**Danish Environmental Protection Agency, DANCEE
and
the Ministry of Environment of Latvia**

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Transposition and Implementation of the EU Water Framework Directive in Latvia

Technical Report No. 1B

Classification and presentation of status of waters

Including proposal for surface water reference conditions and network

Final

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List of Abbreviations

CM	Cabinet of Ministers
CIS	Common Strategy on the Implementation of the Water Framework Directive
COAST	CIS-Guidance on typology, reference conditions and classification systems for transitional and coastal waters
DANCEE	Danish Co-operation for the Environment in Eastern Europe
DEPA	Danish Environmental Protection Agency
ELV	Emission Limit Value
EIA	Environmental Impact Assessment
EPD	Environmental Protection Department
EU	European Union
LEA	Latvian Environmental Agency
LWM	Latvian Law on Water Management
MoE	Ministry of Environment
RB	River Basin
RBD	River Basin District
RBM	River Basin Management
RBMA	River Basin Management Authorities
REFCOND	CIS-Guidance on establishing reference conditions and ecological status class boundaries for inland surface waters
REB	Regional Environmental Board
SEI	State Environmental Inspectorate
SGS	State Geological Survey
WFD	Water Framework Directive (2000/60/EC)
ToR	Terms of reference
TR	Technical Report
WG	Working Group
WRUP	Water Resource Use Permit
WQO	Water Quality Objectives

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1 INTRODUCTION

The present report is part of the reporting for the project financed by the Danish Environmental Protection Agency (DEPA):

Transposition and implementation of the EU Water Framework Directive in Latvia.

The report describes the WFD requirements in Annex V on classification and presentation of status of water, the links to the Latvian Water law, and contains the input to a draft text for a new CM regulation on Classification and presentation of status of water. Moreover the report covers a proposal for surface water reference conditions and reference network for freshwater (according to Annex II of WFD).

The report is No. 1B in the following list of reports:

Technical reports:

- TR 1A: Typology of surface waters and procedure for characterisation of waters
- TR 1B: Classification and presentation of status of waters
- TR 2: Monitoring programs for surface water and groundwater
- TR 3: Draft Action Plan on how to define ecological status of fresh and coastal water
- TR 4: Revision of the draft Regulation on WRUP
- TR 5: Elaboration of a specification of requirements and ToR for a data management/information system

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Outputs:

A: Draft legal acts for the transposition of Annexes II and V of the WFD
B: Assistance to MoE in preparation of information material on the WFD
C: Specification of requirements and ToR for a data management/information system

The report is closely linked to TR1A and TR3. TR1B shall be regarded as input to legal experts drafting the Regulation, while TR3 is dealing with classification on an operational level.

The main basis for the report is Article 4 and Annex V of the WFD: surface water status and groundwater. The establishment of type-specific reference conditions for surface water body types is required according to WFD Annex II. While it is very closely connected to the classification system, the topic is included in this report (instead of TR1A, which covers the WFD Annex II).

The input to the Regulation is structured according to the headlines in Annex V (sections in italic are covered by the regulation):

1. SURFACE WATER STATUS
1.1. *Quality elements for the classification of ecological status*
1.2. Normative definitions of ecological status classifications
1.3. Monitoring of ecological status and chemical status for surface waters
1.4. Classification and presentation of ecological status

2. GROUNDWATER
2.1. *Groundwater quantitative status*

2.2. Monitoring of groundwater quantitative status
2.3. *Groundwater chemical status*
2.4. Monitoring of groundwater chemical status
2.5. Presentation of groundwater status

EU CIS Guidances
EU working groups under the WFD "Common Implementation Strategy" have produced several specific CIS Guidance's. This TR is based on the following guidance's:

Guidance on establishing reference conditions and ecological status class boundaries for inland surface waters (CIS REFCOND).

Guidance on typology, reference conditions and classification systems for transitional and coastal waters (CIS COAST).

Overall Approach to the Classification of Ecological Status and Ecological Potential (ECOSTAT, Working Group 2 A)

2 THE LAW ON WATER MANAGEMENT

The Latvian **Law on Water Management** states the following of relevance to surface water and groundwater classification:

> **Art. 5: (10)** The Cabinet of Ministers determines:
>
> 1) characterisation of surface water body types and the corresponding classification of surface water bodies, as well as the procedure for identification of anthropogenic pressures;
> 2) classes of groundwater bodies and classification criteria, the procedure for identification of anthropogenic pressures, as well as the procedure for review of available groundwater resources;
> 3) quality elements for surface and groundwater as well as elements for high, good and moderate water status;

Re. 1) this TR only considers the classification. Characterisation as well as the procedure for identification of anthropogenic pressures is covered by TR1A.

3 AIM, RESPONSIBLE AUTHORITIES AND DEADLINES

3.1 Aim

The aim of the CM regulation on Classification and presentation of status of waters is to enable classification of the status of water bodies so to compare with their environmental objectives.

The procedure for classification and presentation of status of water bodies shall regulate how the results from the monitoring from the programme established in line with the WFD requirements are evaluated and presented in the River Basin management Plans.

3.2 Responsible authorities

According to the Latvian Law on Water Management (Paragraph 1 Article 9) Co-ordination Committee shall be established for each of the four river basin districts to co-ordinate the management measures within the river basin district.

There are three institutions in Latvia responsible for practical implementation, coordination and supervision of water management related issues defined by Law on Water Management (LWM). Those are:

- State Geological Survey and its regional units;
- The Latvian Environmental Agency;
- The State Environmental Inspection.

The State Geological Survey and its regional units- river basin authorities, shall:

1. establish and update drafts of management plans and programmes of measures;
2. carry out an economic analysis of water resources use;
3. ensure participation of the public in preparation and updating of management plans and programmes of measures and informs about the plans and programmes those municipalities, which administrative territories are covered by these documents;
4. co-ordinate the implementation of programme of measures;
5. develop the budget proposals necessary for the implementation of the programme of measures;
6. facilitate activities of the Co-ordination Committees;
7. co-operate with the competent authorities of the relevant countries to ensure the achievement of the environmental objectives for the whole international river basin district, as well as shall implement joint programmes of measures;
8. participate in the development and implementation of the programmes for monitoring of water status.

The Latvian Environmental Agency shall:

1. develop programmes for monitoring of water status (hereinafter monitoring programmes) within each river basin district;
2. develop budget proposals for the implementation of the monitoring programmes;
3. co-ordinate and arrange implementation of the monitoring programmes;
4. provide the European Commission with the information specified by the Cabinet of Ministers.

The State Environmental Inspection shall supervise implementation of the programme of measures.

3.2.1 Proposal for defining institutional responsibilities

The project propose that classification and presentation of status of surface water bodies shall be carried out by the Latvian Environmental Agency and for ground water bodies the Geological Survey is the responsible institution.

3.3 Deadlines

In the Annex VII of the WFD, River Basin Management Plans, the following is required to be included in the plans:
A map of the monitoring networks established for the purposes of Article 8 and Annex V, and a presentation in map form of the results of the monitoring programmes carried out under those provisions for the status of:

- surface water (ecological and chemical);
- groundwater (chemical and quantitative);
- protected areas;

meaning the deadlines for classification and presentation of status of waters are the same as for the elaboration of River Basin Management Plans:

- Draft copies of the River Basin Management Plans for public information and consultation including presentation of status of waters shall be completed by 22 December 2008 and it shall be reviewed every 6 years.
- The first River Basin Management Plans including classification and presentation of status of waters shall be completed by 22 December 2009 and it shall be reviewed every 6 years.

Requirements on publishing the results of monitoring are included in the Latvian law on Water Management, which states: Management Plans referred to in Article 18 shall be approved and published by the 22nd December 2009.

4 SURFACE WATER, INPUT TO THE CM REGULATION

4.1 Quality elements for the classification of ecological status

The ecological status of surface water bodies shall be classified on the basis of biological, hydro-morphological and physicochemical quality elements of the water body.

The table below gives an overview of the different quality elements to define the status of the different categories of surface waters:

Quality element	**1. Rivers**	**2. Lakes**	**3. Tran-sitional waters**	**4. Coastal waters**
Biological elements				
- Composition, abundance and biomass of phytoplankton		✓	✓	✓
- Composition and abundance of aquatic flora	✓	✓	✓	✓
- Composition and abundance of benthic invertebrate fauna	✓	✓	✓	✓
- Composition and abundance of fish fauna	✓	✓	✓	
- Age structure of fish fauna	✓	✓		
Hydromorphological elements supporting the biological elements				
Hydrological regime				
- quantity and dynamics of water flow	✓	✓		
- residence time		✓		
- connection to groundwater bodies	✓	✓		
River continuity				
- river continuity	✓			
Morphological conditions				
- depth variation	✓	✓	✓	✓
- width variation	✓			
- structure and substrate of the bed	✓	✓	✓	✓
- quantity of the bed		✓	✓	
- structure of the riparian zone	✓			
- structure of the shore		✓		
- structure of the intertidal zone			✓	✓
Tidal regime				
- freshwater flow			✓	
- direction of dominant currents				✓
- wave exposure			✓	✓
Chemical and physico-chemical elements supporting the biological elements				
General				
- Transparency		✓	✓	✓
- Thermal conditions	✓	✓	✓	✓
- Oxygenation conditions	✓	✓	✓	✓
- Salinity	✓	✓	✓	✓
- Acidification status	✓	✓		
- Nutrient conditions	✓	✓	✓	✓
Specific pollutants				
- Pollution by all priority substances identified as being discharged into the body of water	✓	✓	✓	✓
- Pollution by other substances identified as being discharged in significant quantities into the body of water	✓	✓	✓	✓

The Directive specifies quality elements for the classification of ecological status[1] that include hydromorphological elements supporting the biological elements and chemical and physicochemical elements supporting the biological elements.

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.

In annex 1 the quality elements are defined for high, good and moderate status for all surface water categories.

Biological as well as supporting hydromorphological and physico-chemical quality elements are to be used by Member States in the assessment of ecological status, with relative roles as illustrated in Figure 1 and Figure 2.

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[1] *Annex V.1.1*

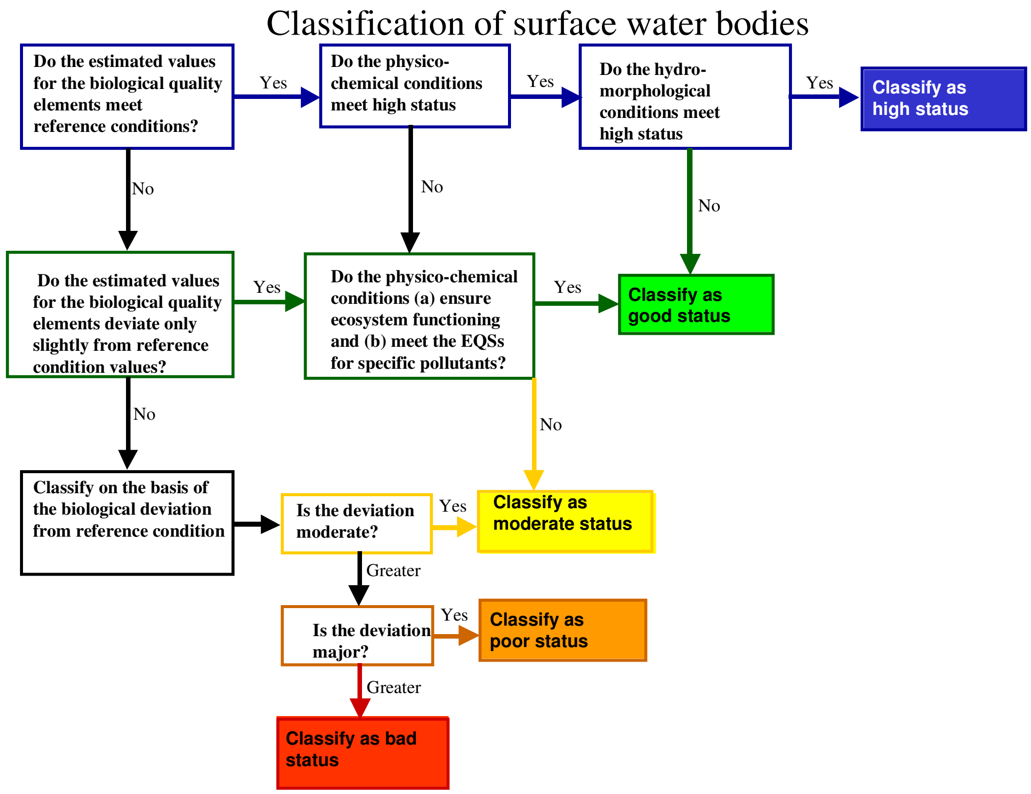


Figure 1. ***Indication of the relative roles of biological, hydromorphological and physico-chemical quality elements in ecological status classification according the normative definitions in WFD Annex V:1.2***

Annex V No. 1.2.5:

[Maximum Ecological Potential (MEP) is defined as the state where] "the values of the relevant biological quality elements reflect, as far as possible, those associated with the closest comparable surface water body type, given the physical conditions which result from the artificial or heavily modified characteristics of the water body."

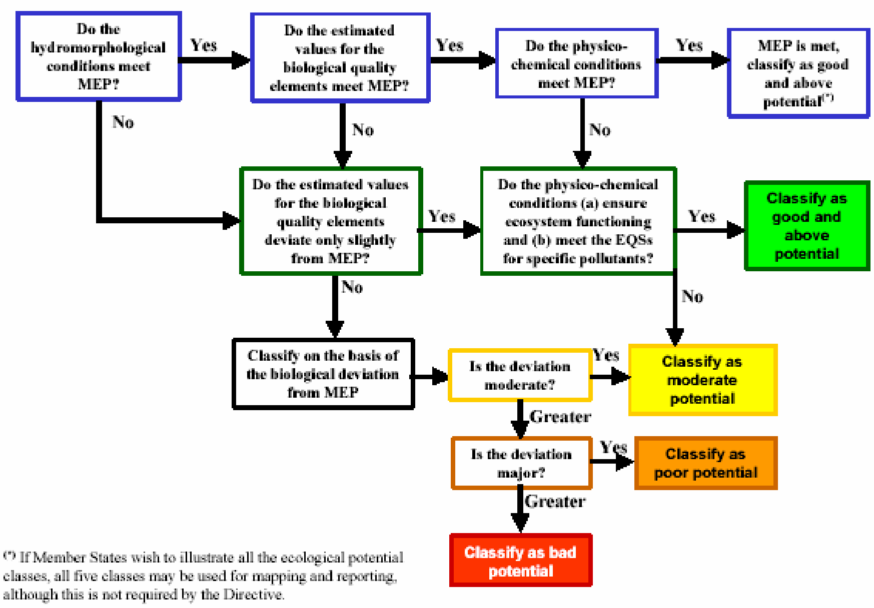


Figure 2. *Indication of the relative roles of biological, hydromorphological and physico-chemical quality elements in ecological* ***potential*** *classification according the normative definitions in Annex V:1.2. The two upper classes MEP and GEP are combined for reporting purposes to good and above potential. The color code of the classification shows equal green/yellow/orange/red and light (AWB) or dark grey stripes (HMWB). For further information see HMWB&AWB guidance document.*

4.2 Ecological status classes of surface water bodies

Ecological status in rivers, lakes, transitional waters and coastal waters shall be classified as high, good, moderate, poor or bad according to the following:

High status

General elements:

There are no, or only very minor, anthropogenic alterations to the values of parameters indicative of the physicochemical and hydro-morphological quality elements for the surface water body type from those normally associated with that type under undisturbed conditions.

