BRITISH STANDARD

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Water quality — Guidance standard on determining the degree of modification of river hydromorphology

ICS 13.060.45

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National foreword

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Contents

Page

Foreword

This document (EN 15843:2010) has been prepared by Technical Committee CEN/TC 230 “Water analysis”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2010, and conflicting national standards shall be withdrawn at the latest by July 2010.

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Introduction

This European Standard will enable broad comparisons to be made of river hydromorphological modifications throughout Europe (e.g. for reporting by the European Environment Agency). The assessment of river "quality" in Europe has evolved over the past 20 years. From its original focus on organic pollution it now relies on methods for analysing a range of chemical and biological attributes. More recently, several European countries have developed systems for evaluating the hydromorphological features of rivers. The EC Water Framework Directive (WFD) has reinforced the need for this broader view of river "quality" through its requirement for determining "ecological status" based on macrophytes, phytobenthos, invertebrates and fish. The Directive also requires that hydromorphological and physico-chemical conditions should be suitable for supporting biological communities, although hydromorphology is only classified at high status. EN 14614, *Water Quality — Guidance standard for assessing the hydromorphological features of rivers* describes a protocol for field survey and feature recording, whereas this standard gives guidance on assessing the modification of river hydromorphological features. It focuses especially on human pressures that affect rivers; thus, it may be helpful for implementing the WFD by indicating the extent to which these pressures might have caused a departure from hydromorphological reference conditions. Although the procedure described in this standard enables the hydromorphological characterization of rivers, it does not attempt either to describe methods for defining high status for hydromorphology under the WFD or to link broadscale hydromorphological classification to assessments of ecological status. In addition to its relevance to the WFD, this standard has applications also for nature conservation, environmental impact assessment, river basin management, flood risk assessment (e.g. the EC Floods Directive) and setting targets for river restoration work.

1 Scope

This European Standard provides guidance on characterizing the modifications of river hydromorphological features described in EN 14614. Both standards focus more on morphology than on hydrology and continuity, and on lateral and longitudinal continuity rather than on vertical continuity which is difficult to measure. This standard will enable consistent comparisons of hydromorphology between rivers within a country and between different countries in Europe, providing a method for broad-based characterization across a wide spectrum of hydromorphological modification of river channels, banks, riparian zones and floodplains. Its primary aim is to assess "departure from naturalness" as a result of human pressures on river hydromorphology, and it suggests suitable sources of information (see Table A.1) which may contribute to characterizing the modification of hydromorphological features.

In doing so, it does not replace methods that have been developed for local assessment and reporting. Decisions on river management for individual reaches or catchments require expert local knowledge and vary according to river type.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 14614, *Water quality — Guidance standard for assessing the hydromorphological features of rivers*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
aquatic macrophytes
larger plants of fresh water which are easily seen with the naked eye, including all aquatic vascular plants, bryophytes, stoneworts (Characeae) and macro-algal growths

NOTE This definition includes plants associated with open water or wetlands with shallow water.

[EN 14614:2004, 2.1]

3.2
attribute
specific recorded element of a hydromorphological feature (e.g. "boulders" and "silt" are substrate attributes; "sheet piling" and "gabions" are attributes of engineered banks)

[EN 14614:2004, 2.2]

3.3
bank
permanent side of a river or island, which is above the normal water level and only submerged during periods of high river flow

[EN 14614:2004, 2.4]

NOTE In the context of this European Standard, the top is marked by the first major break in slope, above which cultivation or development is possible.

3.4
berm
natural or artificial shelf within a river that is exposed above water level during low flows, but is submerged during high flows

[EN 14614:2004, 2.6]

3.5
bog
wetland, fed by atmospheric precipitation, in which the vegetation communities (frequently dominated by *Sphagnum* mosses) form peat over long periods of time

[EN 14614:2004, 2.7]

3.6
braiding
course of a river naturally divided by deposited sediment accumulations, characterised by at least two channels which often change their course regularly

[EN 14614:2004, 2.8]

3.7
compaction
consolidation of the river bed through physical, chemical or biological processes

[EN 14614:2004, 2.10]

3.8
culvert
arched, enclosed or piped structure constructed to carry water under roads, railways and buildings

3.9
ecological status
expression of the quality of the structure and functioning of aquatic ecosystems, expressed by comparing the prevailing conditions with reference conditions

NOTE As classified in accordance with Annex V of the EC Water Framework Directive.

[EN 14614:2004, 2.12]

3.10
floodplain
valley floor adjacent to a river that is (or was historically) inundated periodically by flood waters

[EN 14614:2004, 2.14]

3.11
gabion
wire basket containing stones, used for river-bed or bank protection

[EN 14614:2004, 2.16]

3.12
hard materials/engineering
bank protection using artificial materials such as concrete, sheet piling or bricks

NOTE See "soft materials".

