Guidance for the assessment of Hydromorphological features of rivers within the STAR Project

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1. Introduction and Aims of the Hydromorphological assessement within the STAR Project

The EU Water Framework Directive (Directive 2000/60/EC - Establishing a Framework for Community Action in the Field of Water Policy), which was officially published at 22/12/00, defines a framework for assessing all kinds of waterbodies. A focus of the assessment systems demanded for by the Water Framework Directive is the use of biotic indicators (macrobenthic fauna, fish fauna and aquatic flora). The WFD also requires the Countries of the EU to carry out hydromorphological assessment activities to enable a better understanding of biological and chemical data. In Table 1, the definitions given in the WFD for high, good and moderate ecological status in rivers for the hydromorphological elements are reported.

Table 1. WFD Definitions for high, good and moderate ecological status in rivers for hydromorphological quality elements.

Element	*High status*	*Good status and Moderate status*
Hydrological regime	The quantity and dynamics of flow, and the resultant connection to groundwaters, reflect totally, or nearly totally, undisturbed conditions	Conditions consistent with the achievement of the values specified [..] for the biological quality elements
River continuity	The continuity of the river is not disturbed by anthropogenic activities and allows undisturbed migration of aquatic organisms and sediment transport	Conditions consistent with the achievement of the values specified [..] for the biological quality elements
Morphological conditions	Channel patterns, width and depth variations, flow velocities, substrate conditions and both the structure and condition of the riparian zones correspond totally or nearly totally to undisturbed conditions	Conditions consistent with the achievement of the values specified [..] for the biological quality elements

The EU AQEM Project aimed at providing a common framework for developing assessment systems in Europe, and focused its activities on aquatic invertebrates. Three major impact types for European rivers were investigated, because they were conceived as the most urgent and representative for the actual problems affecting European rivers: acidification (in Northern Europe), water pollution (mainly in Southern Europe) and morphological degradation (all over Europe). Morphological degradation of rivers, to be correlated with invertebrate community metrics, was evaluated according i) to the National methods (e.g. in Austria), ii) to the methods assumed to be more suitable to be adapted to the local environmental and socio-economic conditions (e.g. RHS in Italy) or iii) to information derived by the AQEM field protocol.

In order to obtain a common interpretation of river quality and classification in future stream assessment in all of Europe, the STAR Project needs a standardised way to assess morphological conditions of rivers. This may be coupled with the results of National methods. Thus, a common basis for future inter-calibration of assessment methods will be set.

The hydromorphological assessment within STAR has two main objectives:

- to provide information to quantify morphological degradation of STAR sites, when this is the main impact type investigated as well as when it is a secondary cause of communities modifications
- to obtain data for linking the information supplied by the various biological surveys, e.g. through a habitat characterisation at a larger scale than AQEM invertebrates sampling. The method used should be able to furnish information at the phytobenthos/invertebrate scale as well as at the macrophyte/fish scale.

Additionally, the hydromorphological survey is expected to provide:

- data to be quantitatively used to extend the information gained from the biological elements to different river reaches exhibiting similar habitat features (e.g. to predict taxa occurrence)
- information to investigate the functional relationships between taxa presence/abundance and single hydromorphological features (e.g. to investigate the organism-response relationships).

2. The incoming CEN standard on river hydro-morphology: A guidance standard for assessing the hydromorphological features of rivers

At the moment, the CEN Standard for the assessment of river hydromorphology is in a draft form and will not be inserted in the present STAR guidance manual. When at a wider consultation phase as a prEN (late 2002, possibly) it may access a more public dissemination. For this reason, a short summary only of notable points included in the CEN draft will be provided here, to supply further guide on the application of river habitat assessment methods within STAR.

The aim of the CEN Standard will not be to propose a standard method for assessing river hydromorphological aspect. Instead, the basis for a comparable use and application of the existing methods will be set. A second part of the standard (to be prepared subsequently) will be focused on devising a consistent approach to morphological assessment (possibly including suggestions for scoring systems) and hydrological quality.

No normative references are presently available in the field of hydromorphological assessment of rivers. The "Guidance Standard For Assessing The Hydromorphological Features Of Rivers" has a particular relevancy for the fulfilment of the WFD, but it also has additional aims, not reported here (notes presented here are based on the Fifth Revision, March 2002: CEN TC 230/WG 2/TG 5: N30). As far as it concerns the STAR Project activities, the incoming CEN standard would provide a guidance on which hydromorphological features have to be registered when studying and characterising river reaches to improve the comparability of hydromorphological survey methods presently available, data processing, interpretation and presentation of results. The standard will focus on morphological features of rivers and on river continuity, not considering hydrological aspects.

In the draft, a list of definitions is given for a number of river features relevant for the survey, some of which of major importance when comparing results obtained by applying different assessment methods.

Four areas are identified, where to focus on for the survey:

- river channel
- banks
- riparian zones

- floodplains.