The values of parameters indicative of the biological quality elements for the surface water body reflect those normally associated with that type under undisturbed conditions, and show no, or only very minor, evidence of distortion.

These are the type specific conditions and communities.

Good status

General elements:
The values of parameters indicative of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity, but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions.

Moderate status
General elements:
The values of parameters indicative of the biological quality elements for the surface water body type deviate moderately from those normally associated with the surface water body type under undisturbed conditions. The values show moderate signs of distortion resulting from human activity and are significantly more disturbed than under conditions of good status.

Poor status
Waters showing evidence of major alterations to the values of parameters indicative of the biological quality elements for the surface water body type and in which the relevant biological communities deviate substantially from those normally associated with the surface water body type under undisturbed conditions, shall be classified as poor.

Bad status
Waters showing evidence of severe alterations to the values of parameters indicative of the biological quality elements for the surface water body type and in which large portions of the relevant biological communities normally associated with the surface water body type under undisturbed conditions are absent, shall be classified as bad.

4.3 Normative definitions of ecological status classifications

High, good and moderate ecological status in rivers, lakes, transitional and coastal waters shall be defined according to the values of parameters indicative of the quality elements for ecological status specified in annex 1.

Maximum, good and moderate ecological potential for heavily modified bodies shall be defined according to the values of parameters indicative of the quality elements for ecological status of the corresponding surface water category.

4.4 Procedure for setting of chemical quality standards (environmental quality standards)

For the purpose of assessing ecological status/potential, the specific pollutants (“specific synthetic pollutants and “specific non-synthetic pollutants”, Annex V, 1.1 and 1.2 under physico-chemical elements) must be considered. For good ecological status/potential the environmental quality standard established for the specific pollutants by Latvia (“the member states”) using the following procedure (set out in 1.2.6) must be met (like list II substances under 76/464 Directive).

Environmental (water) quality standards shall be derived for the following pollutants (listed in WFD, Annex VIII):

1. Organohalogen compounds and substances which may form such compounds in the aquatic environment.
2. Organophosphorus compounds.
3. Organotin compounds.
4. Substances and preparations, or the breakdown products of such, which have been proved to possess carcinogenic or mutagenic properties or properties which may affect steroidogenic, thyroid, reproduction or other endocrine-related functions in or via the aquatic environment.
5. Persistent hydrocarbons and persistent and bioaccumulable organic toxic substances.
6. Cyanides.

7. Metals and their compounds.
8. Arsenic and its compounds.
9. Biocides and plant protection products

The standards may be set for water, sediment or biota. Where possible, data shall be obtained for the following basic taxa:

- Algae and/or macrophytes;
- Daphnia or representative organisms for saline waters;
- Fish.

The following method shall apply to the setting of the maximum permissible annual average concentration:

1) Safety factors shall be set on the basis of existing data on hazardousness of pollutants for people and the environment and in accordance with the features specified below:

Safety factor 1000: At least one acute $L(E)C_{50}$ from each of three trophic levels of the base set;

Safety factor 100: One chronic NOEC (either fish or Daphnia or a representative organism for saline waters);

Safety factor 50: Two chronic NOECs from species representing two trophic levels (fish and/or Daphnia or a representative organism for saline waters and/or algae);

Safety factor 10: Chronic NOECs from at least three species (normally fish, Daphnia or a representative organism for saline waters and algae) representing three trophic levels;

NOEC= None observed effect concetration.

Case by case assessment: Other cases, including field data or model ecosystems, which allow more precise safety factors to be calculated and applied

2) where data on persistence and bioaccumulation are available, these shall be taken into account in deriving the final value of the maximum permissible average annual concentration;

3) the water quality standard thus derived should be compared with any evidence from field studies. Where anomalies appear, the derivation shall be reviewed to allow a more precise safety factor to be calculated.

4) the standard derived shall be subject to peer review and public consultation including to allow a more precise safety factor to be calculated.

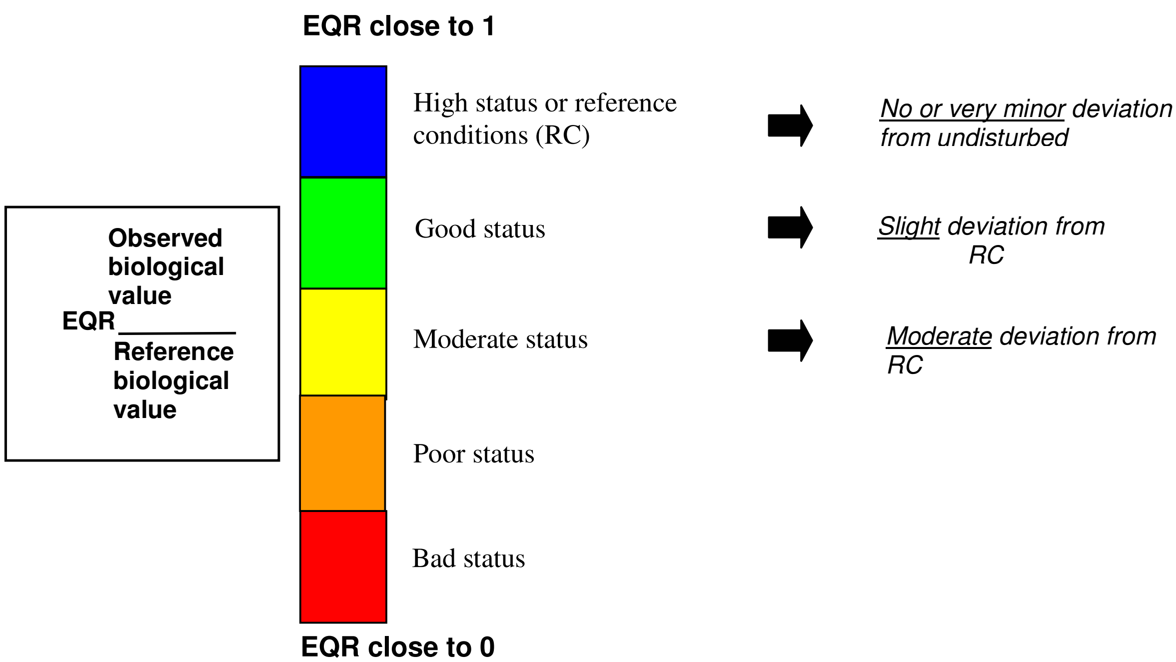
4.5 Comparability of biological monitoring results

Latvia will establish monitoring systems for the purpose of estimating the values of parameters indicative of the biological quality elements specified for each surface water category or for heavily modified and artificial bodies of surface water as specified in CM regulation on Monitoring requirements and requirements for the establishment of the monitoring programmes for surface water and groundwater. In applying the procedure set out below to heavily modified or artificial water bodies, references to ecological status should be construed as references to ecological potential. Such systems may utilise particular species or groups of species which are representative of the quality element as a whole.

In order to ensure comparability of such monitoring systems, the results of the systems operated by Latvia will be expressed as ecological quality ratios for the purposes of classification of ecological status. These ratios shall represent the relationship between the values of the biological parameters observed for a given body of surface water and the values for these parameters in the reference conditions applicable to that body. The ratio shall be expressed as a numerical value between zero and one, with high ecological status represented by values close to one and bad ecological status by values close to zero.

Latvia shall divide the ecological quality ratio (eqr) scale for their monitoring system for each surface water category into five classes ranging from high to bad ecological status, as defined in WFD Annex V, Section 1.2, by assigning a numerical value to each of the boundaries between the classes. The value for the boundary between the classes of high and good status, and the value for the boundary between good and moderate status shall be established through a common European intercalibration exercise carried out in 2005-2006. The purpose is to establish the boundaries consistent with the definition of ecological classes and to be comparable between countries.

In this report section 5.3 examples are given in calculation of EQR of reference values.



Basic principles for classification of ecological status based on Ecological Quality Ratios.

4.6 Presentation of monitoring results and classification of ecological status and ecological potential

Ecological status

For surface water categories, the ecological status classification for the body of water shall be represented by the lower of the values for the biological and physico-chemical monitoring results for the relevant quality elements classified as high, good, moderate, poor or bad status. It means that the classification system is a one-out, all-out scheme on the level of quality elements.

For each river basin district a map shall be provided illustrating the classification of the ecological status for each body of surface water. The colour code shall be as the following:

High ecological status:	Blue
Good ecological status:	Green
Moderate ecological status:	Yellow
Poor ecological status:	Orange
Bad ecological status:	Red

Ecological potential

For heavily modified and artificial water bodies, the ecological potential classification for the body of water shall be represented by the lower of the values for the biological and physico-chemical monitoring results for the relevant quality elements classified as good and above, moderate, poor or bad ecological potential status.

For each river basin district a map shall be provided illustrating the classification of the ecological potential for each body of water. The colour code shall be as the following:

For Artificial Water bodies:

Good and above ecological potential:	Equal green and light grey stripes
Moderate ecological potential:	Equal yellow and light grey stripes
Poor ecological potential:	Equal orange and light grey stripes
Bad ecological potential:	Equal red and light grey stripes

For Heavily modified Water bodies:

Good and above ecological potential:	Equal green and dark grey stripes
Moderate ecological potential:	Equal yellow and dark grey stripes
Poor ecological potential:	Equal orange and dark grey stripes
Bad ecological potential:	Equal red and dark grey stripes.

A black dot on the map shall indicate those bodies of water where failure to achieve good status or good ecological potential is due to non-compliance with one or more environmental quality standard which have been established for that body of water in respect of specific synthetic and non-synthetic pollutants.

Chemical status

Where a body of water achieves compliance with all the environmental quality standards that have been adopted at Community-level for the priority substances (Art.16, Annex X) and under other relevant community legislation setting environmental quality standards (directives listed in Annex IX) it shall be recorded as achieving good chemical status. If not, the body shall be recorded as failing to achieve good chemical status.

A map for each river basin district shall be provided to illustrate chemical status for each body of water. The colour code shall be as the following:

Good chemical status: Blue
Failing to achieve good chemical status: Red

It has been agreed under the Common Implementation Strategy that once environmental quality standards have been adopted at Community level, the concentrations of these substances in water bodies should only be taken into account in the classification of chemical status and not in the classification of ecological status/potential.

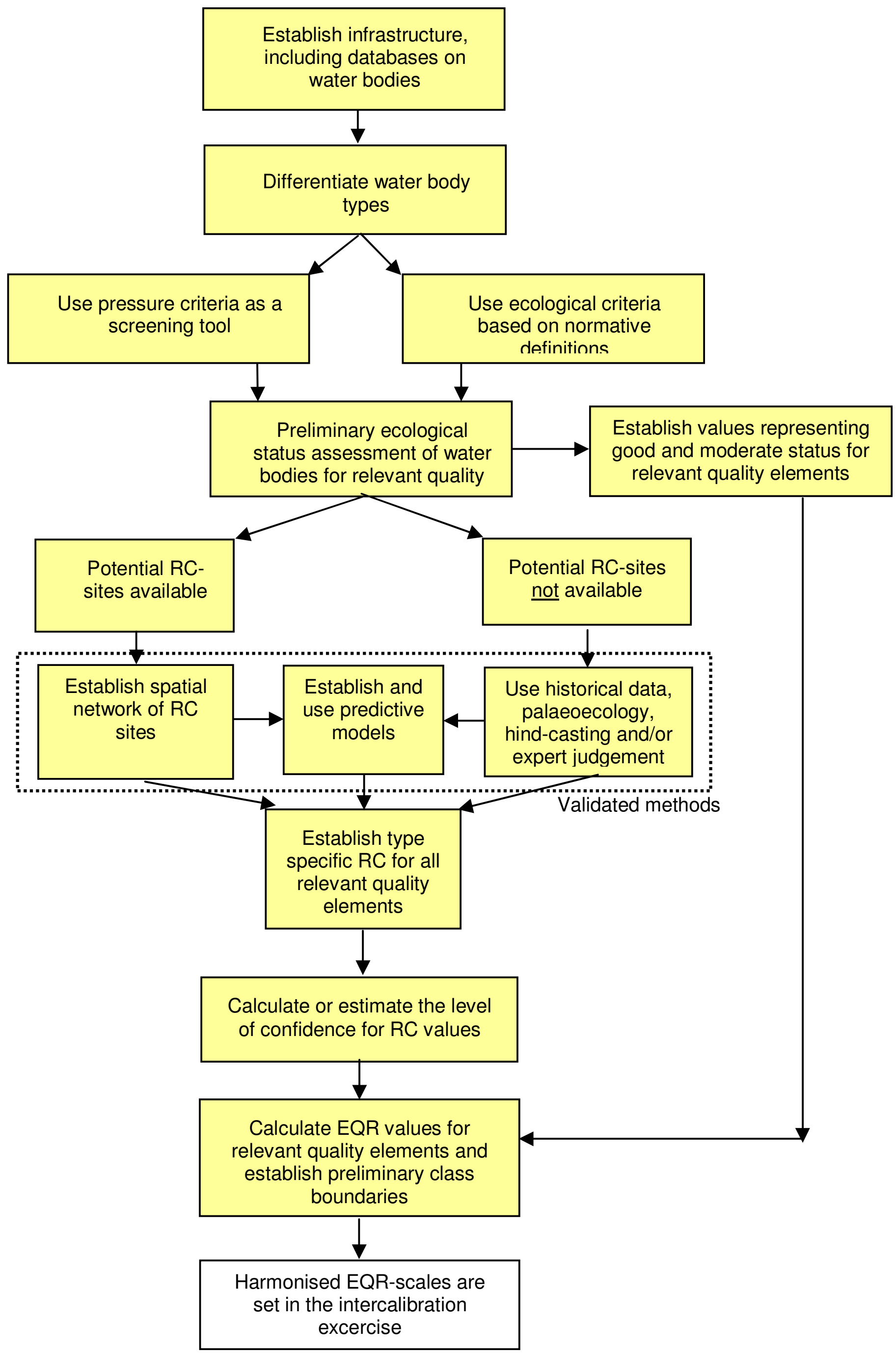
5 REFERENCE CONDITIONS, FRESHWATER

5.1 Introduction

The establishment of reference conditions and the establishment of ecological quality class boundaries are closely interconnected. To establish the boundary between high and good ecological status it is necessary to identify conditions representing very minor anthropogenic disturbances. To establish boundaries between good and moderate ecological status it is necessary to identify conditions corresponding to slight anthropogenic disturbances. The figure below schematically shows a number of steps that may be taken to establish reference conditions and ecological class boundaries.

