the associated surface water receptor.

<b>Standards/Threshold Values</b>	Quantitative standards are the ecological flow requirements/standards for surface water bodies.
<b>Results</b>	Due to a lack of information on ecological flow standards for surface water bodies, the surface water ecological/quantitative assessment could not be undertaken. This assessment will be undertaken in the 2 <sup>nd</sup> River Basin Planning cycle. Therefore no groundwater bodies are at Poor Status in relation to the impact of groundwater abstraction on surface water ecology ( <a href="#">see Map 2</a> ). See <a href="#">Groundwater Results Table</a> .
<b>Test:</b>	<b>Groundwater Dependent Terrestrial Ecosystems</b>
<b>Description</b>	Status is determined through determination of ecological damage at the Groundwater Dependent Terrestrial Ecosystem (GWDTE), and then assessment of the impact of groundwater abstraction on GWDTE ecology. The test is designed to assess whether groundwater abstractions reduce the contribution from groundwater (in terms of water level or groundwater flow) to GWDTEs and if the consequent impact on GWDTE ecology is sufficient to threaten the WFD objectives for these associated GWDTEs.
<b>Criteria</b>	The ecology of an associated GWDTE is damaged due to groundwater abstraction reducing the contribution of flow/water level in the groundwater body, which in turn has an impact in flow/water level in the GWDTE.
<b>Standards/Threshold Values</b>	Quantitative standards are the ecological flow and/or water level standards for wetlands. These have been derived on a case by case basis by the National Parks and Wildlife Service for individual GWDTE.
<b>Results</b>	This element is one of four that are used to determine quantitative status ( <a href="#">see Map 2</a> ). Two groundwater bodies are at Poor Status in relation to the impact of groundwater abstraction on GWDTE. See <a href="#">Groundwater Results Table</a> .
<b>Test:</b>	<b>Water Balance</b>
<b>Description</b>	Status is determined through an assessment of a water balance that is undertaken at the groundwater body scale. The test is designed to detect the presence of groundwater body wide-scale over-abstraction, resulting in insufficient water being left to support the ecology of surface water bodies and wetlands, or the

abstractions are resulting in falling groundwater levels.

The long-term annual average volume of water abstracted from the groundwater body represents more than 80% of the long-term annual average volume of recharge.

OR

**Criteria**

The long-term annual average volume of water abstracted from the GWB represents more than the appropriate percentage of recharge required to support dependent surface water receptors **and** there is a long-term drop in groundwater levels.

**Standards/Threshold Values**

In the absence of any clear minimum flow requirements for rivers and wetlands in Ireland, an arbitrary figure of 20% of recharge has been left to support the flow in rivers and wetlands.

**Results**

This element is one of four that are used to determine quantitative status ([see Map 2](#)). One groundwater body is at Poor Status in relation to over abstraction from groundwater. See [Groundwater Results Table](#).

## 8.4 Groundwater – Assessment of Trends and Trend Reversal

### Groundwater

**Element:** **Environmentally and Statistically Significant Upward Trends**

Trend assessments must be undertaken for parameters that are placing a groundwater body at risk of failing a groundwater chemical status objective. Trend assessments must also be undertaken, where necessary, to verify that plumes from contaminated sites do not expand to such an extent that they put a groundwater body at Poor Status.

**Description**

Where a statistically significant upward trend is identified at an individual monitoring point, this trend must be tested for environmental significance. Where an environmentally and statistically significant upward trend is detected at an individual monitoring point, an assessment of environmentally and statistically significant trends is required for the groundwater body, or group of bodies, associated with the monitoring point.

The Groundwater Regulations indicate that significant and sustained upward trends are those trends that are both statistically and environmentally significant, causing an increase in concentration of a pollutant, group of pollutants, or indicator of pollution in groundwater for which trend reversal would be required.

A statistically significant trend is one that is identified using a recognised statistical trend assessment technique. An environmentally significant trend is one that is statistically significant, which if not reversed would lead to the failure of one or more of the WFD's environmental objectives.