Guidelines on criteria to be combined to define river types are suggested, beyond the few descriptors present in WFD System A. These include features linked to: Size, Gradient, Geology, Geographical location, Altitude and Hydrological regime. Additionally to the river type attribution, the reach and survey units' selection is indicated as fundamental for survey strategy and assessment. Different survey strategies can be used for the survey concerning the assessment of river reaches, by defining and studying possibly smaller contiguous survey units, larger single units (e.g. covering a whole reach of the river) or locating randomly (or according to other statistically robust approaches) the survey units within the reach. When the aim of the assessment is to provide an overall evaluation of the river stretch (e.g. for WFD purposes) data from distinct survey units should be combined considering their relative length. The collected data should support the assessment of the two river banks separately, and the field survey should be preceded or followed by the use and interpretation of all the existing information available for the study site.

Concerning the selection of reference sites and/or the definition of acceptable reference conditions, four main criteria are proposed. These deal with: 1) bed and bank character, 2) the freedom of lateral movement of the river, 3) the free movement of biota and sediments along the river continuum and 4) the condition of the riparian vegetation. The four criteria should be considered when classifying river sites. When reporting, channel, banks and floodplain information should be expressed in different outputs.

3. Methods for assessing river Hydromorphology in Europe

Four European countries have, at the present time, relatively well-developed national programs of hydromorphological river assessment, suitable for application under the WFD. These are the Austrian nation-wide method, the French 'SEQ Physique', the German 'LAWA-vor-Ort' and River Habitat Survey (RHS) from the United Kingdom (CEN/TC230/WG2/TG5: N 15, 16, 17, 18, and 22). These 4 methods are currently undergoing a Europe-wide inter-calibration exercise, which will, among other things, set up common reference definitions for river channel and bank assessments, define boundaries between quality classes and contribute to produce CEN standards to fulfil the WFD demands.

Comparative field studies of three of these four main methods (UK, France and Germany methods) exhibited comparable results for habitat quality, but the highlighted discrepancies do require further investigations. For this reason, and because of the different survey approaches underlaying these methods, their protocols were not adjusted to integrate them into a single field form for STAR use. Moreover, the methods support different calculation formulae and scores to assess morphological impairment, thus leading to an only partial comparability of final results. The subsequent site classification may then be not fully comparable. Even if not required by the WFD, this classification would have been useful for STAR objectives, i.e. allowing an easier interpretation of biological classes. However, the use of a common hydromorphological assessment method within STAR (and of a common scoring system(s) for impairment types and intensity) will support a significant correlation analysis between morphological features (and degradation) and biological response.

The River Habitat Survey (U.K. method) is the method chosen for the Europe-wide application within the STAR Project. It has been selected primarily because of its wide range of possible outcomes and for the objective approach in describing the riverine environment. In addition, the ease of getting resource materials (e.g. all literature written in English) and of accessing to training made this method comparatively more attractive than those from other European Countries. Other attractions of RHS included the transect data in the survey methodology, the recording of 'flow-types' (especially useful to link invertebrate community and habitat composition), and the speed and ease of application.

4. The method selected for a standard assessment within STAR: River Habitat Survey

RHS is a method for the assessment of river habitats developed to support river management and habitat conservation in the U.K. It supports the collection of a large amount of qualitative and quantitative geomorphological data on different scales.

The site protocol consists of four pages, including a section with background map-derived informations (page 1). The length of the sampling unit is 500 meters along the river. Bank and in-channel features are recorded for 10 *spot-checks* (page 2), equally spaced every 50 m: this way of gathering data enables statistical analysis. At each *spot-check* physical features (e.g. flow type, substrate type, channel/bank modification, etc.), land use and channel vegetation type are recorded. An additional listing of characteristics recorded along the whole sampling unit (500 m) has to be completed for the *sweep-up* section (page 3). In this section the features not included in the *spot-checks* are summarised, such as land use within 50 m of banktop, bank profile, extent of trees and extent of channel features (e.g. run, riffle, glide, bars etc.). In the last page of the protocol, channel size have to be recorded togheter with general informations about the site (e.g. features of special interest, evidence of recent management etc.).

One of the most relevant attributes of this methodology is the objectiveness of its application (e.g. it uses a standard distance between spot-checks). The field survey is predominantly based on the recognition of geomorphological features, but no specialists' competence is required. A training course, that has to be attended from all surveyors, gives all the information required for the correct application of the methodology. For further details on the data recorded during field survey see Annex 1 (field protocol), Attachment 1 and the River Habitat Survey Field Guidance Manual (1997). The material distributed during the RHS course for STAR at La Bresse (April 2002) and that will support the application of the method is:

- River Habitat Survey 1997 Field Guidance Manual - Environment Agency, Bristol.
- RHS training video: 'River Habitat Survey. Flow types, Features and Geomorphology' produced by Malcolm Newson and the Audio Visual Centre, University of Newcastle-upon-Tyne, 1997, 19 mins.
- River Habitat Survey database on CD-ROM

Some modifications to the RHS form have been recently made (RHS version 2002). They regard page 4 where some features have been added in the section *features of interest* (M). In the section of *notable nuisance plants species* (O), you have now to record where alien plant species are located (on bankface/banktop only or within 5-50 meters from it). The section artificial features is now in the first page (D). In the same page (B), the valley form assymetric vee replaced asymmetrical floodplain, while no valley sides obvious replaced symmetrical floodplain. Additionally, U shaped valley has been separated from concave/bowl. *Channel features* (page 3) are now directly characterised by the flow type, instead of reporting the name of the habitat only (given in brackets). In page 2 it is now possible to record the presence of braided channels.