The methodology proposed includes a step-wise approach based on use of:

- Existing databases containing monitoring data (spatial data)
- The proposed typology system for rivers and lakes
- Use of ecological criteria as basis for selection of parameters
- Preliminary ecological assessment of water bodies for relevant quality elements.
- Identification of potential reference sites.


Establish infrastructure, including databases on water bodies
Differentiate water body types
Use pressure criteria as a screening tool
Use ecological criteria based on normative definitions
Preliminary ecological status assessment of water bodies for relevant quality
Establish values representing good and moderate status for relevant quality elements
Potential RC-sites available
Potential RC-sites not available
Establish spatial network of RC sites
Establish and use predictive models
Use historical data, palaeoecology, hind-casting and/or expert judgement
Validated methods
Establish type specific RC for all relevant quality elements
Calculate or estimate the level of confidence for RC values
Calculate EQR values for relevant quality elements and establish preliminary class boundaries
Harmonised EQR-scales are set in the intercalibration excercise

5.2 WFD requirements

The definition of reference conditions is included in the Annexes II and V of the Directive:

Annex II: 1.3 (i-vi) regarding Establishment of type-specific reference conditions for surface water body types:
(*i) For each surface water body type characterised in accordance with section 1.1, type-specific hydromorphological and physicochemical conditions shall be established representing the values of the hydromorphological and physicochemical quality elements specified in point 1.1 in Annex V for that surface water body type at high ecological status as defined in the relevant table in point 1.2 in Annex V. Type-specific biological reference conditions shall be established, representing the values of the biological quality elements specified in point 1.1 in Annex V for that surface water body type at high ecological status as defined in the relevant table in section 1.2 in Annex V.*

(ii) In applying the procedures set out in this section to heavily modified or artificial surface water bodies references to high ecological status shall be construed as references to maximum ecological potential as defined in table 1.2.5 of Annex V. The values for maximum ecological potential for a water body shall be reviewed every six years.

(iii) Type-specific conditions for the purposes of points (i) and (ii) and type-specific biological reference conditions may be either spatially based or based on modeling, or may be derived using a combination of these methods. Where it is not possible to use these methods, Member States may use expert judgement to establish such conditions. In defining high ecological status in respect of concentrations of specific synthetic pollutants, the detection limits are those which can be achieved in accordance with the available techniques at the time when the type-specific conditions are to be established.

(iv) For spatially based type-specific biological reference conditions, Member States shall develop a reference network for each surface water body type. The network shall contain a sufficient number of sites of high status to provide a sufficient level of confidence about the values for the reference conditions, given the variability in the values of the quality elements corresponding to high ecological status for that surface water body type and the modelling techniques which are to be applied under paragraph (v).

(v) Type-specific biological reference conditions based on modeling may be derived using either predictive models or hindcasting methods. The methods shall use historical, palaeological and other available data and shall provide a sufficient level of confidence about the values for the reference conditions to ensure, that the conditions so derived are consistent and valid for each surface water body type.

(vi) Where it is not possible to establish reliable type-specific reference conditions for a quality element in a surface water body type due to high degrees of natural variability in that element, not just as a result of seasonal variations, then that element may be excluded from the assessment of ecological status for that surface water type. In such circumstances Member States shall state the reasons for this exclusion in the river basin management plan.

Annex V: 1.2: Normative definitions of ecological status classifications. Table 1.2. General definition of high ecological status, corresponding to the reference condition:
There are no, or only very minor, anthropogenic alterations to the values of the physico-chemical and hydromorphological quality elements for the surface water body type from those normally associated with that type under undisturbed conditions.
The values of the biological quality elements for the surface water body reflect those normally associated with that type under undisturbed conditions and show no or only very minor, evidence of distortion.

5.3 Proposal for procedure

The proposed procedure/method used to identidy reference conditions for rivers and lakes in Latvia is largely based on the approach and results of the ongoing project" Latvian Reference site project" conducted by the Latvian Environmental Agency (financed by the Latvian Environmental Fund), initiated with the objective to define reference conditions and propose a reference network for Latvia. Reference sites have been selected and reference conditions defined for the types of water bodies defined in the proposed typology developed under the project "Transposition and Implementation of the EU Water Framework project in Latvia" (project report TR1A and draft CM regulation on Typology December 2003).
The basic approach for selection of reference sites and defining parametric values characterising un-impacted situation is to utilise existing knowledge (spatial data: monitoring data) and thus corresponds to the recommendations of the REFCOND guideline.

This report includes the conclusion and summary of the study, for more details see the background report from LEA: Establishment of reference conditions and proposal for reference sites.
The methodology used is described in the following:

Development of data base
As first step all available data on lakes and rivers were compiled, including state monitoring programs, research projects (Latvian University) and survey data.
For large rivers monitoring data are available for 60 stations (for the years 1991 to 2002), including relevant physio-chemical parameters and saprobity.
For small rivers monitoring data are available for 32 stations, selected by LEA for the above mentioned project based on the quality asssessed though earlier years biological monitoring (e.g. the stations appearing to be less influenced judging from saprobity index). For these stations monitoring of physio-chemical parameters have been conducted 6 times from July 2002 to June 2003; biological elements - zoo-benthos and macrophytes 1-2 times.
For lakes monitoring data are available from databases of LEA (monitoring activities in recent years) and the database held by the Latvian University, Institute of Biology (the latter are only partly computerised). Monitoring data for the summer season are available for 160 lakes (biomass, TP, TN, chlorophyll a, secci-depth), however long term monitoring has been conducted only on 8 stations.
Prior to conducting the statistical analysis the data have been checked and validated and data falling outside the normal range have been deleted.

Development of typology
The typology for rivers and lakes used as basis for selection of reference sites was developed within the present project as described in project report TR1A. The proposed typology includes 6 types of rivers and 10 types of lakes.

Differentiation of water bodies according to typology
For the purpose of conducting the statistic tests of the monitoring data, the existing river and lake monitoring stations were grouped into water body-types corresponding to the proposed typology.

Screening of data for potential reference sites for each type
The identification of potential reference sites included a screening of

- Pressure data (emissions and land-use in catchment) methodology for evaluation
- Quality data (chemical, biological data).

The methodology is described below in section "definition of reference conditions"

Identification of gaps in available data

For river stations an assessment of gaps in available data was made by the beginning of the LEA project, based on a selection of potential reference sites. The assessment included identification of water body types not sufficiently covered by potential reference sites, or types where the number of existing monitoring stations was to small to provide the statistical basis needed for calculating reference values for priority parameters.

As a result a preliminary selection of potential reference sites for monitoring in the frame of the LEA project was made and a program established for monitoring of 32 sites in small streams included in earlier years programs for biological surveys. The monitoring programme conducted include physico-chemical parameters (oxygen, T, pH, conductivity, colour, BOD, nutrients) measured 6x/year, biological parametres (benthic invertebrates, aquatic vegetation) measured 1-2 /year as well as a description of hydromorphology.

The data were entered into the common database and thus are an integrated part of the data sets used for identification of reference stations and definition of reference condition.

For biological elements data available do not allow defining reference values for all elements.

For **rivers** data are available to allow setting values for macrophytes (coverage and species composition) and saprobity index (macro-invertebrates).

For **lakes** only information on phyto-plancton is available at a level allowing defining of reference values. For this element parameters defined include biomass, dominating taxa, presence of red algae and cyanophytes. Also Parameters are proposed for invertebrates for one lake type (no.1).

Definition of reference stations

The identification of reference stations was based on evaluation of the best monitoring stations according to an integrated evaluation of the following:

According to physico-chemical data

According to biological data

According to pressure data

The methodology for identification of the best stations according to physico-chemical data included

1) Calculating percentile values (10, 20, 30, 40, 50, 60, 70, 80, 90 percentiles) for every parameter in each group:

for rivers – minimal oxygen concentration, BOD, ammonium, nitrites, nitrates, total nitrogen, phosphates, total phosphorus, saprobity index)

for lakes – Secci depth, total nitrogen, total phosphorus, chlorophyll a concentration, phytoplankton biomass

2) Ranking the parameter values of monitoring stations against the percentile values in the following way: For values less than the respective 10 percentile the station received 1 point, for values larger than the 10 percentile but less than 20 percentile the station received 2 points etc. whereas for values exceeding the 90 percentile the station received 10 points (with the exception of Secci depth and minimal oxygen concentration where points were assigned in the adverse way, as the largest values correspond to the most favourable condition);

3) The stations receiving the lowest average score according the evaluation described are defined as the best.

The principle is illustrated by the following example:

River stations

River monitoring station	O_2	BSP_5	N/NH_4	N/NO_2	N/NO_3	Ntot	P/PO_4	Ptot	Average
upstreamValmieras	2	1	1	1	1	2	2	1	1,4
Vičaki	4	4	3	1	1	1	1	2	2,1
downstream Carnikavas	1	6	4	2	2	4	3	4	3,3
upstream Cēsīm	1	2	2	3	4	1	5	9	3,4
upstream Mazsalacas	8	1	1	7	6	5	1	1	3,8
upstream Dūkupjiem	2	3	6	5	5	3	5	5	4,3
upstream Līvāniem	4	7	5	5	3	3	6	6	4,9
upstream Kuldīgas	3	5	5	3	9	9	3	3	5,0
Saka, estuary	6	5	9	4	5	5	7	5	5,8
downstream Mazsalacas	10	3	3	9	8	8	4	3	6,0
downstream Valmieras	4	9	10	6	3	7	10	10	7,4
Aiviekste, estuary	7	7	8	10	7	7	7	7	7,5
downstream Skaistkalnes	8	8	7	7	9	9	8	8	8,0
Dubna, estuary	8	10	9	8	7	6	9	9	8,3
Svēte, estuary	6	9	7	9	10	10	9	7	8,4
Lithuanian boarder	10	10	10	10	10	10	10	10	10,0

Lake stations

Lake	Chlorofyl a, mkg/l	Total phosphorous mg/l	Total Nitrogen, mg/l	Transparency, m	Phytoppl. biomass, mg/l	Chlorophyl, points	Total phosphorous points	Total Nitrogen, points	Transparency, points	Phytoppl. biomass, point	**Rating**
Drīdzis	1,65	0,01	0,29	5,65	0,37	2	1	1	1	2	**1,4**
Riču	1,1	0,016	0,52	5	0,62	1	3	4	2	6	**3,2**
Ilzas (Geraņimovas)	3,75	0,013	0,39	3,9	0,55	5	2	2	3	5	**3,4**
Briģenes	3,25	0,029	t	3,2	0,40	3	8		5	3	**4,8**
Puzes	3,8	0,0215	0,67	2,7	0,75	6	5	6	6	8	**6,2**
Lielais Gusena 1	5,75	0,022	0,78	1,83	0,22	8	6	9	8	1	**6,4**
Garais (Krāslavas) 1	6,8	0,051	0,68	0,8	1,90	9	9	7	9	9	**8,6**
Valguma	145	0,21	1,8	0,8	43,80	10	10	10	9	10	**9,8**

A similar methodology was used for assessment of the existing monitoring stations according to pressure data:
1) Percentile values (10, 20, 30, 40, 50, 60, 70, 80, 90 percentiles) were calculated for:
land use according to 3 categories: agricultural lands, urban areas and natural territories
population density
2) Parameter values of each monitoring station were compared with percentile values. For values less than 10 percentile the station received 1 point, for values less than 20 percentile the station received 2 points whereas for values exceeding the 90 percentile the station received 10 points (in case of natural territories points were designated in the opposite way, as a high proportion of nature territories correspond to a low pressure);
3) Average value for different parameters for every station were calculated, the station holding the lowest score has the least pressure.
The method is illustrated by the following example concerning river stations:

Large potamal streams										
		Catchment use and population density				Evaluation				
River	Monitoring stations	Population density pers./km^2	Natural territories, %	Urbanized areas, %	Agricultural lands, %	Population density, points	Natural territories, points	Urbanized areas, points	Agricultural lands , points	Average
Gauja	upstream Valmieras	11,45	61,94	0,44	37,62	1	1	3	1	1,5
Mēmele	downstream Skaistkalnes	11,14	61,91	0,14	37,95	1	2	1	3	1,8
Salaca	upstream Mazsalacas	12,32	58,42	0,29	41,29	2	4	1	5	3,0
Irbe	Vičaki	14,77	77,85	0,79	21,36	5	1	8	1	3,8
Salaca	downstream Mazsalacas	13,21	58,11	0,34	41,55	3	5	2	5	3,8
Gauja	downstream Valmieras	16,79	61,66	0,63	37,71	7	2	5	2	4,0
Gauja	upstream Cēsīm	16,71	60,26	0,60	39,14	6	4	4	4	4,5
Saka	Saka, estuary	16,39	44,08	0,46	55,46	5	7	3	7	5,5
Gauja	downstream Carnikavas	21,16	61,17	0,84	38,00	9	3	9	3	6,0
Bārta	upstream Dūkupjiem	13,72	42,00	0,63	57,38	3	9	5	9	6,5
Dubna	upstream Līvāniem	14,63	42,38	0,65	56,97	4	8	6	9	6,8
Venta	upstream Kuldīgas	16,87	52,60	0,80	46,60	7	6	9	6	7,0
Aiviekste	Aiviekste, estuary	19,78	51,44	0,66	47,90	9	6	7	7	7,3
Dubna	Dubna, estuary	16,97	42,37	0,71	56,92	8	8	7	8	7,8
Svēte	Svēte, estuary	35,88	31,58	0,92	67,50	10	10	10	10	10
Mūsa	**Lithuanian boarder**	**66,16**	**24,15**	**1,00**	**74,85**	**10**	**10**	**10**	**10**	**10**

The list of reference stations identified is included in annex 2 and showed on map in annex 3.

Calculation of reference values

Calculation of reference values and border value between high and good status was conducted according to the following principle:

1) Reference value and border value were calculated for each of the parameters defined in 4.5;
2) The calculations were based on values from monitoring stations identified as reference sites by data analyses and expert judgment;
3) Values of reference stations which differs significantly from other values were not included in the calculation;
4) Median value was calculated for each of the selected parameters (value that divides all values in two equal parts). This value was defined as the reference value for the parameter in question;

To establish the "class dividers" the EQR values were calculated according to the following procedure:
5) Each parameter value was divided with this reference value (normalization of data);
6) In values of parameter increases to the "bad end" then normalized values must be inverted (1 divided with normalized value);
7) From inverted values 10 percentile value is calculated. This value shows the border between high and good quality on the EQR scale;
8) For this EQR value parameter value can be calculated with this formula: =(1/EQR value)*reference value.