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3.13
hydromorphology
physical and hydrological characteristics of rivers including the underlying processes from which they result

[EN 14614:2004, 2.18]

3.14
hydro-peaking
rapid and frequent fluctuations in flow resulting from hydropower generation to meet peak demands in electricity

3.15
lateral connectivity
freedom for water to move between the channel and the floodplain

[EN 14614:2004, 2.19]

3.16
lateral movement
freedom for a river channel to move across a floodplain

[EN 14614:2004, 2.20]

3.17
planform
view of river pattern from above (e.g. sinuous, straight)

[EN 14614:2004, 2.22]

3.18
reach
major sub-division of a river, defined by physical, hydrological, and chemical character that distinguishes it from other parts of the river system upstream and downstream

[EN 14614:2004, 2.25]

3.19
reference conditions
conditions representing a totally undisturbed state, lacking human impact, or near-natural with only minor evidence of distortion

NOTE For waters not designated as heavily modified or artificial, synonymous with "high ecological status" in the Water Framework Directive.

[EN 14614:2004, 2.26]

3.20
regrading
river widening and deepening and modifying the bed and bank profiles to accommodate increased flows

3.21
reinforcement
strengthening of river beds and banks for various purposes (e.g. ford construction, erosion control) using materials such as boulders, sheet piling, geotextiles, etc.

3.22
residual flow
flow remaining in a river after abstraction (e.g. for hydropower generation, water supply, etc.)

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NOTE A minimum residual flow may be set to protect downstream uses, below which abstraction is not permitted.

3.23
riparian zone
area of land adjoining a river channel (including the river bank) capable of directly influencing the condition of the aquatic ecosystem (e.g. by shading and leaf litter input)

[EN 14614:2004, 2.29]

NOTE In this European Standard, the term "riparian zone" does not include the wider floodplain.

3.24
river type
group of rivers that can be broadly differentiated from other groups on the basis of their physical and chemical characteristics (e.g. lowland chalk streams; upland ultra-oligotrophic rivers)

[EN 14614:2004, 2.32]

3.25
sheet piling
material used for vertical bank protection (e.g. corrugated metal sheets)

[EN 14614:2004, 2.34]

3.26
sinuosity
degree of deviation from a straight line, defined as channel length/valley length

[EN 14614:2004, 2.36]

3.27
soft materials/engineering
bank protection using biodegradable materials such as brushwood, reeds or live willows

NOTE See "hard materials".

3.28
substrate
material making up the bed of a river

[EN 14614:2004, 2.40]

3.29
weir
structure used for controlling flow and upstream surface level, or for measuring discharge

[EN 14614:2004, 2.41]

3.30
willow spiling
method of soft engineering used for strengthening river banks using retaining walls constructed of woven willow stems from which trees will sprout

3.31
woody debris
dead woody material that falls into rivers and streams, ranging in size from leaf fragments (fine woody debris) to branches or whole trees (coarse woody debris)

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4 Principle

4.1 A standard protocol is described for assessing the extent to which the hydromorphological features of river channels, banks, riparian zones and floodplains are modified. These features have been divided into two groups – a larger group of "core features" and a smaller group of "subsidiary features". Core features are used to establish "departure from naturalness" as a result of human pressures on river hydromorphology. Subsidiary features also include some that contribute to habitat quality assessment. The former can be determined without reference to river type using data from field survey, remote sensing, maps or local knowledge, whereas the latter require an understanding of the features to be expected in different types of river.

Both this European Standard and EN 14614 focus attention on river features as surrogates for river processes. Those making assessments, therefore, do not need to be trained geomorphologists, although some geomorphological input may be useful in determining the contribution made by subsidiary, type-specific features.

4.2 The principal output from this standard is an assessment of the modification of hydromorphological features of an entire river reach. A definition of the term "river reach" and its relationship with survey units is given in EN 14614. However, the principles in the standard may also be applied to much shorter stretches, such as those requiring restoration, or where near-natural conditions need to be protected.

4.3 To ensure consistency in approach, the main feature categories are the same as those in EN 14614. However, some minor adjustments have been made to the details to help facilitate scoring.

5 Determining the hydromorphological modifications of rivers

5.1 Feature categories

Assessments are made for all of the feature categories listed in EN 14614, some of which have been sub-divided into core and subsidiary features (Table 1).