This updated version should be used in STAR (Annex 4).

The analysis to be performed on the data derived by the RHS application within STAR will be defined in details further on. In general terms, on one hand the application of RHS allows the collection and storage of a wide number of parameters useful for the characterisation of a river in terms of its habitat features. On the other hand it is possible to classify the site by the calculation of different indices. The first indices that were developed are the *Habitat Modification Score (HMS)* and the *Habitat Quality Assessment (HQA)*. The first one is an index derived from the data regarding morphological modification of the river due to human activities (e.g. bank reinforcement, channel resectioning, culverting, number of weirs etc.). Different scores are given to each modification, accordingly to the importance of the impact type and to the extent of its presence. HMS is thus the sum of all the individual scores. Through the calculation of HMS it is possible to classify a river site into 6 different classes (Table 2; Raven *et al.*, 1998). No artificial modification is present in a pristine site.

Table 2. Habitat Modification Score categories.

HMS Score	*Descriptive category of channel*
0	Pristine
0-2	Semi-natural*
3-8	Predominantly unmodified
9-20	Obviously modified
21-44	Significantly modified
45 or more	Severely modified
**Semi-natural includes pristine channels*	

The HQA index assesses the ecological quality of the site through the habitat richness evaluated on the basis of the extent and variety of natural features recorded (e.g. number of different flow types, different substrates and naturalness of land use). It is numerically expressed as the sum of the scores given to each single feature. Each single feature can get a score from a minimum of 0 for *No Flow* to a maximum of 7 for *Broadleaf woodland* or *Wetland* (if they are the only land-use categories recorded). If a reference database is available (like in the U.K.), it is possible to furnish a judgment of the site habitat quality that can be: “excellent”, ”good”, “fair” or “bad”. This is obtained from the comparison between the values of the HQA in the studied site and the HQA observed in the pool of representative sites whose information is already present into the database. While it is possible to give the score of HQA for every river-site, for the formulation of a judgement, it is necessary to have a reference database containing informations about (at least) hundreds of sites.

Two new indices to assess the overall quality of the site are under development. One is named *Benchmark Distance score* (*BCD)* and is calculated only for pristine and semi-natural sites. This score measures the distance from HQA score of the site to the HQA score of the nearest benchmark site *(reference site).* If BCD equals 1, this means that the study site is equivalent to the reference site, while if BCD gets the score of 5, it means that they are very dissimilar. The remaining index, named *River Habitat Quality* (*RHQ),* derives from the combination of the three previous scores (HMS, HQA and BCD) and supports an overall evaluation of the site. Using this score (RHQ), it is possible to assign the site to one of five quality classes (I: excellent – V: very poor). The classification is based on a two entry table and the final class is estimated from the combination of HQA value and HMS score. For the semi-natural sites, the final class results from the value of BCD (which is 1 for class I, 2 and 3 for class II and >3 for class III) only. This means that if a site falls into the lower percentile of the distribution of the HQA values (bottom 20%), but it is very similar to a reference (BCD = 1), can be attributed to the first quality class. For the calculation of RHQ it is necessary to use the RHS database which enable the calculation of the percentile of the HQA distribution (which determines the vertical entry) and the calcualtion of BCD Benchmark categories. It is necessary to make clear that this database has been developed for U.K. rivers and contains the data of these rivers. To properly assess RHQ for other european rivers it is necessary to develop similar databases, e.g. one for each Country, or one containing data from all the studied European stream types.

5. South Europe RHS

At present a survey method which satisfies the detailed demands of the WFD concerning river hydromorphology does not exist for South Europe. RHS seems to be the best suitable method for an adaptation to the South European situation because of the same reasons listed for its selection for the STAR Project (see the Introduction). However, RHS in its standard U.K. version may lack resolution in describing the riverine environment, meaning that can fail to pick up subtle yet meaningful changes between sites. RHS was developed to describe British rivers, which, despite varying in character considerably, do not include the full gamut of types found Europe-wide. Moreover, a cost-effective compromise between the data to be collected and the speed of application was met to support an extensive and quick use all over the U.K. for producing an overall picture of rivers quality. Of particular relevance to Southern Europe is the fact that RHS assesses only the habitat provided by one (main) channel. In the U.K. this is perhaps a limited problem. Raven *et al.* (1998a; 2000) report that braided channels (currently recorded in the standard RHS as 'present' or 'extensive' braided/side channels, section O) are uncommon in lowland rivers, although they are present in more than 5% of upland sites. Besides, RHS in its current form is unsuitable for >100 m wide rivers or multi-thread rivers and, even if the underlying survey design can be retained, it should be adapted to local conditions for such rivers (Raven *et al*., 2000).

Recently, a slightly modified version of RHS (mainly page 2 of the field form), which retains a full comparability with the standard U.K. RHS, has been proposed to allow a better description of South European rivers (Buffagni & Kemp, in press: Annex 2 and Attachment 2). In the South Europe version (SE_RHS), particular attention is given to two river features, concerning what described above:

- the presence of secondary wetted channels
- the relative width of the wetted channel(s) *versus* total channel width.