Example:
Daugava upstream Jēkabpils – Ptot values for 12 years.

Ptot	Normalized values	Inverted values
0,066	1,082	0,924
0,063	1,033	0,968
0,050	0,820	1,220
0,055	0,902	1,109
0,048	0,787	1,271
0,042	0,689	1,452
0,059	0,967	1,034
0,069	1,131	0,884
0,050	0,820	1,220
0,064	1,049	0,953
0,074	1,213	0,824
0,065	1,066	0,938
Median	EQR value	0,888
0,061	Parameter value	0,069

Choice of parameters

Chemical parameters
Based on the availability of data from the monitoring stations included in the statistical assessment described above it is proposed that reference values are set for the following physio-chemical parameters:

For Rivers: dissolved oxygen (min O_2), biological oxygen demand (BOD_5), ammonium nitrogen (N/NH_4), ammonium nitrogen (NH4-N) total nitrogen (N_{tot}), total phosphorus (P_{tot}), saprobity index;

For lakes: total nitrogen (N_{tot}), total phosphorus (P_{tot}), Secci depth,, chlorophyll-a**;**

Definition of values defining reference condition/high status
Using statistical analysis the monitoring data have been grouped in percentiles (in 10, 25, 50 75 and 90 percentiles) for each of the river and lake water body types defined in TR1A.

In general the 10 percentile is considered to be suitable for definition of a "non-impacted" status. For oxygen and secci depth however 90 percentile should be used, as the highest values correspond to the highest ecological quality.
The specific physio-chemical values as defined in co-operation with LEA are included in tables in annex 4.

Biological elements
The biological elements have been selected based on an assessment of data available for the elements included in the proposed monitoring program for surface waters.

Benthic invertebrate fauna (Saprobity index) is proposed as one of the main element for biological monitoring in **rivers**. Data are available for definition of reference values (refer Annex 5). The possibility to use Saprobity index as one of the main element for biological monitoring of littoral part of **lakes** are discussed in working group meetings. The possibilities should be assessed based both on already existing data bases and on proposed biological monitoring data.

Fish fauna is proposed as an element for rivers with a mean summer-flow below 200 l/s and mean summer water depth below 0,3 meter (to allow electro-fishing).Reference values are defined as an additional project task. Detailed description is presented in TR3: Action plan – How to define ecological status of surface water and TN "Proposal for Amendments of CM Regulation No.93". For ***lakes*** fish fauna is included as a quality element.

Macrophytes is proposed as an element for all reference sites in rivers and lakes, including overall surface coverage in percents, species composition and presence of indicator taxa - *Potomogeton alpinu* – for **rivers** and indicator species, presence of indicator species, indicator species coverage, total coverage with macrophytes for **lakes.** Reference values are defined both for lakes and rivers (refer – Annex 5 (for reference condition) and TR3 (for ecological classes).

It is proposed to include ***phytoplankton*** (frequency of algal blooms, species composition and indicator species) as an element for reference stations in **lakes.** The chlorophyll – a is defined as an additional chemical parameter for temporary use. (refer – Annex 5).

The parametric values for the biological elements have been defined by expert judgement/modelling involving experts from, Institute of Biology, Laboratory of Hydrobiology (Latvian University).

It is recommended to establish monitoring programs and scientific programs to allow determination of the other parametric values, especially fish in lakes. Other biological elements, e.g. zooplankton, bacteria etc. are not proposed a present, however they could bee included if the information on environmental status compared with costs justify it.

Hydro-morphological elements
At reference conditions there should be no, or only very minor, anthropogenic alterations to hydro morphology of the water bodies. A field inspection is required to evaluate whether the hydro morphology of a water body corresponds to reference conditions, i.e. whether the water body habitats have been changed by anthropogenic activities such as river regulation, damming or digging.
A description of hydro morphological reference conditions at different reference sites is needed as the basis for establishing a more precise typology in future. The description should at least include the following variables:

For rivers

- Geology (bedrock, sediments)
- distance form river source
- river continuity (e.g. absence of dams etc.)
- a measure of the energy of the river channel (slope/stream power)
- a morphological measure of the channel (river width/depth ratio)
- a measure of river substratum (e.g. index)
- a measure of low flow conditions (magnitude and duration)
- a measure of frequency and magnitude of high flows (spates)

For lakes elements according to the directive should include

- quantity and dynamics of water flow, level and residence time
- connection to groundwater bodies
- depth variation
- structure and substrate of the bed
- quantity of the bed
- structure of the shore

The un-impacted residence time as well as quantity and dynamics of water flow should be calculated based on information on the run-off data from the catchment in the un-impacted situation.

Presently data are not available for defining parametric reference values of hydro-morphological elements. The monitoring of the above-mentioned hydro-morphological variables is proposed to be part of the first monitoring of the reference stations for Latvian river and lake types.

Use of other tools.
The REFCOND guidelines recommend use of additional tools, to supplement use of existing databases, information on pressures and expert assessment, as appropriate to support the selection of reference stations or for calculation of parametric reference values. Within the present project the following methods have been investigated:

- a precise definition of catchment areas
- use of paleolimnology
- use of forecasting and hind-casting models

Delineation of catchment-borders of river and lake stations has been conducted for potential reference stations. This allows a description of catchment (pressures) based on GIS assessment of pressures using information on land-cover (e.g. CORINE), point-source outlet (water use permit database) from the LEA databases. It is recommended that a table be elaborated for each reference station (as well as for other proposed monitoring stations) describing the catchment regarding area, run-off characteristics, land use, population density, as well as situation of monitoring stations and access.

Presently no tradition for conducting Paleo-limnological research is established in Latvia, the use of this method as a tool for calculation of lake base-line conditions is not an option in Latvia.

Latvian experience of use of models for predicting baseline condition (cleared of pressures) is available. To support the selection of reference stations in rivers, calculations were conducted using a model developed in the "Daugava basin management plan project". For a detailed description please refer to annex 6.

The possibilities should be assessed to use a species index for zoo-benthos for Latvian rivers, as an alternative to the saprobic index presently used.

Common reference sites with neighbour countries.
The Refcond guidelines open the possibility to use common reference stations with neighbour countries. Within the project no specific proposals have been made, as suitable reference stations appear to be available for the majority of types of water bodies proposed. Contacts have been established to the competent authorities in Estonia and Lithuania.
Presently however the availability of potential reference stations in Latvia does not call for use of stations in neighbouring countries, as the difference in the selected typology between the Baltic states makes this complicated. An exception could be the river type 5.

It is recommended to cooperate on common monitoring of reference sites, because it can decrease the costs and optimise the collection of data.

5.4 CONCLUSIONS

Proposal for establishing a reference network.
The proposal for a reference network is elaborated on the basis of the screening of all stations by LEA, ranking the existing monitoring stations for compliance with the assumed reference condition (the 10% percentile of physico-chemical and biological parameters), and including an expert assessment of the catchment areas. Monitoring stations in each group corresponding to the types of water bodies have been analysed for compliance with the condition defined by the 10 percentile, and ranked in order of compliance with maximum number of parameters as well as an assessment of pressures. For each type of water body ideally 3 stations characterising reference conditions should be identified.

The specific approach for the groups included is:
Small rivers have been sorted according to chemical characteristics and saprobity index, and potential reference sites identified. This group has proved to be the most complicated, as the chemical data for small rivers are very fluctuating, this is especially the case in the spring period.

Long term river monitoring stations.
Rivers are grouped according to the quality of chemical data, and are presented in increasing order according to quality. Potential reference stations have been identified for all but one group.

Lakes
Lakes were divided in groups according to proposed typology;
the evaluation mainly has been based on nutrients (P-tot, N-tot), chlorofyl-a concentration, phytoplankton biomass, transparency using Secci disc. The position of each lake in the list is according to its arithmetic mean of points corresponding to compliance with the percentiles established (the lakes have been ordered in an increasing order).
Further the chemical data were compared and reviewed together with the pressure data, data on vertical distribution of oxygen and biological data (refer to the last columns).
The resulting identification of potential reference stations is presented the following tables:

River type	1	2	3	4	5	6
Number of potential reference sites	5	3	2	1	(1)	3

For the majority of types of rivers proposed, potential reference sites have been identified based on statistical analysis of existing monitoring data and an assessment of pressures resulting from land use and population density in the catchments area. For the river type 5, however this approach cannot be used to define reference condition, as only one monitoring station exists. Therefore another approach should be used, e.g. modelling or expert judgement.

Lake type	1	2	3	4	5	6	7	8	9	10
Number of potential reference sites	4	1	3	4	2	1	3	3	2	1

For all the types of lakes proposed in the draft CM regulation on typology potential reference sites have been identified based on statistical analysis of existing monitoring data and an assessment of pressures (land use and population density) in the catchment. For a list of the reference sites and a map of their location please refer to annex 2 and annex 3 respectively.

Reference values
The reference values for biological and physico-chemical parameters have been identified based on statistical analysis of existing monitoring data, supplemented with expert opinions, especially regarding biological parameters.
Lists of proposed parametric values are enclosed in annex 4 and annex 5.

Parametric values for hydro-morphological elements have not been defined in this study, as no monitoring of these parameters has taken place till now. However we know that some data is available in different Ministerial institutions. After completion of this study on reference conditions an additional task in the project has been carried out to collect this information. The result is shown in TR3, the action plan for establishment of the classification system. Collection of experience in this field should be given high priority in the coming monitoring programs for the reference sites.

Next steps and recommendations
The monitoring of the above-mentioned hydro-morphological variables is proposed to be part of the first monitoring of the reference stations for Latvian river and lake types
.
A point of special attention should be establishing a hydrological monitoring system, which will allow definition of the undisturbed hydrological regime for rivers and lakes, including contacts to ground water bodies

It is recommended to establish monitoring programs and research programs to allow determination of the other parametric values, especially fish in lakes and rivers and macrophytes in lakes.

It is recommended that description (table) be elaborated for each reference station (as well as for other proposed monitoring stations) describing the catchment regarding area, run-off characteristics, land use, population density, as well as situation of monitoring stations and access.

A suitable reference site for river type 1.5 should be identified, through modelling or co-operation with neighbouring countries.

6 REFERENCE CONDITIONS, COASTALWATER

6.1 Introduction

While preparing this chapter Latvian experts, all of them being well familiar with marine monitoring programme and marine environmental data, and participating in CHARM project work packages, received a task to formulate parameters for reference condition description within quality elements in their sphere of expertise. Where possible, experts were requested to give descriptions of reference conditions for Latvian coastal and transitional water types and establish metrics describing good ecological status. Experts were also requested to describe their reasoning and to identify information gaps if such exist.

Type specific reference conditions are to be established for the **biological** quality elements for that type of surface water at high status (COAST, 2003). Consequently, reference conditions are a description of the biological quality elements at high status. By this, the task reduces to quantifying parameters that describe high and good status.
As a first attempt, this chapter should be viewed rather as an exercise aiming to check the approach and assess to what extent information produced by the current monitoring practice meets the demands emerging during implementation phase of WFD, not as basis for drafting national normative documents.

Reference conditions should be described according to the definitions of the biological quality elements at high status in Annex V tables 1.2.3 and 1.2.4. of WFD. The definitions for transitional and coastal water appears in annex 1.

In addition to these biological quality elements, high status shall also be supported by the defined physio-chemical and hydro-morphological elements. (see annex 1).

A hierarchical approach for defining reference conditions is suggested using the various methods in the following order:

1. An existing undisturbed site or a site with only very minor disturbance; or
2. historical data and information; or
3. models; or
4. expert judgement.

Although, establishing of the reference network of really existing high status sites is the preferred approach for deriving reference conditions for transitional and coastal waters, it is most likely that no such sufficiently pristine sites could be found for majority of European coastal marine and transitional types. It is almost clear that no undisturbed sites usable for determining reference conditions for the Baltic types presently exist.

As a second option, it may be possible to use historical information to derive reference conditions if the historical data are of assured quality. If reference conditions are derived from historical conditions, these should be based upon the condition of water bodies at times of no or very minor anthropogenic influence. No single date can be used to determine the reference conditions.

Theoretically, a number of different modelling techniques may be used to derive reference conditions. These modelling approaches are, however, in the development phase, and degree of resolution and confidence limits for these models are questionable. Most statistical approaches need sufficiently rich historical and spatial data which is the major problem. Some attempts are being done, for instance, within the CHARM project for macrophytes, zoobenthos and phytoplankton.

In fact, as emphasised in CIS Guidance for transitional and coastal waters (COAST, 2003), expert judgement is required with all the above techniques: for example, use of historical data will require expert judgement in deciding which data are appropriate. In addition, robust predictive models can only be developed using data plus expert judgement. In the early stages of implementation of the Directive, expert judgement will be used alongside the development of classification tools to derive reference conditions consistent with the normative definitions.

In present exscersice, historical information in combination with expert judgement has been applied.

Definitions of classification classes for surface water bodies.

Definitions of the five ecological status classes are given in WFD, Annex V table 1.2. These are referred to as the normative definitions.

Annex V Table 1.2. General definition for rivers, lakes, transitional waters and coastal waters

High status

"There are no, or only very minor, anthropogenic alterations to the values of the physicochemical and hydromorphological quality elements for the surface water body type from those normally associated with that type under undisturbed conditions.
The values of the biological quality elements for the surface water body reflect those normally associated with that type under undisturbed conditions, and show no, or only very minor, evidence of distortion.
These are the type specific conditions and communities."

Good status

"The values of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity, but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions."

Moderate status

"The values of the biological quality elements for the surface water body type deviate moderately from those normally associated with the surface water body type under undisturbed conditions. The values show moderate signs of distortion resulting from human activity and are significantly more disturbed than under conditions of good status."

Poor status

"Water showing evidence of major alterations to the values of the biological quality elements for the surface water body type and in which the relevant biological communities deviate substantially from those normally associated with the surface water body type under undisturbed conditions, shall be classified as poor."

Bad status

"Water showing evidence of severe alterations to the values of the biological quality elements for the surface water body type and in which large portions of the relevant biological communities normally associated with the surface water body type under undisturbed conditions are absent, shall be classified as bad."

6.2 Biological quality elements

Following sub-chapters give examples of various parameters/indicators suggested for transitional and coastal waters of Latvia.

Phytoplankton

High status (reference condition) and good status criteria have been only described for the transitional water type in the southern part of the Gulf of Riga. Four types of coastal waters proposed earlier, in case of pelagic parameters may be in fact reduced to sets of classification criteria, since the two respective couples of types: one in the open Baltic coast, and other in the GULF OF Riga, differ exclusively by the bottom character. Coastal strip within ca. 1-mile distance has been seldom sampled and poorly represented in the monitoring programme; therefore, existing historical information and monitoring data are scarce. In future preparation for implementation of WFD it will be necessary to investigate to what extent data from the closest offshore observation points may be used for this purpose. Also data exchange and mutual inter-comparison will be necessary with the potentially similar coastal types in Lithuania (open Baltic coast) and Estonia (Gulf of Riga coast).