Table 1 — Categories of "core" and "subsidiary" features for determining modification

Category	Core	Subsidiary
1. Channel geometry		
1a Planform	✓	
1b Channel section (long-section and cross-section)	✓	
2. Substrates		
2a Extent of artificial material	✓	
2b "Natural" substrate mix or character altered		✓
3. Channel vegetation and organic debris		
3a Aquatic vegetation management		✓
3b Extent of woody debris if expected		✓
4. Erosion/deposition character		✓
5. Flow		
5a Impacts of artificial in-channel structures within the reach	✓	
5b Effects of catchment-wide modifications to natural flow character	✓	

Table 1 (*continued*)

Category	Core	Subsidiary
5c Effects of daily flow alteration (e.g. hydropeaking)	✓	
6. Longitudinal continuity as affected by artificial structures	✓	
7. Bank structure and modifications	✓	
8. Vegetation type/structure on banks and adjacent land	✓	
9. Adjacent land-use and associated features	✓	
10. Channel-floodplain interactions		
10a Degree of lateral connectivity of river and floodplain	✓	
10b Degree of lateral movement of river channel	✓	

5.2 Procedure for scoring

5.2.1 Annex A sets out guidance on how to allocate scores for each feature category. Table A.1 contains two separate procedures for scoring − using score band A with quantitative data, or score band B with qualitative data. Score band A is a five-point scale (1 = lowest degree of modification, 5 = highest degree of modification). Score band B is a three-point scale (1, 3, 5; following the same general approach as for score band A). Users should state which scores have been assigned based on quantitative data and which on qualitative descriptions, as this determines the degree of confidence in the assessment. This note should also be added to any maps produced that show the results of river hydromorphological assessment. An attribute should be left unscored where the user is not confident in allocating a score.

5.2.2 Where the majority of scores have been derived from five-band scales users may wish to retain the five bands. Where the majority have been derived from three-band scales users may wish to change the five-band scores to three-band scores as follows:

Five-band score	Three-band score
1	1
2	1
3	3
4	5
5	5

5.2.3 For those features where scoring 1 = 0 % to 5 % change (features 1, 2a, 7, 8, 9, 10), an asterisk should be added (i.e. 1*) where the recorded change is only 0 % to 1 %. This is to highlight river reaches with extremely low levels of modification. A ☠ symbol should be added (i.e. 5☠) to indicate extreme levels of modification.

5.2.4 The importance of each of the features in Table 1 for geomorphological and ecological functioning will not be the same. However, at present there is insufficient scientific evidence to justify differential weighting of the scores allocated.

6 Interpreting and reporting hydromorphological modifications

6.1 Modification scores

6.1.1 Scores should be tabulated as shown in Table 2. This process provides a range of options for different purposes, but shows clearly how each of the three combined scores (options 2, 3 and 4 in Table 2) has been derived.

Table 2 — Options, applications and procedures for reporting hydromorphological modification scores

Reporting option	Examples of applications	Procedure
1: Tabulate 16 scores separately	Providing maximum amount of information for river management	Score as in Annex A for all features (1a, 1b, 2a, 2b, 3a, 3b, 4, 5a, 5b, 5c, 6, 7, 8, 9, 10a, 10b); do not combine.
2: Create a three-digit code	Reporting river modification within the three main hydromorphological quality elements given in the WFD (morphology, flow regime, and longitudinal continuity) but with no attempt to link hydromorphology with biology	Combine the scores for categories 1a, 1b, 2a, 2b, 7, 8, 9, 10a, 10b to create a single mean score for morphology (the first of the three digits). Scores should be rounded up or down to the nearest integer (rounding up any that end in ,5) Report the score for category 5 for flow (the second of the three digits) using 5a, 5b or 5c, whichever has the higher score (i.e. represents the greater impact). Report the score for category 6 for longitudinal continuity (the third of the three digits). [For example, a code of 111 would indicate a river with the lowest degree of morphological modification, near-natural flow, and with no structures inhibiting upstream and downstream movement of sediment and biota.]
3: Group features according to zone	Reporting on the three main river zones: "channel", "banks/riparian zone" and "floodplain", as recommended in EN 14614.	Feature categories should be grouped as follows and mean scores calculated for the three zones. Scores should be rounded up or down to the nearest integer (rounding up any that end in ,5): Channel: 1a, 1b, 2a, 2b, 5a, 5b, 5c, 6 Banks/riparian zone: 7, 8 Floodplain: 9, 10a, 10b
4: Produce a single score for the reach assessed	Reporting overall hydromorphological modification of a river reach without the detail	Take the mean of the 16 scores (see no. 1 in table). Round up or down to the nearest integer. Scores ending in ",5" should be rounded up.

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6.2 Assigning classification terms

6.2.1 Where five classes are used, the following terms should be assigned to descriptions of hydromorphological modification, and represented (if required) on a map using the colour codings recommended in EN 14614.