Furthermore, to better describe river habitats, extra substrate and flow types are recorded, i.e. two of them are recorded, instead of one only (see SE_RHS form: Annex 2). The information gained by collecting these additional data will assist when interpreting biological element responses. They may result particularly useful for linking invertebrates, macrophytes and fish data to habitat quality and diversity for the different quality classes (e.g., when estimating variability of biological components).

6. How to apply RHS within STAR

6.1 RHS version to be used

Two versions of RHS are here proposed for the application. The standard RHS represents the method whose application is necessary within STAR Project in all the European Countries involved. This will ensure a full comparability between the Countries and will provide a well-established set of facilities at the European scale.

Standard RHS proved to be a very good tool to provide a hydromorphological description of rivers in the U.K. for catchment management and restoration, but its use to link morphological degradation (i.e. one of impacts investigated in the STAR Project) to the invertebrate, macrophyte and fish habitats still needs investigation. The AQEM protocol for invertebrates to be used in STAR is strongly focused on the detailed investigation of river instream habitats. For this reason, the collection of more detailed habitat data, as requested by the South Europe version of RHS, may result in an increased ability of linking invertebrate data and hydromorphological information. Moreover, STAR wants to investigate the links and overlap between the variouos biological components, to derive a conceptual frame for the proper selection and use of each biological indicator group. To do this, the collection of additional data (e.g. concerning the presence of secondary channels, highly relevant for many biological components in rivers) may result in far richer information.

Thus, European teams may deliberate the application of the additional module developed for South European rivers, based on the knowledge of the rivers they are going to investigate. Greek, Italian and Portuguese teams will adopt the extended SE_RHS version. Other teams may consider it according to the general STAR objectives and to their specific needs.

A simple key to conceive when the application of SE_RHS would be particularly useful for STAR purposes is reported below. It represents a rough guide to help understand if the rivers each team is going to investigate may result comparable to the river types for which the SE_RHS was developed. The percentages given below are based on the assessment of a set of Italian rivers, and should not be considered rigorously. The pictures provided will help interpreting and using the key (Annex 3). The key is designed for the use at relatively unmodified river sites (according to hydromorphology) and to help defining if the river type under investigation would require a more detailed analysis than offered by the standard RHS. If a special purpose of relating biological data (e.g. taxa presence and distribution in the river) and instream habitat features is recognised, the advantage of using SE_RHS page 2 form is preserved even if the river type is not close to the South European ones where the SE method was developed.

6.2 Key to determine when the application of SE_RHS may result especially useful for STAR purposes

The river features for the application of the following key can be recorded at the assessment site by a quick sweep-up (over a representative length of the survey area), through a large scale observation of the river (e.g. when selecting sites to be investigated) or by previous knowledge of the river (e.g. map based or by road observation of the river). For example of river sites/types see pictures in Annex 3.

1. a. One or more wetted secondary channels are present in the river ………….. SE_RHS

   b. No wetted secondary channels are present in the river ……………………………... 2

2. a. Wetted channel width < 50% Total channel width (not including bankface) …………………………… …………………………………………….. SE_RHS

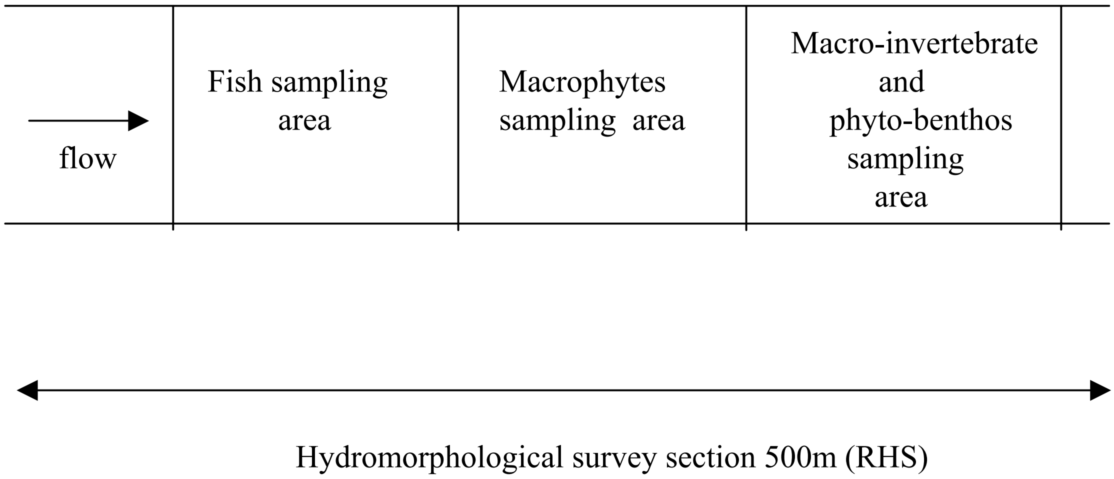
   b. Wetted channel width > 50% Total channel width (not including bankface) ……………………………………………………………………….……..... 3

3. a. Wetted channel width < 70% Total channel width (not including bankface) …… ………………….……………..……………………………… SE_RHS (optional)

   b. Wetted channel width > 70% Total channel width (not including bankface) ……… ……….……………………………………………………….. Standard RHS

6.3 Field application of RHS for the STAR Project: Positioning of RHS survey area(s) and biological components sampling site

To improve the comparability between the RHS application and the biological components data, it is necessary that the hydromorphological survey includes the river area selected for the invertebrates, macrophytes and fish collection. In particular, the upstream stretch of the river must be assessed, together with the contiguously downstream one. For STAR general purposes, a standard positioning of the sampling points for different "taxonomic" groups at each sampling site must be executed. This should be as shown in the following schematic stream diagram:



When additional assessment systems for hydromorphology (e.g. National methods) will be applied, the length of the river stretch and the number of reaches to be investigated must be set according to the method requirements.