All three parameters (species composition, abundance and total biomass) are being suggested as descriptors for phytoplankton quality element as prescribed by WFD.
Transitional water close to the mouth of Daugava is being intensively sampled. Thus, each of the biological seasons (within productive period of April – November) may be distinguished and specific average values characterizing type-specific phytoplankton quality for each of the seasons may be obtained from monitoring data. All values given in the table below refer to the upper 10 m layer. Measurements are performed in accordance with the standard monitoring methods. Species composition is represented here as a biomass proportion of different phytoplankton taxonomic groups found in the samples. Total phytoplankton biomass is given as wet weight (cell bio-volume) calculated in according to monitoring methodology.

The data for high quality status are picked out from literature from 1908-1947 (Nikolaev, 1953; Nikolaev, 1957; Kalveka, 1980; Rudzroga, 1974a and Rudzroga, 1974b). Good quality status is calculated from long-term monitoring observations, to describe the tendencies of phytoplankton development.

Table: Phytoplankton values corresponding to the ecological status classes of transitional waters.
South-Eastern Gulf of Riga (transitional water)

No.	Parameter	Season	High status	Good status
1	Species composition	Spring	Bacillariophyceae (60-75% of total biomass): *Achnanthes taeniata, Thalassiosira spp., Aulacoseira spp., Chaetocerus spp., Nitzschia spp., Navicula spp., Sceletonema costatum, Diatoma spp., Fragillaria spp.,* etc.	Bacillariophyceae (35-55% of total biomass): *Achnanthes taeniata, Thalassiosira spp., Sceletonema costatum, Aulacoseira spp., Chaetocerus spp., Nitzschia spp., Navicula spp., Diatoma spp., Fragillaria spp.,* etc.
			Dinophyceae (20-30% of total biomass): *Peridiniella catenata, Protoperidinium spp., Gymnodinium spp., Glenodinium spp.,* etc.	Dinophyceae (35-45% of total biomass): *Peridiniella catenata, Protoperidinium spp., Gymnodinium spp., Glenodinium spp.,* etc.
			Others (5-10% of total biomass): *Scenedesmus spp., Pediastrum spp., Oocystis spp., Aphanizomenon flos-aquae, Teleaulax spp.,* etc.	Others (10-20% of total biomass): *Scenedesmus spp., Pediastrum spp., Oocystis spp., Aphanizomenon flos-aquae, Teleaulax spp., Ebria tripartita, Eutreptiella spp., Pyramimonas spp.,* etc.

		Summer	Cyanophyceae (60-80% of total biomass): N_2- fixing species (80-90% of Cyanophyceae biomass): *Aphanizomenon flos-aquae, Nodularia spumigena, Anabaena spp.,* etc. 2) Not-N_2-fixing species (10-20% Cyanophyceae biomass): *Snowella lacustris, Woronichinia compacta*, etc.	Cyanophyceae (40-60% of total biomass): 1) N_2- fixing species (60-80% of Cyanophyceae biomass): *Aphanizomenon flos-aquae, Nodularia spumigena, Anabaena spp.,* etc. 2) Not-N_2-fixing species (20-40% Cyanophyceae biomass): *Microcystis spp., Snowella lacustris, Woronichinia compacta, Merismopedia spp., Chroococcus spp.*, etc.
			Chlorophyceae (5-10% of total biomass): *Oocystis spp., Pediastrum spp., Scenedesmus spp.,* etc.	Chlorophyceae (10-15% of total biomass): *Oocystis spp., Pediastrum spp., Scenedesmus spp., Monoraphidium spp.*, etc.
			Bacillariophyceae (10-20% of total biomass): *Actinocyclus octonarius, Thalassiosira spp., Coscinodiscus spp., Aulacoseira spp., Chaetocerus spp., Diatoma spp., Asterionella spp.,* etc.	Bacillariophyceae (20-30% of total biomass): *Actinocyclus octonarius, Thalassiosira spp., Nitzschia spp., Skeletonema costatum, Coscinodiscus spp., Aulacoseira spp., Chaetocerus spp., Diatoma spp., Asterionella spp.,* etc.
			Others (5-10% of total biomass): Dinophyceae: *Dinophysis spp., Prorocentrum spp., Protoperidinium spp., Heterocapsa rotundata*, etc.	Others (10-15% of total biomass): Dinophyceae: *Dinophysis spp., Prorocentrum spp., Protoperidinium spp., Amphidinium spp., Heterocapsa rotundata, Gymnodinium spp*., etc. Cryptophyceae: *Teleaulax spp., Plagioselmis spp*., etc. Prasinophyceae: *Pyramimonas spp*., etc.
		Autumn	Bacillariophyceae (40-50% of total biomass): *Actinocyclus octonarius, Coscinodiscus granii, Chaetocerus spp., Thalassiosira baltica*, etc.	Bacillariophyceae (50-70% of total biomass): *Actinocyclus octonarius, Coscinodiscus granii, Skeletonema costatum, Chaetocerus spp., Thalassiosira baltica*, etc.
			Others (50-60% of total biomass): Cyanophyceae: *Aphanizomenon flos-aquae, Snowella spp., Woronichinia spp.,* etc. Dinophyceae: *Dinophysis spp., Protoperidinium spp., Heterocapsa spp., etc.* Chlorophyceae: *Pediastrum spp.,* etc.	Others (30-50% of total biomass): Cyanophyceae: *Aphanizomenon flos-aquae, Microcystis spp., Snowella spp., Woronichinia spp.,* etc. Dinophyceae: *Dinophysis spp., Protoperidinium spp., Ebria tripartita, Heterocapsa spp., etc.* Chlorophyceae: *Pediastrum spp.,* etc. Cryptophyceae*: Teleaulax spp., Plagioselmis spp*., etc. Euglenophyceae: *Eutreptiella spp., Euglena spp*., etc
2	Abundance	Spring	$1.5*10^6$-$3.0*10^6$ count.units/m^3	$3.0*10^6$-$4.5*10^6$ count.units/m^3
		Summer	$\geq 2*10^6$ count.units/m^3	$1*10^6$-$2*10^6$ count.units/m^3
		Autumn	$\leq 1.5*10^6$ count.units/m^3	$1.5*10^6$-$2.0*10^6$ count.units/m^3

3	Biomass	Spring	2000-7000mg/m^3	7000-14000mg/m^3
		Summer	≥1000mg/m^3	500-1000mg/m^3
		Autumn	≤1000mg/m^3	1000-3000mg/m^3

Underwater vegetation

WFD requires usage of data on composition and abundance of aquatic flora as descriptors for this quality element. Annex V 1.2.4. defines high status of coastal waters as such where "*All disturbance sensitive macroalgal and angiosperm taxa associated with undisturbed conditions are present.*" and " *The levels of macroalgal cover and angiosperm abundance are consistent with undisturbed conditions*". While presence of disturbance-sensitive macroalgal and angiosperm taxa are required for good status. Good status also accepts that *"macroalgal cover and angiosperm abundance shows slight signs of disturbance"*.

Information on temporal and spatial variability of coastal underwater flora is not sufficient to distinguish between the disturbance-sensitive and opportunistic species. To other hand, common ellgrass (*Zostera marina*, the most typical Baltic coastal underwater vascular plant species used in various classification schemes), is not characteristic for Latvian open sea and Gulf of Riga coast, therefore angiosperm abundance can not be used as parameter for this quality element. Consequently, the most feasible parameters will be those characterising the condition of macrophyte coverage – maximal depth distribution of specific key species. To certain extent, these species may be regarded as "disturbance - sensitive", thus the previous requirement is partly fulfilled as well.

The depth distribution of macroalgae is supposed to reflect water transparency conditions and the level of pelagic productivity (Kautsky, 1988). It also allows to assess the status of environmental conditions if the key species has decreased due to other reason, e.g. mass development of filamentous algae (Martin et al., 2003).

Macroalgae as a quality element can be used only in the stony coastal water types of Latvia, as the underwater habitat structure in the transitional waters and on soft sediments does not support growth of phytobenthos.

The use of the particular indicator for characterization of water body or for establishing potential reference areas depends greatly on available historical data and analysis of long-term changes. The relationship between water quality and the chosen indicators is of similar importance. In case of Latvia the best data coverage could be found for depth limit of *Fucus vesiculosus* and macroalgal community in the Gulf of Riga and depth limit of *Furcellaria lumbricalis* and macroalgal community at the coast of Baltic Proper. *F. vesiculosus* is known as a good and obvious example of direct response to eutrophication by decrease in abundance when water transparency declines (HELCOM, 1996), while *F.lumbricalis* forms up to 90% of macroalgal biomass at the open Baltic coast and avoids polluted areas (Trei, 1987).

Following these arguments depth limit of brown algae species *Fucus vesiculosus* is being suggested as a paremerte characterizing benthic macrophyte element in the Stony coasts of the Gulf of Riga and depth limit of red algae Furcellaria lumbricalis –characterizing Stony coasts of the Baltic Proper. In both coastal water types depth limit of distribution of the whole macroalgal community is used as indicator as well. The following table gives proposed range of values for these parameters corresponding to high and good biological status.

Table: Values of indicators for the ecological status classes of coastal waters

Stony coasts of the Gulf of Riga

Indicator	High	Good
Depth limit of *Fucus vesiculosus*	> 10 m	6 – 10 m
Depth limit of macroalgal community	> 11 m	10 – 11 m

Stony coasts of the Baltic Proper

Indicator	High	Good
Depth limit *Furcellaria lumbricalis*	15 - 20 m	10 – 15 m
Depth limit of macroalgal community, Baltic coast	15 - 22 m	10 – 15 m

For the Gulf of Riga values for the 'high' status class are based on data from early 1920s (Skuja, 1924). Values for the 'good' status class are based on data, collected in early 1970s – before the considerable reduction of water quality for *F.vesiculosus* – and compared with data from 1999 when the freshwater nutrient loading has been decreasing for almost 10 years.

For the Baltic Proper all values are based on data from 1998 as the earlier references (Korolev et al., 1993) have records of reduced algal depth limits and distribution due to tanker accident in this area. Maximal depth limit both for F.lumbricalis and for whole macrophyte community may possibly be higher, *i.e.* the algae can grow deeper as the suitable substrate is present down to the depth of 30 meters, but no data are available. There is an urgent need for additional surveys and investigations.

For assessment purposes the sampling of macroalgal community should be performed in August-September, using SCUBA diving for sample collection and supported by side scanning or remote video. The choice of sampling sites and sampling methods should be in accordance to HELCOM Guidelines for monitoring of phytobenthic communities elaborated especially for the Baltic Sea.

Macrobenthos

From the limited number of classification tools using benthic invertebrate fauna as a quality element, the integrated Biotic Index approach has been chosen and tested. This method is being Spain to establish the ecological quality of soft bottom benthos (Borja, 2000; Borja, 2003) and based on earlier investigations of Glemarec and Hily (1981, 1984, 1986). The index has been designed for use with in European estuarine and coastal environments. The UK has also started to test the Spanish classification tool within a number of estuaries and this work is to be continued over the forthcoming year (COAST, 2003).

The advantage of the method is that it combines both benthic invertebrate fauna abundance and its species composition in a single quantitative value that is sensitive enough to enable classification of water bodies.

Method is based in the assumption that the soft-bottom macrofauna could be ordered in five groups, according to their sensitivity to an increasing stress gradient (i.e. increasing organic matter enrichment). These groups have been summarized by Grall and Glémarec (1997), as outlined below.

Group I: Species very sensitive to organic enrichment and present under unpolluted conditions (initial state).

Group II: Species indifferent to enrichment, always present in low densities with non-significant variations with time (from initial state, to slight unbalance).

Group III: Species tolerant to excess organic matter enrichment. These species may occur under normal conditions, but their populations are stimulated by organic enrichment (slight unbalance situations).

Group IV: Second-order opportunistic species (slight to pronounced unbalanced situations). Mainly small sized polychaetes: subsurface deposit-feeders, such as cirratulids.

Group V: First-order opportunistic species (pronounced unbalanced situations). These are deposit-feeders, which proliferate in reduced sediments.

The Biotic Index (BI) method requires that the fauna of the community in question be grouped in accordance with the above formulations. For the Baltic, a list of abundant benthic macrofauna, species each incorporated into a specific sensitivity group, has been developed by H.Cederwall (pers. communication).

Ecological sensitivity groups of Baltic macro-invertebrate fauna.

Species	Group	Species	Group
Balanus improvisus	**II**	*Leptocheirus pilosus*	**III**
Bathyporeia pilosa	**I**	*Lymnaea peregra*	**I**
Bryozoa	**II**	*Macoma baltica*	**I**
Cerastoderma edule	**III**	*Manayunkia aestuarina*	**II**
Cerastoderma lamarcki	**III**	*Marenzellaria viridis*	**III**
Chironomidae	**IV**	*Mya arenaria*	**II**
Corophium sp.	**III**	*Mysidacea*	**II**
Corophium volutator	**III**	*Mytilus edulis*	**III**
Cyanophthalma obscura	**III**	*Nematoda*	**III**
Fabricia sabella	**II**	*Nemertea*	**III**
Gammarus locusta	**I**	*Oligochaeta*	**V**
Gammarus sp.	**I**	*Pontoporeia affinis*	**I**
Halicryptus spinulosus	**III**	*Pontoporeia femorata*	**I**
Harmothoe sarsi	**II**	*Potamopyrgus jenkinsi*	**II**
Hediste diversicolor	**III**	*Praunus inermis*	**I**
Hydrobia sp.	**III**	*Pygospio elegans*	**III**
Hydrobia ulvae	**III**	*Saduria entomon*	**III**
Hydrobia ventrosa	**III**	*Streblospio shrubsolii*	**III**
Idotea balthica	**II**	*Theodoxus fluviatilis*	**I**
Jaera albifrons	**I**	*Turbellaria*	**II**

The distribution of these ecological groups, according to their sensitivity to pollution stress, provides a biotic index with eight levels, from 0 to 7. A single formula was proposed based upon the percentages of abundance of each ecological group, within each sample, to obtain a continuous index (the Biotic Coefficient, BC):

$$BC=\{(0 \times \%GI) + (1.5 \times \%GII) + (3 \times \%GIII) + (4.5 \times \%GIV) + (6 \times \%GV)\}/100$$

where: %GI, %GII, %GIII, %GIV, %GV are percentage of abundance in each of ecological sensitivity groups.

Biotic index is then derived implicitly as a series of continuous values, from 0 to 6, being 7 when the sediment is azoic. This represents the benthic community "health", represented by the entire numbers of the Biotic Index. See table below.

Site Pollution classes derived from the Biotic Coefficient (COAST, 2003).