Table 3 — Classification terms for five classes

Score	Class	Description	Map colour
1 to < 1,5	1	Near-natural	Blue
1,5 to < 2,5	2	Slightly modified	Green
2,5 to < 3,5	3	Moderately modified	Yellow
3,5 to < 4,5	4	Extensively modified	Orange
4,5 to 5,0	5	Severely modified	Red

6.2.2 Where three classes are used, the following terms should be assigned to descriptions of hydromorphological modification, and represented (if required) on a map using the following colour codings:

Table 4 — Classification terms for three classes

Score	Class	Description	Map colour
1 to < 2,5	1	Near-natural to slightly modified	Blue
2,5 to < 3,5	3	Slightly to moderately modified	Yellow
3,5 to 5,0	5	Extensively to severely modified	Red

The names used to describe each class (e.g. "near-natural") have been deliberately chosen to be different from terms used in the WFD (e.g. "high", "good") to emphasise that classifications using this standard are unrelated to classifications of ecological status for the WFD. Although the five colours listed in 6.2.1 for reporting hydromorphological modification are the same as those in the WFD, they are also used routinely for reporting other (non-WFD) aspects of environmental quality.

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Annex A
(normative)

Characterization of river modification based on hydromorphological features

Explanation for Table A.1:

"Core features" (shown in roman type): those that may be evaluated without reference to river type.

"Subsidiary features" (shown in italics): require expert judgement (in some cases geomorphological).

The score for each feature should be given an "A" or "B" suffix according to which of the two score bands has been used.

N/A = Not applicable.

Table A.1 — Protocol

	Features assessed	Score band A – Quantitative	Score band B – Qualitative	Guidance	Examples of suitable methods/data use
1. Channel geometry	**1a: Planform** (reach-based)	1 = 0 % to 5 % of reach length with changed planform. 2 = > 5 % to 15 % of reach length with changed planform. 3 = > 15 % to 35 % of reach length with changed planform. 4 = > 35 % to 75 % of reach length with changed planform. 5 = > 75 % of reach length with changed planform.	1 = Near-natural planform. 3 = Planform changes throughout part of the reach. 5 = Planform changed in majority of reach, or reach completely, or almost completely, straightened.	In this context, "planform" both to changes in channel sinuosity and to changes in channel braiding or to multiple channels. If possible, use absolute or recorded amounts of change rather than estimates from variety of sources. Where a river has some artificial sinuosity, but has lost its natural meandering, assign score 5.	— Consult maps and compare historical with present-day planform where changes have resulted from engineering, etc. (includes loss of braiding, etc.) (1a/1b). — Engineering construction and maintenance work records (1a/1b). — Local/management personnel/expert assessment (1b). — Survey data (e.g. evidence of regrading), structures installed (e.g. deflectors) (1b). — Knowledge of changes to width/depth ratios (1b).
	1b: Channel section (long-section and cross-section) (use site and other data and combine for whole reach) If no data for 1b, the score for Channel geometry is 1a by itself. Keep two elements separate; take worse case	1 = 0 % to 5 % of reach length with changed channel section. 2 = > 5 % to 15 % of reach length with changed channel section. 3 = > 15 % to 35 % of reach length with changed channel section. 4 = > 35 % to 75 % of reach length with changed channel section. 5 = > 75 % of reach length with changed channel section.	1 = Near-natural. No, or minimal, change in cross- and/or long-section. 3 = Moderately altered. Channel partially affected by one or more of the following: regrading, reinforcement, culvert, berm, or clear evidence of dredging causing some changes in width/depth ratio. 5 = Greatly altered. Channel predominantly affected by one or more of the following: regrading, reinforcement, culvert, berm, or clear evidence of dredging causing major change in width/depth ratio.		

Table A.1 (*continued*)

	Features assessed	Score band A – Quantitative	Score band B – Qualitative	Guidance	Examples of suitable methods/data use
2. Substrates	**2a: Extent of artificial material** (e.g. concrete, rubble, gabion baskets)	1 = 0 % to 1 % artificial material. 2 = > 1 % to 5 % artificial material. 3 = > 5 % to 15 % artificial material. 4 = > 15 % to 30 % artificial material. 5 = > 30 % artificial material.	1 = No, or minimal, presence of artificial material. 3 = Small to moderate presence of artificial material. 5 = Extensive presence of artificial material.	User assesses how the channel sediment is not natural (e.g. increased siltation, gravel compaction/ cementation).	Hydromorphological survey information (2a/2b). Observations made by walk-over surveys (2a/2b). Local/management personnel/expert assessment (2b). Observations made during biological sampling. (Includes evidence of sediment running off fields; boulders installed for fish, compaction of gravels, etc.).
	2b: "Natural" substrate mix or character altered	*Feature not scored.*	*1 = Near-natural mix.* *3 = Natural mix/character slightly to moderately altered.* *5 = Natural mix/character greatly altered.*	Record only natural substrates: mud, silt, sand, pebbles, gravel, stones, rocks, organic substrates. NOTE 1 In lowland streams with sandy or loamy substrates the diversity of substrates is restricted to smaller grain sizes. NOTE 2 Recording of substrates might be difficult in larger and turbid rivers and streams, and may need to be estimated approximately.	
3. Channel vegetation and organic debris	***3a. Aquatic vegetation management***	*Feature not scored.*	*1 = No vegetation management, or very little (e.g. affecting < 10 % of reach).* *3 = Moderate level of vegetation management (e.g. 10 % to 50 % of reach affected by vegetation management at least every two years).* *5 = High level of vegetation management (e.g. annual vegetation management affecting > 50 % of reach).*	Assessments of aquatic vegetation structure should be carried out during the period of active growth. Local knowledge should be used to apply the guidance for scoring in 3a and 3b to situations not specifically covered in the score bands.	