However, the standard lenght of river to be assessed for hydromorphology in STAR is 500 meters (one single application of RHS method). The positioning of the spot-checks should be performed after selecting the macroinvertebrate sampling area (see 6.5 for further explanations). Figure 1 draws the relative positioning of the survey areas for the macroinvertebrates and phytobentos sampling areas and the three most downstream spot-check transects of RHS.

Figure 1. Positioning of RHS spot-checks in relation with macroinvertebrates and phytobenthos sampling area

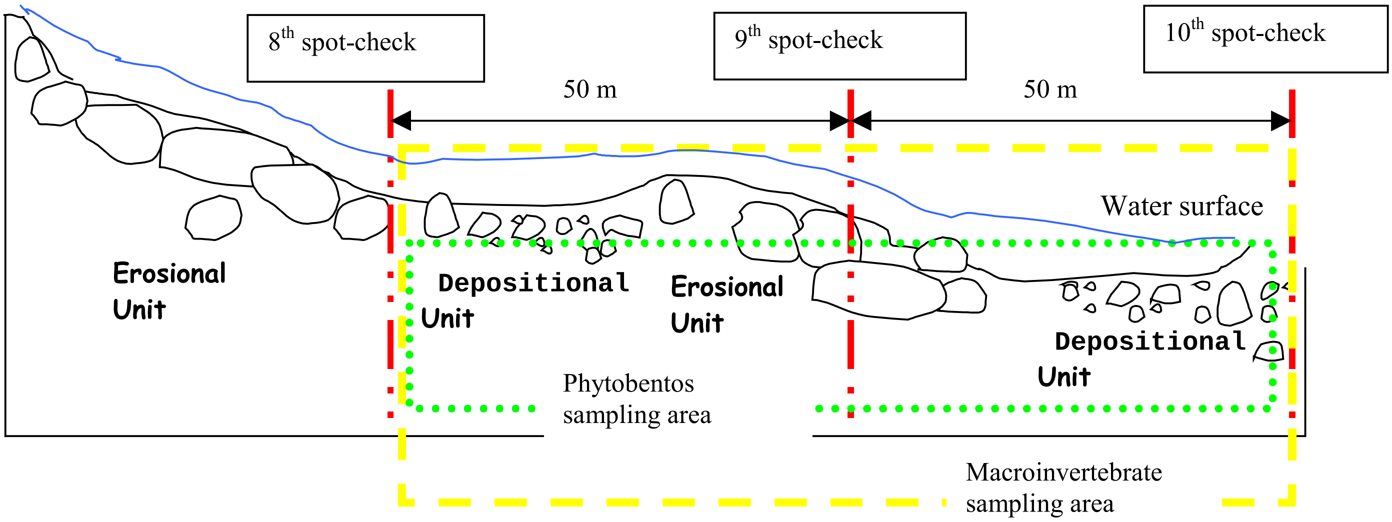
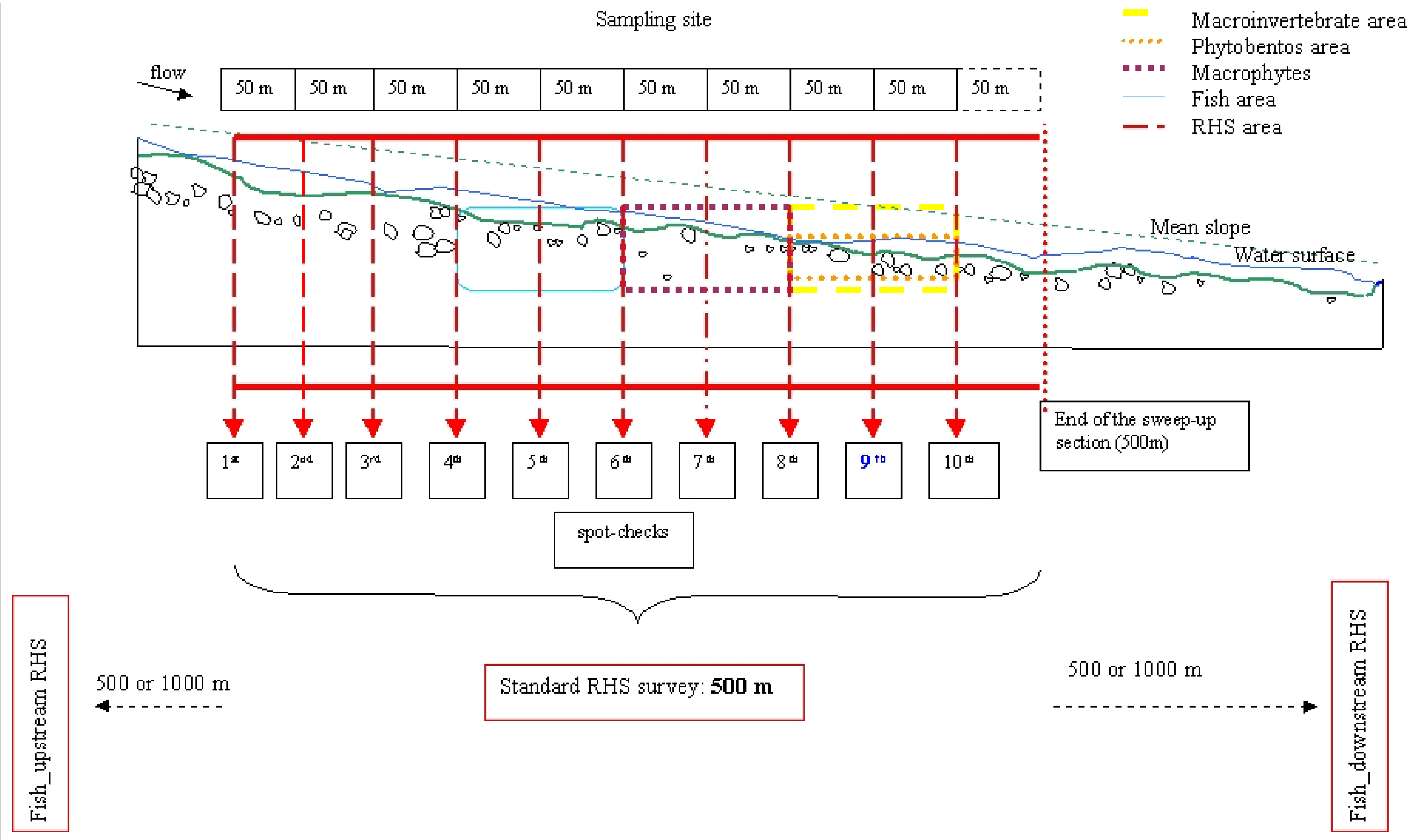