Site Pollution Classification	Biotic Coefficient	Biotic Index	Dominating Ecological Group	Benthic Community Health
Unpolluted	0.0 < BC ≤ 0.2	0	I	Normal
Unpolluted	0.2 < BC ≤ 1.2	1		Impoverished
Slightly Polluted	1.2 < BC ≤ 3.3	2	III	Unbalanced
Meanly Polluted	3.3 < BC ≤ 4.3	3		Transitional to pollution
Meanly Polluted	4.3 < BC ≤ 5.0	4	IV-V	Polluted
Heavily Polluted	5.0 < BC ≤ 5.5	5		Transitional to heavy pollution
Heavily Polluted	5.5 < BC ≤ 6.0	6	V	Heavy polluted
Extremely Polluted	Azoic	7	Azoic	Azoic

Software available from AZTI (www.azti.es) was used to test performance of the BI method on the Gulf of Riga data representing coastal and transitional water types. Comparison of recent data with relatively rich observation data of the late 40-ies and 50-ties allowed proposing classification scale based on benthic biotic index (see annex 7).

6.3 Chemical and physio-chemical quality elements

WFD, Annex V 1.1.3. and 1.1.4., gives similar lists of chemical and physio-chemical elements supporting biological elements for transitional and coastal waters, respectively:

General:

- Transparency
- Thermal conditions
- Salinity
- Oxygenation conditions
- Nutrient conditions

Specific Pollutants:

- Pollution by all priority substances identified as being discharged into the body of water
- Pollution of other substances identified as being discharged in significant quantities into the body of water.

Parameters describing the elements above are given in the table below

Table: Characterisation of parameters describing status of chemical and physico-chemical elements for transitional and coastal waters of Latvia.

No	Parameters	Season (months)
1.	Transparency (Secci depth, metres)	spring – summer (April – September)
2.	Oxygen content and saturation (ml/l; %)	summer (June – September)
3.	Phosphate concentration (µmol/l)	winter (late January – early February)
4.	Nitrate concentration (µmol/l)	winter (late January – early February)
5.	Silicate concentration (µmol/l)	winter (late January – early February)

Supplementary parameters/measurements

No	Parameters	Season (months)
1.	Total phosphorus	winter (late January – early February), spring (late April – early May) and

		summer (July – August)
2.	Total nitrogen	winter (late January – early February), spring (late April – early May) and summer (July – August)
3.	Phosphate	spring (late April – early May)
4.	Nitrate	spring (late April – early May)
5.	Silicate	spring (late April – early May)

Justification of the parameter choice.

- *Winter levels of phosphate, nitrate and silicate are necessary* to assess long-term trends and pre-spring nutrient conditions – including N:Si:P ratios – for phytoplankton growth.
- *Winter levels of total phosphorus and nitrogen* better represent the phosphorus and nitrogen pools for temporal trend estimations. However, the nutrient winter levels provide only rough knowledge on spring algae supply because riverine nutrient inputs during spring flood modify the marine nutrient pool (nitrogen, silicon) significantly.
- *Spring levels of phosphate, nitrate and silicate determine* nutrient limitation along the coastline and in the long term.
- *Spring and summer levels of total phosphorus and nitrogen are needed to* to follow up a seasonal nutrient enrichment pattern.
- *Oxygen content and saturation:* to assess a degree of oxygen deficiency.
- *Transparency:* to assess water turbidity caused predominantly by phytoplankton that determines light conditions for phytobenthos.
- *Temperature and salinity measurements* are most likely not the elements disturbed by antropogenic impact in transitional and coastal waters of Latvia (unless the impact of global change is not touched upon). Therefore, numeric values of these parameters will not contribute directly for classification of these water bodies. Still, these parameters are are necessary to calculate water oxygen saturation. They also allow following the water mass dynamics when interpretation of the monitoring data. In addition, the salinity value is useful for assessment of nutrient origin via nutrient-salinity plots.
- *Complementary physicochemical and nutrient measurements in the open Gulf* are necessary to explain environmental events and tendencies over the coastal areas.

Table: Values of physicochemical and nutrient indicators corresponding to the ecological status classes of coastal and transitional waters of the Gulf of Riga.

Eastern Gulf of Riga (stony coast)

No	Parameter	Season	High status	Good status
1	Transparency	summer	4.5-5.5 m	3.5-4.5 m
2	Oxygen	summer	> 6 ml/l; >95%	5.5-6.0 ml/l; >90%
3	Phosphate	winter	0.35-0.50 µmol/l	0.50-0.75 µmol/l
4	Total phosphorus	winter	0.50-0.70 µmol/l	0.70-1.00 µmol/l
5*	Nitrate	winter	3.0-4.5 µmol/l	4.5-8.0 µmol/l
5**	Nitrate	winter	5.5-8.0 µmol/l	8.0-12.0 µmol/l
6*	Total nitrogen	winter	7-11 µmol/l	11-19 µmol/l
6**	Total nitrogen	winter	9-13 µmol/l	19 (13?)-29 µmol/l

Western Gulf of Riga (predominantly sandy coast)

No	Parameter	Season	High status	Good status
1	Transparency	summer	5-6 m	4-5 m
2	Oxygen	summer	> 6 ml/l; >95%	5.5-6.0 ml/l; >90%
3	Phosphate	winter	0.25-0.45 µmol/l	0.45-0.65 µmol/l
4	Total phosphorus	winter	0.35-0.60 µmol/l	0.60-0.90 µmol/l
5*	Nitrate	winter	2.5-4.0 µmol/l	4.0-7.0 µmol/l
5**	Nitrate	winter	4.0-7.0 µmol/l	7.0-10.5 µmol/l
6*	Total nitrogen	winter	6-10 µmol/l	10-17 µmol/l
6**	Total nitrogen	winter	10-17 µmol/l	17-25 µmol/l

South-Eastern Gulf of Riga (transitional water)

No	Parameter	Season	High status	Good status
1	Transparency	summer	4-5 m	3-4 m
2	Oxygen	summer	> 6 ml/l; >95%	5.5-6.0 ml/l; >90%
3	Phosphate	winter	0.40-0.55 µmol/l	0.55-0.80 µmol/l
4	Total phosphorus	winter	0.55-0.75 µmol/l	0.75-1.10 µmol/l
5*	Nitrate	winter	3.5-5.5 µmol/l	5.5-9.0 µmol/l
5**	Nitrate	winter	6.5-9.0 µmol/l	9.0-13.0 µmol/l
6*	Total nitrogen	winter	8-13 µmol/l	13-22 µmol/l
6**	Total nitrogen	winter	16-22 µmol/l	22-31 µmol/l

Comments on calculations of the physicochemical and nutrient indicator values for the Gulf of Riga

- The data on the early 1960s are picked out as the reference values for water transparency.
- It is complicated to define the ecological quality classes for oxygen. Deviations from formulated good quality values will be dependent on the influence of oxygen-deficient deep waters in the coastal area during the observation period.
- Phosphate high status values are derived from the environmental conditions of 1957-1962 taken as the reference conditions.

- Two different approaches are used for nitrate. First, nitrate high status values (data with a one asterisk) are derived from the environmental conditions of 1957-1962. Second, nitrate high status values (data with two asterisks) are calculated according to the Redfield ratio by use of the borders defined for phosphate. The last approach is based on the assumption that in future N:P ratio on the inorganic nutrients will not return to the conditions of nitrogen deficiency.
- Probably, the environmental conditions of the 1930s have to be used as a high status indicator. Unfortunately, observations in the 1930s are sparse and do not cover the winter season.
- Total phosphorus and total nitrogen levels are calculated from phosphate and nitrate data, respectively applying the coefficient 1.37 for phosphorus and the coefficient 2.4 for nitrogen. These coefficients are found by use of the phosphorus and nitrogen data of 1991-2000 for the coastal area.
- The lower limits of the good ecological status are calculated by increase of an upper limit value by 50% and 65% in the case of phosphorus and nitrogen, respectively.
- Ecological status values for silicate are not showed because the silicate pool depends highly on main nutrient supply and can be calculated according to the relationships developed.

As described earlier the costal water types suggested for open Baltic coast of Latvia at no antropogenic stress (reference conditions) would not differ in pelagic community above sandy and stony bottom. Therefore a single set of chemical and physio-chemical parameter values is being proposed in the table below.

Table: Values of physio-chemical and nutrient indicators corresponding to the ecological status classes of open Baltic coastal water types of Latvia.

South-Eastern Baltic Proper (sandy and stony coasts)

No	Parameter	Season	High status	Good status
1	Transparency	summer	7.0-8.0 m	5.5-7.0 m
2	Oxygen	summer	>6.5 ml/l; >98%	6.0-6.5 ml/l; >95%
3	Phosphate	winter	0.15-0.30 μmol/l	0.30-0.50 μmol/l
4	Total phosphorus	winter	0.20-0.40 μmol/l	0.40-0.65 μmol/l
5	Nitrate	winter	2.0-4.0 μmol/l	4.0-6.5 μmol/l
6*	Total nitrogen	winter	6.0-12.0 μmol/l	12.0-19.5 μmol/l
6**	Total nitrogen	winter	6.5-13.0 μmol/l	13.0-21.0 μmol/l

Comments on the calculations of the physicochemical and nutrient indicator values for the Baltic Proper.

- The data on August 1961-1964 are used to characterise reference conditions.
- Like the Gulf of Riga, oxygen conditions along the coast of the Baltic Proper will be highly affected by temperature and salinity parameters and by water exchange. An anthropogenic forcing seems to be of secondary importance. Therefore, sudden drops in oxygen levels strongly below the good status boundary can be expected occasionally.
- The lower nutrient limits of good ecological status are calculated by increase of an upper limit value by 65%.
- Total phosphorus and total nitrogen levels are calculated from phosphate and nitrate data, respectively applying the coefficient 1.31 for phosphorus and the coefficient 3.0 for nitrogen (first version for total nitrogen marked by *). Total nitrogen values are also calculated from the total phosphorus data using the coefficient 32 (second version marked by **). These all calculations are based on the data of February 1992-1994.

- There are no historical nitrate data on the early 1960. Therefore, the nitrate values for this period are calculated by use of the corresponding phosphate data and the N:P ratio in the inorganic phase 12.4:1 derived from the nutrient conditions of February 1992-1994.

6.4 Concluding remarks and summary

One of the basic methodological questions is how to apply the set of multiple quality elements in assessing of status a single water body, especially, in a very probable case if the values of different quality elements give controversial class estimates. It is important to stress here that the "One Out, All Out" principle shall be applied while implementing the classification scheme This means that the ecological status of the water body equates to the lower status of either the biological quality elements or the physio- chemical elements.

Not all biological and chemical/physio-chemical quality elements required for identification of reference conditions and classification of four coastal water types and one transitional water type of Latvia was possible to describe here - mostly because of lack of the data. The following table gives summary of the present status in determining of reference conditions and classification for these water types.

Quality element	**Water body type**	
	Open Baltic sandy coast	***Open Baltic stony coast***
Biological		
Phytoplankton	Not described due to lack of direct monitoring. Surveillance and investigative monitoring must be established before developing of RBNP. Intercomparison with the similar type in Lithuania necessary. Occurrence of blooms too variable and dependant on climatic factors to be included as a parameter.	Does not differ from the sandy coast.
Macroalgae	Not relevant for soft bottom.	Parameter values on macroalgal coverage partly reflecting composition suggested for high (reference) and good status. Investigative monitoring necessary to derive more detailed composition descriptions.
Angiosperms	Angiosperms not present.	Angiosperms not present.
Benthic Invertebrate Fauna	Not described due to lack of direct monitoring. Surveillance and investigative monitoring must be established before developing of RBNP. Intercomparison with the similar type in Lithuania necessary.	Specific monitoring, not performed in Latvia, necessary to collect benthic invertebrate data on hard bottom.

Chemical/physico-chemical	***Open Baltic sandy coast***	***Open Baltic stony coast***
Temperature	No values proposed, suggested as supplementary parameter.	No values proposed, suggested as supplementary parameter.
Salinity	No values proposed, suggested as supplementary parameter.	No values proposed, suggested as supplementary parameter.
Transparency	Values characterizing high and good status proposed.	Values characterizing high and good status proposed.
Nutrients	Parameters defined; values characterizing high and good status proposed.	Parameters defined; values characterizing high and good status proposed.
	Gulf of Riga sandy coast	***Gulf of Riga stony coast***
Biological		
Phytoplankton	Not described due to lack of direct monitoring. Surveillance and investigative monitoring must be established before developing of RBNP. Intercomparison with the similar type in Lithuania necessary. Occurrence of blooms too variable and dependant on climatic factors to be included as a parameter.	Does not differ from the sandy coast.
Macroalgae	Not relevant for soft bottom.	Parameter values on macroalgal coverage partly reflecting composition suggested for high (reference) and good status. Investigative monitoring necessary to derive more detailed composition descriptions.
Angiosperms	Angiosperms not present.	Angiosperms not present.
Benthic Invertebrate Fauna	Composite biotic index based on species composition and abundance suggested as indicator. Values characterizing high (reference) and good status proposed. Macrozoobenthos biomass not suggested as parameter due to methodological uncertainties and high sensitivity to the sampling season.	Specific monitoring, not performed in Latvia, necessary to collect benthic invertebrate data on hard bottom.
Chemical/physio-chemical		
Temperature	No values proposed, suggested as supplementary parameter.	No values proposed, suggested as supplementary parameter.
Salinity	No values proposed, suggested as supplementary parameter.	No values proposed, suggested as supplementary parameter.
Transparency	Values characterizing high and good status proposed.	Values characterizing high and good status proposed.
Nutrients	Parameters defined; values characterizing high and good status	Parameters defined; values characterizing high and good

	proposed.	status proposed.
	Gulf of Riga transitional water	
Biological		
Phytoplankton	Parameters describing species composition, abundance and biomass of phytoplankton determined; parameter values for high (reference) and good status set. Occurrence of blooms too variable and dependant on climatic factors to be included as a parameter.	
Macroalgae	Not relevant for unstable soft bottom of the transitional water.	
Angiosperms	Angiosperms not present.	
Benthic Invertebrate Fauna	Composite biotic index based on species composition and abundance suggested as indicator. Values characterizing high (reference) and good status proposed. Macrozoobenthos biomass not suggested as parameter due to methodological uncertainties and high sensitivity to the sampling season.	
Chemical/physio-chemical		
Temperature	No values proposed, suggested as supplementary parameter.	
Salinity	No values proposed, suggested as supplementary parameter.	
Transparency	Values characterizing high and good status proposed.	
Nutrients	Parameters defined; values characterizing high and good status proposed.	

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7 GROUNDWATER

The Geological Survey of Latvia shall assess the status of the Latvian groundwater bodies, which have been delineated as part of the characterisation.

Classification of the quantitative status for groundwater bodies shall be done on basis of groundwater levels.

Classification of the chemical status for groundwater bodies shall be done on basis of electrical conductivity and concentrations of pollutants.