Table A.1 (*continued*)

	Features assessed	Score band A – Quantitative	Score band B – Qualitative	Guidance	Examples of suitable methods/data use
	3b. Extent of woody debris if expected	*Feature not scored.*	*1 = Near-natural amount and size of woody debris; no active removal or addition.* *3 = Amount and size of woody debris slightly to moderately altered; occasional active removal or addition.* *5 = Amount and size of woody debris greatly altered; regular active removal or addition.*		Note that the score for management of woody debris can be affected by management within the reach or upstream from the reach. Although scores are given only for woody debris, the presence of other organic debris (e.g. leaf packs) is important and should be noted where it occurs.
4. Erosion/deposition character	***Presence of in-channel features such as gravel bars, etc.***	*Feature not scored.*	*1 = Erosion/deposition features reflect near-natural conditions.* *3 = Erosion/deposition features reflect moderate departure from near-natural conditions (10 % to 50 % of the features expected are absent).* *5 = Erosion/deposition features reflect great departure from near-natural conditions (≥ 50 % of the features expected are absent).*	In-channel features comprise depositional features (e.g. steps, riffles, bars, islands, shallow waters), and erosional features (e.g. pools, potholes, cliffs-, and also features such as cushions of aquatic plants, large wood, etc. This feature is essentially a measure of the combination of pressures that affect river processes. It is assessed using expert judgement, based on river type, the presence and extent of features expected under near-natural conditions, and the intensity of management both in the channel (e.g. realignment, gravel removal, dredging) and in the catchment (e.g. underdrainage that increases sediment input). Notes should be made when more (as well as fewer) in-channel features are present than would be expected owing to catchment disturbance.	Users should state what data were used, how collected, how used, and the level of confidence they have in determining whether erosion and deposition features should be present.

Table A.1 (continued)

	Features assessed	Score band A – Quantitative	Score band B – Qualitative	Guidance	Examples of suitable methods/data use
5. Flow	**5a: Impacts of artificial in-channel structures within the reach**	*Feature not scored*	1 = Flow character not, or only slightly, affected by structures within the reach. 3 = Flow character moderately altered. 5 = Flow character extensively altered.	This feature covers the effects of artificial structures (e.g. groynes, weirs, bridges, fords) or water abstraction on flow type diversity and sediment transport. Feature 5a does not refer to changes in discharge; these are assessed in feature 5b.	— Local/management personnel/expert assessment (5a/5b). — Hydromorphological and walk-over surveys (5a). — Air photos (5a). — Water resource and operational records for water management, etc. (5b). — Runoff-maps or area statistics. — Seasonal flow records for regulated versus natural conditions.
	5b: Effects of catchment-wide modifications to natural flow character (upstream of the reach evaluated) (e.g. by hydropower dams, abstractions, etc.)	Score 1 to 5 on quantitative scale according to how much mean daily flow departs from natural using the "look up" Table A2. Assess flow in spring, summer, autumn and winter periods and take the worst (highest) score as the score for 5b.	1 = Discharge near-natural. 3 = Discharge moderately altered. 5 = Discharge greatly altered.	Need hydrological data to establish relevance of discharge alterations. Where long-term river discharge data are not available, it is only possible to use expert judgement applied to score band B.	
	5c: Effects of daily flow alteration (e.g. hydro-peaking)	1 = No alteration to natural daily flow changes, or intervention results in flow for < 2 % of the time (seven days per year) being at least doubled or halved, or rises/falls in level of > 5 cm per hour occurring. 2 = Intervention results in flow for > 2 % to 5 % of the time being at least doubled or halved, or rises/falls in level of > 5 cm per hour occurring. 3 = Intervention results in flow for > 5 % to 20 % of the time being at least doubled or halved, or rises/falls in level of > 5 cm per hour occurring. 4 = Intervention results in flow for > 20 % to 40 % of the time being at least doubled or halved, or rises/falls in level of > 5 cm per hour occurring. 5 = intervention results in flow for > 40 % of the time at least doubled or halved, or rises/falls in level of > 5 cm per hour occurring.	1 = No rapid flow ramping or peaking occurring (< 5 % of the time) 3 = Rare or irregular flow ramping or peaking occurring (*ca* 5 % to 20 % of the time). 5 = Regular flow ramping or peaking occurring (*ca* > 20 % of the time).	Ramping is the rapid increase in discharge owing to releases that result in river level rises and falls exceeding 5 cm/h. Hydro-peaking is the sharp increase in discharge on a daily basis owing to releases; such increases may occur gradually with water levels rising or falling at rates less than 5 cm/h. The effect of hydro-peaking regimes varies (e.g. according to timing of release, quantity of residual flow); this will affect scoring. *Move up one class if affected reach is downstream of lakes/delaying reservoirs, or if ramping is significantly smoothed in river.	Local/management personnel/expert assessment. Daily or preferably hourly flow records.