Figure 2 shows the positioning of the sampling areas of the four biological elements (macroinvertebrates, phytobentos, macrophytes and fishes) in relation with the RHS survey area. The macroinvertebrate sampling section is located between spot-checks 8 and 10. The 100 m macroinvertebrates sampling area should be centred on 9th spot-check (for the correct positioning of this spot-check see 6.5). The phytobentos samples should be taken in the same 100 m section. The macrophytes survey should be performed between RHS spot-checks 6 and 8 (immediately upstream from the macroinvertebrates area): it will cover 100 m. Fish sampling will take place close to the middle of the RHS survey section, upstream from the two previous areas. The minimum length is likely to be 100 m and fishing should take place between RHS spotchecks 4 and 6 (upstream from macrophytes survey area). If a longer fishing length is needed, the fished section should be extended upstream only.

Figure 2. Positioning of the sampling areas for the biological elements in relation to the RHS survey area.



Depending on the relative importance of the different biological elements (and their scale of pertinence), on impact and river type, it can be highly relevant to characterise also the upstream and downstream river stretches and not only the 500 m of one single RHS application at the sampling site (e.g. for a better interpretation of the fish data). To do this, the size of the river and catchment area should be considered. If the option of extending the investigation upstream and downstream from the invertebrate sampling area is adopted, it is suggested that RHS is applied three times: the standard one discussed above (Figs. 1 and 2), one upstream from this area and one downstream. For small streams (catchment area < 100 Km^2) it is suggested to move 500 meters upstream and downstream for the two additional RHS applications. In this case, the total river length embraced between the two more distant spot-check areas will be 2.5 km. For mid-sized streams (c.a. > 100 Km^2) a longer stretch would be more representative. It is then suggested to disconnect the contiguous RHS areas of 1 km one from each other. The total river length embraced will be 3.5 km.