> Note:
> The classification of groundwater chemical status is only concerned with the concentrations of substances introduced into groundwater **as a result of human activities**. The concentration of substances in an undisturbed body of groundwater will not affect the body's status. However, naturally occurring substances released by human activities will be relevant to the assessment of status, and the spreading of natural anomalies (i.e. increasing concentrations) in near-by abstractions is also a subject for the classification of status.

Quantitative status of groundwater bodies shall be ascribed as good according to the following conditions:

7.1 Good quantitative status

The level of groundwater in the groundwater body is such that the available groundwater resource is not exceeded by the long-term annual average rate of abstraction.

In relation to surface waters, the level of groundwater is not subject to anthropogenic alterations such as would result in:

- failure to achieve the environmental objectives set for associated surface waters,
- any significant diminution in the status of such waters,
- any significant damage to terrestrial ecosystems which depend directly on the groundwater body,.

In relation to well fields (i.e. significant abstractions) the WFD allows permanent and temporary alterations to flow direction resulting from level changes, provided they occur in a spatially limited area. However, it is not allowed that such level changes cause saltwater or other intrusions or indicate a likely risk of such intrusions.

Good groundwater chemical status shall be ascribed as in the following.

7.2 Good chemical status

According to the WFD Annex V, article 2.3.2 groundwater is considered to be of good chemical status when the chemical composition of the groundwater body is such that:

> the concentrations of pollutants:
> - do not exhibit the effects of saline or other intrusions;
> - do not exceed the quality standards applicable under other relevant Community legislation in accordance with art. 17;

- are not such as would result in failure to achieve the environmental objectives specified under Article 4 for associated surface waters nor any significant diminution of the ecological or chemical quality of such bodies nor in any significant damage to terrestrial ecosystems which depend directly on the groundwater body;
- changes in conductivity are not indicative of saline or other intrusion into the groundwater body.

All the criteria must be satisfied for a body to achieve good groundwater chemical status. If not the body should be classified as poor groundwater chemical status.

So, evaluation of chemical status is in principle simple, as it by definition only requires a selection of

- a parameter (being part of the quality element)
- a limit value (standard - or threshold value)

but in practice it is highly complicated, because, due to natural variations, it has not been possible to present general groundwater chemical standards in the WFD. The consequence of this is described in more detail in chapter 7.2.2. (Regarding impact on surface waters, a separate threshold value might be calculated in cases where the inflow of groundwater to surface waters cause a risk for the quality of that surface water).

As mentioned in the box above, the natural concentrations as such are not an issue for the WFD, as it concerns only pollutants which are a result of human activities. However, when impacts of human activities are to be described, the natural variations must be known rather detailed, except for parameters where the background values are zero.

7.2.1 Parameters

Following the requirements of WFD the chemical status of GWB should be characterised using as a minimum the set of core parameters shown below:

- Conductivity
- pH
- Nitrate
- Ammonium
- Oxygen content

- Other parameters

Other parameters means that for groundwater bodies at risk the evaluation should include **also those parameters which cause this risk**. This risk is identified not only on basis of the threshold values, but also – or mainly - on the analysis of the pressures on the groundwater bodies.

EC or Electrical Conductivity is an indicator of changes in concentrations of electrically charged compounds. It is an indirect parameter in the sense that it reflects the sum of main ions in the water, and thus the conductivity will increase if a main ion increases in concentration. However, it does not tell *which* ion is increasing. The rate of increase will in some degree depend on the ion, as each main ion has a different electrical charge and therefore a different impact on the conductivity, and furthermore the absolute concentrations of ions are very different.

As an example, an increase of ammonium (in the range normally found, i.e. around 1 mg/l) will most likely be hidden in the variations between measurements, but an increase in chloride (in the range normally found) will show a clear increase in the conductivity.

The conductivity will be mostly affected by the following ions:

Kat ions: Calcium, Magnesium, Sodium and Potassium
Anions: Bicarbonate, Chloride, Sulphate, Nitrate

If a significant increase in conductivity is detected, it is necessary to follow up with specific analyses for the main ions in order to detect the reason for the increasing conductivity.

pH should always be measured in the field, as changes in the water quality due to aeration may change the value before the sample reaches the laboratory. Changes in pH should be followed up by specific analyses.

Nitrate is an indicator of excessive use of natural or artificial fertiliser on agricultural areas and is therefore also an indicator of vulnerability of the groundwater bodies. In well-protected and deep aquifers the background value will be zero.

Ammonium is an indicator of pollution, but it also occurs naturally in anaerobic aquifers, i.e. mostly in deep aquifers and well protected aquifers. Changes must therefore be analysed in detail in order to detect if they are caused by human activities.

The concentration of **oxygen** (also called DO for Dissolved Oxygen) in groundwater is not an indicator of pollution, and there are no requirements to the content in groundwater, but it illustrates the vulnerability and it shows whether the aquifer is aerobic or anaerobic, which is important for evaluation of the fate of other compounds in the groundwater.

In well-protected and deep aquifers the oxygen concentration will be zero, and in shallow, sandy aquifers the value may reach a few milligrams per litre. Oxygen is not commonly measured in groundwater, and there are strict requirements to the sampling procedure in order to obtain reliable results. It is important that such sampling procedures are followed; otherwise the results will not be useful.

Other parameters
For groundwater bodies at risk the monitoring programs shall also include the chemical compounds, which are causing this risk.

As an example monitoring for specific pesticides is relevant in areas where they are used, but as such analyses are relatively costly, they should initially be focused at groundwater bodies where they are most likely to be found, based on the assessment of pressures. This would comprise groundwater bodies where high concentrations of nitrates are found, and/or very vulnerable groundwater bodies with shallow aquifers and sandy topsoils). If they are not found in the most vulnerable groundwater bodies, then they are probably also not found in better protected groundwater bodies.

The parameters and the monitoring points to be included should be selected on basis of a ranking procedure emerging from analysis of pressures.

7.2.2 Threshold values

At the moment (November 2003) an EU groundwater standard exists only for two substances:

- Nitrate 50 mg/l
- Pesticides 0.1 µg/l

These limits must not be exceeded in order for the groundwater bodies to have good status.

Article 17 of the WFD says that the European Parliament and the Council shall present

- criteria for fulfilment of good groundwater chemical status
- criteria for the identification of trends

However, if such criteria have not been adopted at Community level by 22 December 2005, according to the WFD Lithuania and other Member States must establish these criteria individually by that date and present them to the Commission half a year later. The Commission will then evaluate which criteria can be used commonly in EU[2].

The draft groundwater daughter directive further suggests that threshold values be established by each Member State for the following substances, which may be introduced as a result of human activities:

Table 7.1: Minimum List of Substances suggested by the draft GW directive

Quality element	Threshold value
Naturally occurring:	
Ammonium Arsenic Cadmium Chloride Lead Mercury Sulphate	?
Man-made:	
Trichloroethylene Tetrachloroethylene	?

The existing Latvian groundwater monitoring data on some of these substances have been analysed, and a preliminary table of values is shown in annex 8.

Note:
For water works the quality of the treated water, which is supplied to the consumers, must fulfil the requirements given in Regulation No. 235, but for the untreated groundwater there are no specific requirements to naturally occurring parameters in existing legislation. The future EC directive on groundwater is expected to cover this in more detail.

When establishing threshold values it is recommended that the Maximum Permissible Values (MPV) for Drinking Water are considered, but only for the those substances, which are NOT removed or reduced by normal treatment, and only if the natural background is below the MPV. If the background value in a GW body exceeds the MPV, then a threshold value higher than the MPV must be established for that GW body.

Latvian threshold values and background values shall be developed for the assessment of groundwater bodies that are characterised as being at risk.

Naturally occurring substances

[2] According to the draft groundwater daughter directive, version Sept. 2003

The pollutants selected shall be chemical substances that may occur both naturally and as a result of human activities. Compliance with the requirements on good chemical status shall be based on threshold values, which shall take into account the risks posed by these pollutants for the groundwater body.

According to the draft groundwater daughter directive the threshold values can be established at the national level, at the level of the river basin district or at the level of body or group of bodies of groundwater.

For Latvia this could lead to a quite comprehensive table of threshold values, given the very big different background values in many of the GWB. However, for some parameters such individual threshold values for GWB would be more useful than general values at national level, because changes would be hidden in the natural geographical variation.

For example, if a common threshold value for sulphate is chosen for the whole of Latvia, it has to be very high in order not to designate GWB with natural high concentrations as poor (i.e. impacted by human activities). But a common high value on national level would mean that human impact in areas with low background value could not lead to poor quality, because the threshold value would be too high for those areas. This is the reason for the daughter directive's suggestion of individual threshold values for individual groundwater bodies[3].

The table below illustrates the suggested approach. Each of the first two columns would be subdivided according to the number of bodies and districts.

Table of threshold values to be established before 22.12.05

Naturally occurring:	**GWB**	**RBD**	**National**	**EU**
Nitrates				50 mg/l
Ammonium				-
Arsenic				-
Cadmium				-
Chloride				-
Lead				-
Mercury				-
Sulphate				-
Man-made:				
Trichloroethylene				-
Tetrachloroethylene				-
Pesticides				0.1 µg/l

The most appropriate approach for evaluation of regional changes in groundwater quality would be to compare present status of groundwater with the geochemical background composition, i.e. data collected before the human impact (groundwater extraction and pollution) in the region started. But of course this approach leads to a very limited amount of background data.

[3] The ideas presented by the revised draft (now common position) of the draft groundwater daughter directive became available during the autumn of 2003. Therefore it has not been possible to incorporate the ideas in most of the work which forms the basis of this note and which was carried out earlier. However, since the daughter directive will be an important tool in the future, the ideas are included here, as well as in the CM Regulation.

7.3 Lower objectives

When the impact of changes in **groundwater levels** is reviewed, the Geological Survey of Latvia shall identify those bodies of groundwater for which lower objectives are to be specified as a result of consideration of the effects of the status of the body on:

- (i) surface water and associated terrestrial ecosystems
- (ii) water regulation, flood protection and land drainage
- (iii) human development.

When the impact of pollution on **groundwater quality** is reviewed, the Geological Survey of Latvia shall identify those groundwater bodies for which lower objectives are to be specified because, as a result of the impact of human activity, the body of groundwater is so polluted that achieving good groundwater chemical status is infeasible or disproportionately expensive.

The status of the groundwater bodies shall then be assessed on basis of the revised objectives.

7.4 Interpretation and presentation of groundwater quantitative status

The results obtained from the monitoring network for a groundwater body or group of bodies shall be used to assess the quantitative status of that body or those bodies. Statistical methods relevant for the evaluation of monitoring data are described e.g. in the CIS guidance for groundwater.

The method for doing this shall comprise a map of groundwater levels for each groundwater body. The typical seasonal variations shall be determined for each groundwater body on basis of monitoring programmes. The trends shall be analysed taking the annual variation of precipitation into account.

If the groundwater level in a monitoring point shows a downwards trend (during several years), and this is not caused by low precipitation, the status shall be determined as poor. However, if a balance has been reached, the status may be good.

If a well field causes a significant depression cone – i.e. it shows a local impact on a surface water, or it shows a deteriorating chemical quality due to hydrological or geochemical imbalance - then this area may be defined as a sub-body with poor status, leaving the rest of the relevant groundwater body with a good status.

Example:
If the groundwater level is significantly lower (this has to be quantified in a case-by-case study) than the normal seasonal minimum, but without showing a downwards trend, then this indicates that there is a hydrological balance, and therefore the status may be determined as **good**, if the status of the surface waters in the catchment area is also good, but it must be determined as **poor** if the lower level causes a poor status of the surface waters.

The Geological Survey of Latvia shall provide a map of the resulting assessment of groundwater quantitative status, colour-coded in accordance with the following regime:

Good: green
Poor: red

7.5 Interpretation and presentation of groundwater chemical status.

In assessing status, the results of individual monitoring points within a groundwater body shall be aggregated for the body as a whole. For the parameters listed in 8, supplemented with the parameters in table 7.1 the mean value of the results of monitoring at each point in the groundwater body or group of bodies shall be calculated, and these mean values shall be used to demonstrate compliance with good groundwater chemical status.

Statistical methods relevant for the evaluation of monitoring data are described e.g. in the CIS guidance for groundwater[4].

The background concentrations normally found for some of the substances in Latvian groundwater, mentioned in annex 8, may be used as a support for determining the status. However, the list is incomplete and preliminary and should be updated when new data are available, and when new river basin management plans are elaborated, the list should be revised if necessary.

The Geological Survey shall use data from the groundwater monitoring programmes in order to identify long term anthropogenically induced upward trends in pollutant concentrations and the reversal of such trends. The base year or period from which trend identification is to be calculated shall be identified. The calculation of trends shall be undertaken for a body or, where appropriate, group of bodies of groundwater. Reversal of a trend shall be demonstrated statistically and the level of confidence associated with the identification shall be stated.

Examples:
If the background concentrations are not exceeded, and there is no upwards trend in the measured concentrations, the status can be determined as good.

If the background concentrations are exceeded, but there is no upwards trend in the measured concentrations, the status can be determined as good, but only if the exceeding values are not caused by human activities.

If there is a trend of increase in concentrations, caused by human activities, the status shall be determined as poor if the threshold values are exceeded, and good if they are not exceeded. It is recommended that the trend be reversed when the concentration exceeds the background value with 75% of the difference between the threshold value and the background value.

The Geological Survey of Latvia shall provide a map of groundwater chemical status, colour-coded as indicated below:

Good: green
Poor: red

The Geological Survey shall also indicate by a black dot on the map, those groundwater bodies which are subject to a significant and sustained upward trend in the concentrations of any pollutant resulting from the impact of human activity. Reversal of a trend shall be indicated by a blue dot on the map.

The Geological Survey shall present these maps in the river basin management plans.

[4] The EU Water Framework Directive: Statistical aspects of the identification of groundwater pollution trends and aggregation of monitoring results

8 MORE DETAILS ABOUT SURFACE WATER

8.1 Ecological status and chemical status

The Water Framework Directive article 2 defines the following:

“Good surface water status means the status achieved by a surface water body when both its ecological status and its chemical status are at least good”. (18)

“Good ecological status is the status of a body of surface water, so classified in accordance with Annex V.” (22)

“Good surface water chemical status means the chemical status required to meet the environmental objectives for surface waters established in Article 4(1)(a), that is the chemical status achieved by a body of surface water in which concentrations of pollutants do not exceed the environmental quality standards established in Annex IX and under Article 16(7), and under other relevant Community legislation setting environmental quality standards at Community level”. (24)

The approach is illustrated in the following simple diagram.