Table A.1 (*continued*)

	Features assessed	Score band A – Quantitative	Score band B – Qualitative	Guidance	Examples of suitable methods/data use
6. Longitudinal continuity as affected by artificial structures	**Reach-based and local impacts of sluices and weirs on ability of biota (e.g. migratory fish) to travel through reach, and sediment to be transported naturally**	*Feature not scored.*	1 = No structures, or if present they have no effect (or minor effect) on migration or on sediment transport. 3 = Structures present, but having only minor or moderate effects on migratory biota and sediment transport. 5 = Structures that in general are barriers to all species and to sediment.	This assessment applies only to artificial barriers on rivers, and not to natural barriers such as lakes. It is not possible to provide guidance on scoring with respect to the sizes or heights of structures, as their impact will vary according to river type, migratory species present, etc. NOTE If barriers are large, and the reach is in the downstream part of the catchment, they may affect many other reaches upstream. In some cases fish are prevented from passing through dams even though fish passes have been installed. A score of 3 should be assigned where a dam has a fish-pass fitted that functions effectively. Where all sediment is retained behind a dam a score of 5 should be assigned even if a few species are able to pass through. Where a large dam is present, assign 5. A large dam is defined by the International Commission on Large Dams as "those having a height of 15 m from the foundation or, if the height is between 5 m to 15 m, having a reservoir capacity of more than 3 million m³".	— Local/management personnel/expert assessment. — Hydromorphological and walk-over surveys. — Air photos. — Fisheries personnel. — Special surveys assessing structures.

Table A.1 (*continued*)

	Features assessed	Score band A – Quantitative	Score band B – Qualitative	Guidance	Examples of suitable methods/data use
7. Bank structure and modifications	**Extent of reach affected by artificial bank material (% of bank length)** (both "hard" and "soft")	1 = Banks affected by 0 % to 5 % hard, or 0 % to 10 % soft, artificial materials. 2 = Banks affected by > 5 % to 15 % hard, or >10 % to 50 % soft, artificial materials. 3 = Banks affected by > 15 % to 35 % hard, or > 50 % to 100 % soft, artificial materials. 4 = Banks affected by > 35 % to 75 % hard artificial materials. 5 = Banks affected by > 75 % hard artificial materials.	1 = Banks not, or only minimally, affected by hard artificial materials, or moderately affected by soft materials. 3 = Banks slightly or moderately affected by hard artificial materials, or greatly affected by soft materials. 5 = Majority of banks composed of hard artificial materials	If modified bank materials are "natural" (e.g. willow spiling) maximum score is 3. Assessment of extent of bank affected is based on predominant material present (may be a mix of two types). Data from both banks are combined for the assessment.	— Local/management/engineering personnel/ expert assessment. — Hydromorphological and walk-over surveys. — Air photos.
8. Vegetation type/structrue on banks and adjacent land	**Land cover in riparian zone (% of bank length)**	1 = 0 % to 5 % non-natural land cover in riparian zone. 2 = > 5 % to 15 % non-natural land cover in riparian zone. 3 = > 15 % to 35 % non-natural land cover in riparian zone. 4 = > 35 % to 75 % non-natural land cover in riparian zone. 5 = > 75 % non-natural land cover in riparian zone.	1 = No, or only minimal, areas of the riparian zone with non-natural land cover. 3 = Moderately large areas of the riparian zone with non-natural land cover. 5 = Non-natural land cover is dominant in the riparian zone.	Overall aim is to record the naturalness of the vegetation in the riparian zone (the strip of vegetation adjoining a river channel), where naturalness is based on land cover as a surrogate, thus not requiring the expertise of professional botanists. This standard does not specify any fixed width for the riparian zone. However, users should state (with reasons) the width of the riparian zone used for each reach assessed. The width may be a fixed value (e.g. 1 m, 5 m, 20 m) or be related to the width of the river (e.g. 1,5 x). Abrupt changes in land cover could indicate the boundary between the riparian zone and the floodplain. Non-natural land cover classes include: recreational and high intensity agricultural grassland, cultivated land, urban areas, etc. Near-natural land cover classes include natural wetland, alluvial forest/natural woodlands, moorland.	May combine reach-scale and site-based information from: — Hydromorphological surveys. — Local knowledge. — Databases. Also use: — Aerial photos. — Walk-over surveys.