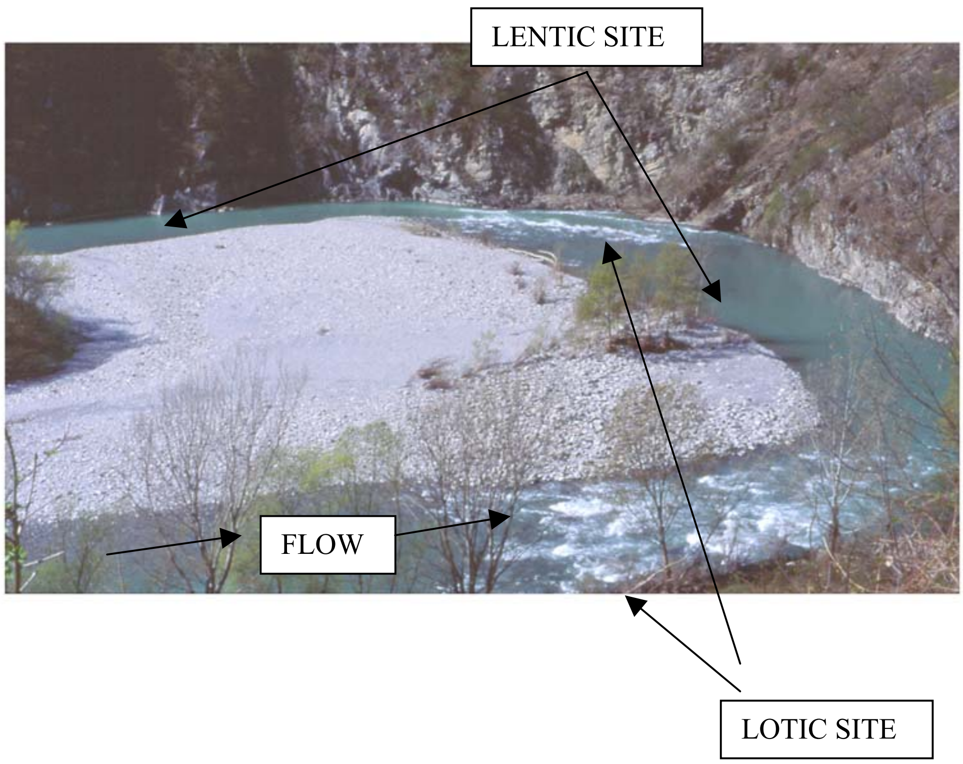
6.4 Depositional and Erosional units in RHS application and AQEM invertebrate sampling

According to the AQEM sampling methodology and for a correct (i.e. representative) selection of sampling site in the river reach, it is necessary to recognise *riffle* and *pool* areas. The sampling site must reflect the share of *riffles* and *pools* of the reach and both, when distinguishable, must be sampled (see AQEM manual). Thus, it is important to define what has to be considered a *riffle* unit and what a *pool* unit, i.e. the two distinct areas in which the 20 invertebrate replicates will be proportionally positioned. This is needed to settle the starting point for the RHS application. In fact, for STAR purposes, a non random positioning of the RHS spot-checks is preferred, to derive information more closely linked to the biological data collected than obtainable by randomly setting the hydromorphological survey transects.

To avoid confusion with RHS flow habitat connotations, areas called *pool* and *riffle* in the AQEM sampling protocol and Manual, will be hereafter respectively called ***lentic site*** (*pool* = depositional unit) and ***lotic site*** (*riffle* = erosional unit) for use in the STAR Project.

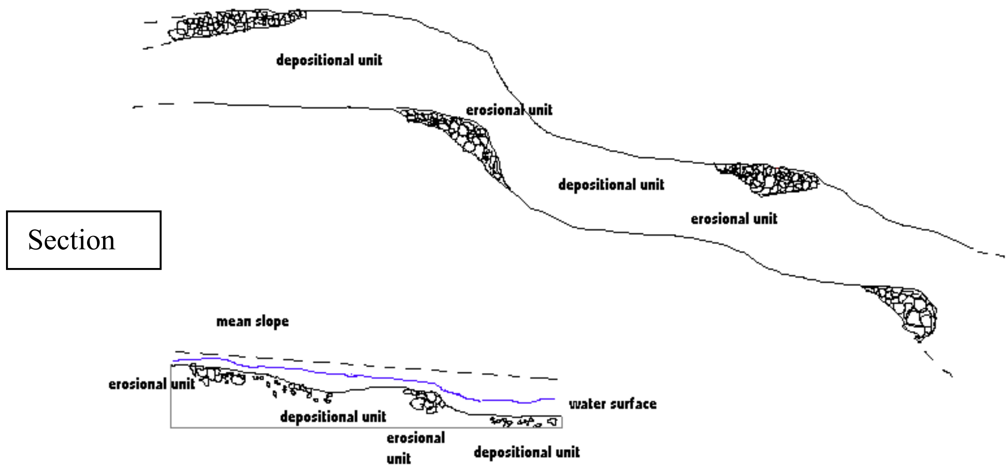
More in detail, the stretch of the river where depositional features are dominant makes up the *lentic site* (depositional unit, Fig. 5). The *lotic site* (erosional unit), is an area of the river where the erosional attribute is usually dominant. This unit is often associated with a more turbolent flow and higher flow velocities than the *lentic site*. On the other hand, the two sites are often easily recognisable by comparing adjacent areas of the river: hence, they can be identified in a comparative way, i.e. by distinguishing pairs of river unts showing different flow features.

Figure 5. Example of ***lentic/lotic sites*** (*depositional/erosional* units = *pool/riffl*e sequence) in the Trebbia River, Northern Apennine, Italy.