**Criteria**

As groundwater data have asymmetric or non-normal distributions, non-parametric statistical methods are required for trend assessment. The non-parametric Seasonal Kendall test is a statistical method that reduces the impact of seasonality on trend assessments. Where significant trends have been detected, the Sen's method can be used to project the trend into the future, as this method is robust when there are outliers or gaps in the time series data.

When assessing trends, data should be considered for as long a time series as is deemed necessary to demonstrate a trend. The baseline year for the assessment of trends is 2007, which relates to the implementation of surveillance and operational monitoring programmes. As a minimum, a time series length of six years is required to determine if a trend is statistically significant using the Seasonal Kendall method, with at least one measurement required in each year.

Annual average concentrations were calculated at monitoring points over a period of ten years and trend assessments have been undertaken at 119 of the 211 monitoring locations for Conductivity, Chloride, Sulphate, Sodium, Ammonium, Nitrate, Molybdate Reactive Phosphorus (MRP), Iron and Manganese, as these are the only parameters placing a groundwater body at risk that had data records greater than six years in the 1<sup>st</sup> River Basin Planning cycle.

An Excel program MAKESENS (incorporating a Mann-Kendall test for trends and a Sen's test for slope projection) was used to assess trends in time series using annual concentrations. Trends were identified as being non-existent, upward or downward, and the confidence of the statistical significance of the trend was 90%, 95%, 99%, 99.9% or the trend was not statistically significant.

## Assessment

Where statistically significant upward trends were discovered at an individual monitoring point, the environmental significance of the trend was determined by extrapolating the trend until 2021. If the predicted concentration exceeded the Threshold Value in 2021, the trend was deemed to be statistically and environmentally significant.

Where environmentally and statistically significant upward trends were detected at individual monitoring points, data for the upward trending parameter were aggregated for all monitoring points in the groundwater body or group of bodies. Where statistically significant upward trends were discovered for the aggregated data, the trend was extrapolated until 2021. If the predicted concentration exceeded the Threshold Value in 2021, the groundwater body or group of bodies were deemed to have statistically and environmentally significant upward trends; as such the trends are subject to trend reversal.

Environmentally and statistically significant trends were detected at 18 monitoring locations, although aggregation of the data across groundwater bodies resulted in no groundwater bodies having environmentally and statistically significant trends. Further investigation is required during the 2<sup>nd</sup> River Basin Planning cycle to evaluate and explain the reasons for the significant upward trends at individual monitoring locations.

## Results

The length of time series was insufficient to determine trend significance at monitoring locations where monitoring was initiated in 2007; trends will be assessed at these locations during the 2<sup>nd</sup> River Basin Planning cycle.

Trend assessments will also be undertaken to evaluate contamination plumes from point sources, as this information was not available during the 1<sup>st</sup> River Basin Planning cycle.

See [Groundwater Results Table](#).

## Element:

### Trend Reversal

**Description**

Where environmentally and statistically significant upward trends are identified at a groundwater body scale, programmes of measures are required to reverse these trends.

**Criteria**

The starting point for trend reversal must be expressed as a percentage of the relevant groundwater quality standard or Threshold Value. The start date for trend reversal is based on the significance of the trend and the risk associated with it. By default, Schedule 8 of the Groundwater Regulations indicates that the starting point for trend reversal is the date when 75% of the standard or Threshold Value is likely to be exceeded, but an earlier or later starting date can be chosen to meet the environmental objectives in a cost effective manner.

Measures should be introduced on or before the date when 75% of the Threshold Value (concentration), of the parameter with the statistically and environmentally significant trend, is exceeded.

**Assessment**

The Excel program MAKESENS predicts future concentrations for a particular parameter using the projected slope of the trend. The year in which the trend is predicted to exceed 75% of the TV can therefore be determined. This year becomes the starting date for trend reversal and is the year in which Measures should be introduced, although an early start date can also be chosen.

**Results**

As there were no groundwater bodies with environmentally and statistically significant upward trends, there was no requirement to assess trend reversal. See [Groundwater Results Table](#).