Table A.1 (*continued*)

	Features assessed	Score band A – Quantitative	Score band B – Qualitative	Guidance	Examples of suitable methods/data use
9. Adjacent land-use and associated features	**Land cover beyond the riparian zone**	1 = 0 % to 5 % non-natural land cover beyond the riparian zone. 2 = > 5 % to 15 % non-natural land cover beyond the riparian zone. 3 = > 15 % to 35 % non-natural land cover beyond the riparian zone. 4 = > 35 % to 75 % non-natural land cover beyond the riparian zone. 5 = > 75 % non-natural land cover beyond the riparian zone.	1 = No, or minimal, areas of the river corridor beyond the riparian zone with non-natural land cover (e.g. dominated by near-natural vegetation and/or features such as ox-bows, remnant channels, bogs). 3 = Moderately large areas of the river corridor beyond the riparian zone with non-natural land cover. 5 = Non-natural land cover is dominant in the river corridor beyond the riparian zone (e.g. near-natural vegetation and/or features such as ox-bows, remnant channels, bogs) mainly or totally absent).	This feature includes the floodplain where one exists. Overall aim is to record the naturalness of the vegetation in the river corridor beyond the riparian zone, where naturalness is based on land cover as a surrogate, thus not requiring the expertise of professional botanists. Non-natural land cover classes include: recreational and high intensity agricultural grassland, cultivated land, urban areas, etc. Near-natural land cover classes include natural wetland, alluvial forest/natural woodlands, moorland. Floodplain features include remnant channels, bogs, and artificially created open-water habitats.	May combine reach-scale and site-based information from: — Hydromorphological surveys. — Local knowledge. — Databases. Also use: — Remote sensed data (e.g. aerial photos, satellite imagery, especially for large rivers). — Walk-over surveys.

Table A.1 (*continued*)

	Features assessed	Score band A – Quantitative	Score band B – Qualitative	Guidance	Examples of suitable methods/data use
10. Channel-floodplain interactions	**10a. Degree of lateral connectivity of river and floodplain** (Extent of floodplain not allowed to flood regularly due to engineering-based on hydromorphological surveys.)	Is over-bank flooding likely to occur (or likely to have occurred historically) naturally in the reach? Yes/No. If No – N/A. If Yes, score: 1 = 0 % to 5 % reach affected by floodbanks or other measures impeding flooding of floodplain (e.g. channel and bank regrading). 2 = > 5 % to 15 % as above. 3 = > 15 % to 35 % as above. 4 = > 35 % to 75 % as above. 5 = > 75 % as above.	Is over-bank flooding likely to occur (or likely to have occurred historically) naturally in the reach? Yes/No. If No – N/A. If Yes, score: 1 = None, or minimal amount, of reach affected by floodbanks or other measures impeding flooding of floodplain (e.g. deep dredging). 3 = Moderate amount of reach affected by floodbanks or other measures impeding flooding of floodplain. 5 = Majority of reach affected by floodbanks or other measures impeding flooding of floodplain.	Need to know historical extent of floodplain – e.g. some may now be lost to urban development (include all, not just recent, development that has reduced the natural inundation of the floodplain). Land cover may be a guide – grassland, wet woodlands and other wetlands more likely to be flooded than arable/cultivated and urban land. NOTE Area data should be used where available; if not, use % length of reach. Any flooding deliberately allowed as flood storage under the EC Floods Directive should not be taken as natural.	Use whatever information allows an assessment of the extent to which natural flooding is controlled: — Land use in floodplain. — Controlling structures (e.g. floodbanks, flood walls). — Engineering records (e.g. deepening, resectioned banks, two-stage channel). — Indicative floodplain maps. — Local knowledge. — Hydromorphological surveys/assessments. — Aerial photos. — Walk-over surveys. — Historical maps.
	10b. Degree of lateral movement of river channel (Capacity of river to migrate naturally within its floodplain.)	Is the river likely to move laterally within its floodplain in the absence of any man-made constraints? Yes/No. If No – N/A. If Yes, score: 1 = 0 % to 5 % reach constrained. 2 = > 5 % to 15 % reach constrained. 3 = > 15 % to 35 % reach constrained. 4 = > 35 % to 75 % reach constrained. 5 = > 75 % reach constrained.	Is the river likely to move laterally within its floodplain in the absence of any man-made constraints? Yes/No. If No – N/A. If Yes, score: 1 = Free. 3 = Partially constrained. 5 = Totally constrained.	Only score 3 or 5 if there are heavy engineering works (e.g. sheet piling, gabions) that stop the river from moving NOTE There will often be similar scores generated for feature 10b as for feature 7. However, whereas feature 7 is assessing the lack of bank naturalness caused by hard engineering, and its impact on sediment erosion and deposition, feature 10 is assessing the ability of the river channel to move within the floodplain.	The following should provide information: — Engineering records and asset registers. — Hydromorphological surveys. — Aerial photos. — Walk-over surveys. — Local knowledge (with care).