Biological quality elements

supported by

quality elements

and

general chemical quality elements
+ specific pollutants

↓

good ecological status

priority substances and “relevant” substances
under other directives

↓

good chemical status

↓

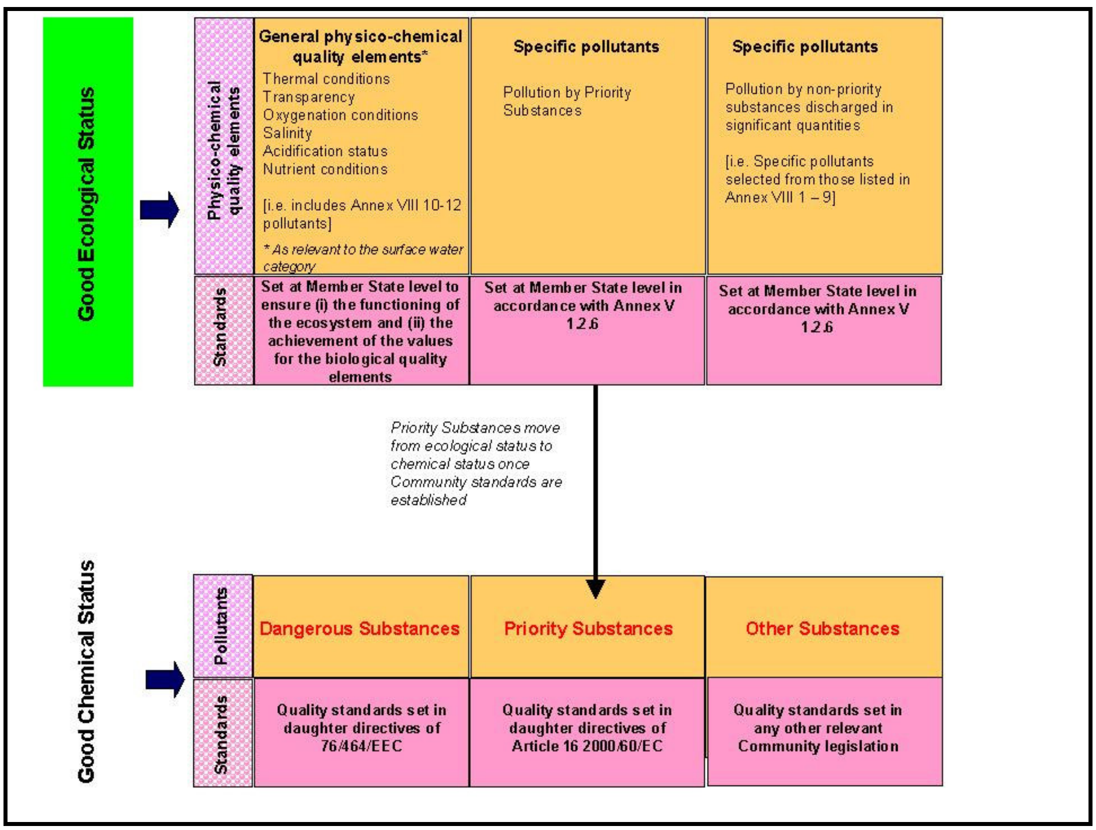
good status of surface waters

At high ecological status concentrations of specific *synthetic* substances are close to zero or at least below the detection limit, and the concentrations of specific *non-synthetic* substances are within the range associated with undisturbed conditions, i.e. at background levels. Some specific synthetic and non-synthetic substances have been designated as priority substances (incl. a subgroup of priority *dangerous* substances). For those substances Community measures shall be adopted according to WFD article 16, including the establishing of environmental quality standards (EQS). If the establishing of EQS at Community level is delayed, EQS shall be established at the national level (cf. WFD article 16.8 for details). The establishment of national EQS shall follow the procedures described in this report section 4.4.

Compliance with EQS established at the national level for specific synthetic and non-synthetic substances (priority substances or not) shall be included in the assessment of **ecological status**. Compliance with EQS established at Community level for priority substances shall be included in the assessment of **chemical status**. Moreover, under the Common Implementation Strategy it has been agreed that compliance with EQS established at Community level for priority substances shall *not* be included in the assessment of ecological status (some Member States and the Commission found that the WFD was unclear on this last point. The issue was discussed and Member States agreed as indicated).

The principle is shown in the figure below.

The relationship between good ecological status and good chemical status (CIS COAST).



The chemical status

The chemical status must be established for all bodies of surface water.

The requirements are set in Annex V of the WFD in point 1.4.3, which states that good chemical status is achieved through compliance with the following environmental quality standards:

Annex IX (18 substances, governed EU-wide by the Daughter Directive to Dangerous Substances Directive 76/464/EEC),
the 33 priority substances under Art. 16 and Annex X of the WFD, and
all other relevant Community regulations in which environmental quality standards are set.

These provisions demand compliance with diverse environmental quality standards. In particular, the conditions set under earlier water protection directives also have to be observed. An overview gives us the following environmental quality standards:

for 18 substances from List I of Directive 76/464/EEC (Daughter Directives)
pursuant to Nitrate Directive 91/676/EEC: 50 mg NO_3/l
the requirements of Fresh Waters Directive 78/659/EEC will be replaced from 2007 by the biological monitoring of fish fauna
the provisions of Directive 75/440/EEC concerning the quality required of surface water intended for the abstraction of drinking water in the Member States will be replaced from 2007 by environmental quality standards for the ecological status which also cover the standards for drinking-water abstraction.

The **priority substances** under the Water Framework Directive replace the list of candidate substances (132 substances and substance groups of Directive 76/464/EEC) contained in the Commission Communication of 22 July 1982. The Daughter Directive of Directive 76/464/EEC are not affected by this as long as they are not rescinded or amended. The environmental quality standards for the substances requiring EU-wide regulation cover all the protection aspects relevant to water management, i.e. not only the protection of aquatic biotic communities but also the protection of human health.

Among the priority substances, the so-called priority hazardous substances have special position: these substances or substance groups are particularly critical in terms of marine protection and other aspects. Their emissions, discharges and losses are to be gradually eliminated no later than 20 years after the adoption of EU-wide provisions for these substance in order to achieve the ultimate aim as defined in Art. 1 of the WFD, namely to ensure that their concentrations in the marine environment fall to values that remain at background levels for naturally occurring substances and fall close to zero for man-made synthetic substances.
A third group among the priority substances is still subject to possible revision; the classification as “priority” or “priority hazardous” will only be made after further information is available, but no later than one year after the priority list has been adopted (October/November 2002).

Compliance with the environmental quality standards will be checked by calculating annual mean values from all individual measurements per monitoring point (76/464/EEC). The test value for the environmental quality standards for priority substances will be set internationally (decision pending).

Chemical status is divided only into 2 classes: good and bad status and good status is defined as being less than the environmental quality standard.

A thematic map for “chemical status” is to be produced, presenting the pollution situation of water bodies and evaluating it in terms of the quality standards (defined pursuant to Annex IX, Art. 16 and all other pertinent regulations set by the Community).

Determinations of the EU committee on “Priority Substances” (drawing up Daughter Directives to the WFD to elaborate environmental quality standards and emission limits for the priority substances); results from the EU working group on “strategy papers on WFD implementation” on the subject of monitoring.

Classification and presentation of monitoring results (ecological and chemical status)
Reference to the Directive: Annex V, 1.4.2.

The ranking of the ecological status of bodies of surface water is made on the basis of assessments of quality elements classified as relevant, starting from the worst-case approach and giving special weight to the biological elements.

“High status” is achieved when the biological quality elements correspond to the reference conditions.

“Good status” occurs where the biological elements are classified as good and there is no exceedance of the environmental quality standards set by Member States for specific pollutants. Failures to meet the environmental quality standards lead to the downgrading of waters to the status of “moderate” even where good biological conditions occur.

“Moderate”, “poor” and “bad” status are defined purely in terms of the biological quality elements.

The map presentation of the ecological status of surface water bodies takes the form of colour-coding for the five status classes shown in bands. Artificial or heavily modified discrete and significant elements of a water (cf. 2.1.5 below) are classified into four classes with reference to the ecological potential and colour-coded analogously (the best class of “good and better” is presented – dispensing with the blue marking – in green for “high ecological status”; to distinguish them from natural waters, the respective blocks of colour are marked with dark-grey stripes (for heavily modified bodies of surface water) or light-grey stripes (for artificial bodies of surface water).

If good ecological status / good ecological potential is not achieved due to an exceedance of environmental quality standards for specific pollutants, the respective water bodies shall also be marked with black dots.

Chemical status is determined on a yes/no principle as follows: If all the environmental quality standards for priority substances under the Daughter Directives of Directive 76/464/EEC and the Nitrate Directive are achieved (cf. chap. 2.1.2), the chemical status is classified as “good” and the body of surface water is marked in blue on the required map. But even if one quality target is not reached, the chemical status must be classified as “not good” and coded accordingly in red. The same approach shall also be applied to the chemical status of artificial and heavily modified bodies of surface water.

8.2 Provisional classification and designation of artificial or heavily modified bodies of surface water

Reference to the Directive: Article 2(8)+(10), Article 4 (1 a iii)+(3) and Annex V nos. 1, 2, 3, Article 5 (1) and Annex II.

Article 4 (3) prescribes that the designation of an artificial or heavily modified water body is presented and justified in the management plan required under Article 13. While the final designation of these heavily modified water bodies must be carried out by 2008/9 and reviewed every 6 years, bodies of surface waters in the categories rivers, lakes, transitional waters and coastal waters (see No. 112) must already be provisionally identified as artificial surface water bodies or heavily modified surface water bodies pursuant to Annex II of the WFD, by 2004. The provisional identification as “heavily modified” is undertaken where necessary for those bodies of water which are not expected to achieve good ecological status due to hydromorphological interventions and are, in their physical character, heavily modified. Subsequently, a study must be made by 2008/9 of the necessary improvement measures to achieve good ecological status and their impacts on uses, and other environmental options are to be examined (Article 4, (3), a, b). The findings of this study will determine the final designation or non-designation of a water body.

Under Article 2 (8) of the WFD an "artificial water body" means a body of surface water created by human activity. We have here a surface water body that was created at a site where no water body previously existed. An artificial water body has, moreover, been created neither by the direct physical alteration of an existing water body nor by its repositioning or levelling. Where an existing water body has been altered or relocated (i.e. to a site that had previously been dry land), it should be classified, if appropriate, as heavily modified and not as artificial. The same applies to water bodies that have been assigned to another category as a result of physical alterations. Such water bodies (e.g. impounded lakes crated from a river by damming) are to be classified as heavily modified water bodies and not as artificial water bodies. The category of artificial bodies of surface water includes, for instance:

- canals built for the purposes of navigation, for hydropower uses and for irrigation and drainage, which meet the above conditions,
- lakes formed in pits, quarries and open-cast mines, ponds,
- impounded reservoirs and artificial storage basins fed by transferred water,
- docks.
-

These surface waters can be designated as artificial water bodies, but they do not have to be so designated. Under certain conditions they may also be classified as natural water bodies (e.g. old lakes formed in mining landscapes. Artificial bodies of surface water are, however, certainly not natural waters that have been modified by hydroengineering measures, e.g. to become canals or reservoirs. These are usually to be regarded as heavily modified water bodies. Thus, artificial water bodies cannot, by definition, be designated as heavily modified water bodies.

All other bodies of surface water are first to be treated as natural waters, and their reference condition should be set in accordance with high ecological status.
If it can be demonstrated that an ecological status of at least “good” can be achieved as part of the management plan within 15 years of the WFD entering into force, a designation of the water/body of surface water as heavily modified is not possible.

However, bodies of surface water which are being considered for classification as heavily modified must be provisionally classified as such by 2004. A heavily modified body of water is, under Article 2 No. 9 of the WFD, "a body of surface water which as a result of physical alterations by human activity is substantially changed in character".

Should the environmental objective of “good ecological status” under Art. 4 not be achievable in an designated body of surface water, we must then examine whether the reason for the failure to meet targets does in fact lie in anthropogenic physical changes. If this is the case, and if the conditions defined in Art. 4 (3) a and b (negative effects, technically unfeasible, disproportionate costs, ...) are not fulfilled, the water or body of surface water may be designated as heavily modified.

The designation of heavily modified bodies of surface water therefore occurs as the final step of an examination. Thus, an initial and provisional classification of bodies of surface water as “heavily modified” should be made in the course of the inventory by 2004, and the formal designation by 2008/9. The designation shall be subject to regular reviews every six years. Unlike the case of natural water bodies, the reference condition for artificial or heavily modified bodies of surface water is the “maximum ecological potential” (review every six years).The maximum ecological potential is derived from the water body type which is most similar to the body of surface water. In view, e.g. of the continuity of the water body, this is the best possible status that could be achieved after taking every appropriate measure that would be attainable (cf. Annex V, WFD). As an objective, the good ecological potential deviates only slightly from the maximum ecological potential in terms of biology.

As for the assessment of chemical status, the same requirements apply to artificial and heavily modified bodies of surface water as to natural water bodies.

The CIS Working Group 2.2 HEAVMOD has produced guidance for the identification and designation of heavily modified and artificial waters that was adopted by EU Water directors in November 2000 in Copenhagen. Artificial and heavily modified surface water bodies are to be designated in accordance with these guidelines. Practical examples of preliminary classification and of designation can be found in a synthesis of 34 European case studies and a collection of examples (toolbox).

The work of characterising waters under Annex II involves a preliminary classification of heavily modified bodies of surface water, while the final designation shall only be made after various checks have been carried out as part of the production of the first management plan. The artificial or heavily modified bodies of surface water are to be established in accordance with the criteria via a series of steps, bearing in mind that a distinction must be made between preliminary classification and the actual designation.
1st step: Survey to identify water bodies

2nd step: Designating bodies of surface water created by human activity as artificial waters (continues at step 8)

3rd step: "Screening" – exclusion of water bodies without hyromorphological alterations from the further process of designation (for the objective of good ecological status)

4th step: Establishing water bodies with significant hydromorphological alterations (according to structure classes 6 and 7) and description of these significant alterations

5th step: Identifying surface water bodies that might fall short of good ecological status due to significant hydromorphological alterations (check whether the type-specific "biology" is correct)

6th step: Preliminary classification as "heavily modified" if water bodies have been significantly altered in character in the form of physical changes resulting from human interventions.

7th step: Determining improvement measures that would be needed to achieve good ecological status. Examining whether these measures have significant impacts on the environment in the broad sense or on the "uses listed" (if no negative impacts , the objective will be good ecological status)

8th step: Examining whether the uses cannot be realised by other, much better environmental options if these are technically feasible and not unreasonably expensive (if yes, then the objective will be good ecological status; for artificial waters, optimised ecological potential)

9th step: Designating heavily modified or artificial bodies of surface water in the management plan by 2008/9 (review every six years)

10th step: Defining the maximum ecological potential, by including all measures to limit ecological damage in the calculation which ensure the best approximation to ecological continuity (migration of fauna, appropriate spawning and growth habitats)

11th step: Defining good ecological potential where only a minor deviation of the biological parameters from the maximum ecological potential is calculated.