Table A.2 — Look-up table for scoring Feature 5b
(Score 1 to 5 according to the guidance given in the table)

% days flow different from natural in spring, summer, autumn or winter (worst)	< 20	20 to < 40	40 to < 60	60 to < 80	≥ 80
< 5 % decrease or < 10 % increase in flow	1	1	1	2	2
5 % to < 15 % decrease in flow or 10 % to < 50 % increase in flow	1	2	2	3	3
15 % to < 30 % decrease in flow or 50 % to < 100 % increase in flow	1	2	3	3	4
30 % to < 50 % decrease in flow or 100 % to < 500 % increase in flow	1	2	3	4	5
≧ 50 % decrease in flow or ≧ 500 % increase in flow	2	3	4	5	5

Annex B
(informative)

Some key points in the development of this European Standard

B.1 Introduction

Much of the work on developing and testing the protocol set out in this European Standard was carried out by a small international group of river management specialists. The following paragraphs, summarised from the working documents of the group, provide additional background information on the perceived uses of the standard and on the reasons for some of the decisions made in its development.

B.2 Principal applications for the European Standard

The main uses for the standard include:

— Reporting on modification of river hydromorphology at a European level;

— Assisting in identifying hydromorphological pressures that might lead to a reduction in ecological status under the Water Framework Directive;

— Strategic Environmental Assessment;

— Site- or reach-based Environmental Impact Assessment;

— Maintenance work on rivers;

— Catchment appraisals for catchment management;

— Management of Natura 2000 sites and other sites of conservation importance;

— Protecting valuable fish habitat.

B.3 Selecting features for inclusion

The assessment system is based on the ten categories of river habitat features contained in the CEN guidance standard EN 14614, *Water Quality — Guidance standard for assessing the hydromorphological features of rivers*. Factors such as geographical location, altitude, underlying geology and river size mean that rivers of different types vary greatly in their natural physical characteristics. This standard has been designed principally to assess features that are found in all rivers, irrespective of their type ("core features") with a limited suite of assessments of type-specific characteristics ("subsidiary features").

B.4 Using quantitative and qualitative data in hydromorphological assessments

Some hydromorphological assessment systems already in use are based on qualitative rather than quantitative measurements (e.g. the Austrian "NoeMorph" system). Thus, the appropriate tables in this standard have been created so that scores can be assigned on the basis of qualitative descriptors alone. However, users are encouraged to record and analyse quantitative data wherever possible to improve the consistency and comparability of assessments. It is important also that users state which of the two systems

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has been used to score each attribute, as this can have a bearing on the degree of confidence in the assessment.

B.5 Comments on subsidiary features

B.5.1 Channel vegetation and organic debris

The type and quantity of channel vegetation and organic debris varies according to surrounding land-cover, altitude, degree of shading, recent flooding, etc. At one extreme, for example, no organic debris are expected in high-altitude regions lacking terrestrial vegetation.

There are differences in the way that countries assess this feature. Assessments of macrophytes as a structural habitat type vary from the RHS approach in the UK (recording dominant macrophytes in ten structure categories) to the Austrian approach where macrophyte habitat is not recorded as it is not considered to be an important factor in most rivers. Similar contrasts are found in the way that woody debris are assessed. In Germany, for example, woody debris are always scored the same way in rivers where their presence is expected. In Austria, assessments of woody debris are only qualitative, and unrelated to typology.

B.5.2 Erosion/deposition character

Although several river hydromorphological survey methods (e.g. RHS) record structural characteristics such as mid-channel bars, it has not proved possible to predict the extent of these features in near-natural reaches for different river types. For this reason, these features have not been included as part of the core assessment. However, because they are considered to be important, they have been retained in the protocol for assessment by qualitative descriptions of their extent and type.

B.6 Highlighting rivers with near-natural hydromorphology

In this European Standard a score of 1 represents the lowest degree of hydromorphological modification, yet this still allows considerably more departure from a near-natural state than might equate to a description of "reference condition". Thus, for those attributes where scoring 1 = 0 % to 5 % change (attributes 1, 2a, 7, 8, 9, 10), an asterisk should be added (i.e. 1*) where the recorded change is only 0 % to 1 %.

B.7 Weighting and scoring

Although there are arguments for assigning greater importance to some feature categories than others, there is insufficient scientific evidence to justify incorporating a weighting system in the scoring protocol.

For the purposes of river management, it is important to keep the scores for features separate. For high-level reporting purposes, there might be a case for combining scores into a single quality score for a river or river reach. This standard provides four options for displaying the outputs of an assessment, according to the application for which the assessment is required.

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