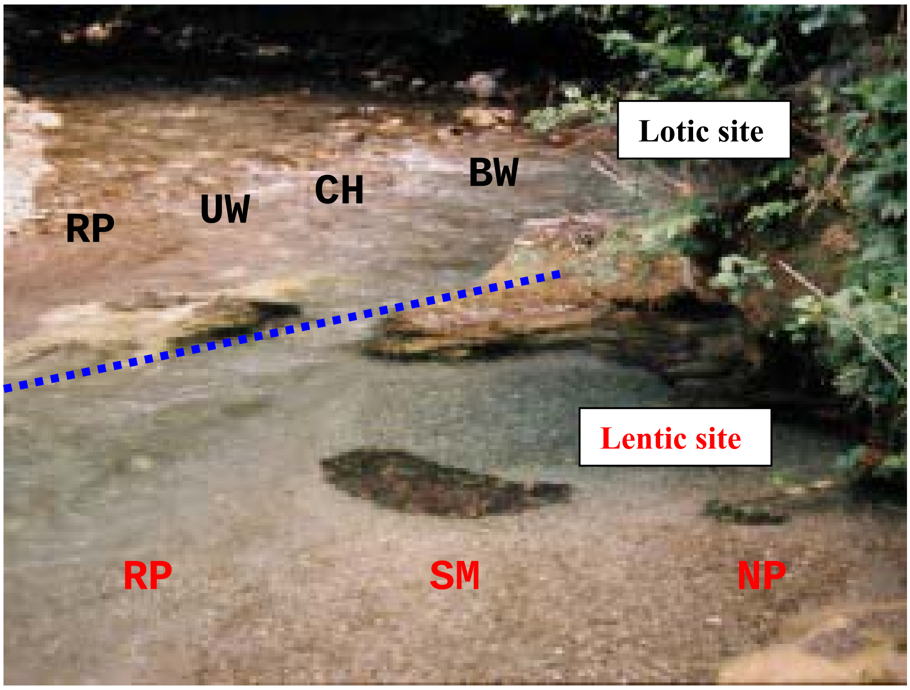
This means that not only the areas with e.g. *no perceptible flow* (=RHS *pools*) may constitute a *lentic site* (depositional unit), but also others where current velocity can be appreciable (however, in general this unit is not characterised by turbulent flows). *Lotic sites* (erosional units) are generically shallower areas with mixed gravel-cobble substrate in comparison with *lentic* ones, which are deeper and characterized by finer substrate, at least at the surface of the river sediments (Fig. 6).

Figure 6. Map of *lentic* (depositional) and *lotic* (erosional) sites sequence.



These definitions are different from the ones given in the RHS Field Survey Guidance Manual (U.K. Environment Agency, 1997), regarding *riffles* and *pools*. According to RHS, these areas, whose identification is based on the flow type, are two of the possible main habitats that can be found in a river (e.g. *riffle* is characterised by *unbroken standing waves* as dominant flow type, *glide* by *smooth flow*, *pool* by *no percetible flow*, etc.). By contrary, according with the definitions given above (dealing with the AQEM protocol), a *lentic site* may simultaneously include extensive river areas characterised by flow types typical of a *run*, a *glide* and a *pool*, meanwhile a *lotic site* may e.g. include both ares with flow type corresponding to a *riffle* and a *run*, or a *rapid* plus a *riffle* plus a *run* RHS habitats at once. In Figure 7, an example of *lentic/lotic* sequence showing the encountered flow types in both of them along transversal sections is reported (see caption for further details).

Figure 7. Example of the flow types observed in the *lotic* (erosional) and *lentic* (depositional) sites along two transversal transects from one bank to the other (Tanagro river, Southern Apennine, Italy)(flow types: RP, rippled; UW, unbroken waves; CH, chute; BW, broken waves; SM, smooth; NP, no perceptible).



The occurence of the different flow types to be recorded for RHS can be compared with the occurrence of the flow types that may be recordeded on the AQEM form for every invertebrate replicate (Figure 8). Also from this form it is clear that the *lentic* site (*pool*) can be characterised by a wide variety of flow types, such as the *lotic* site (*riffle*). The difference between the two sites lays in dominance of *unbroken waves* for the *lotic* site (*riffle*) and of *rippled* flow for the *lentic* site (*pool*). This second unit is also characterised by finer substrate in comparison with the *lotic* site (Fig.8).

Figure 8. Characteristics of the sample replicates (AQEM sampling protocol, version used in Italy) for the Trebbia Reference site during February 2001.

***116* Sample replicates (v= current velocity)** F. TREBBIA REFERENCE 20. 02. 01

EROSIONAL	Micro Hab	Depth cm	v ~~cm/s~~ giri/30"	~~Fun Hab~~ Notes	Flow Type	Flow Type	DEPOSIT.	Micro Hab	Depth cm	v ~~cm/s~~ giri/30"	~~Fun Hab~~ Notes	Flow Type
1	PG	30	179	RIF	BW	FF	11	PF	23	55	RR	RP
2	BL	2	89	RIF	CH	CH	12	GH	32	0	Backwat	NP
3	PG	18	112	RIF	BW	BW	13	PF	34	88	RR	RP
4	PG	55	182	RIF	UW	UW	14	PF/CO	12	28	RR	RP
5	PF	33	124	RIF	BW	CF	15	CO	33	10	Pool	SM
6	TP	18	156	RIF	UW	RP	16	PF	28	53	RR	RP
7	PF	22	96	RIF	UW	UP	17	PF	50	12 cm/s	pool	SM
8	PF/PG	42	227	RIF	UW	SM	18	SA	25	7 cm/s	RSM	SM
9	PF	27	170	RIF	UW	NP	19	TP	8	57 cm/s	RCM	RP
10	PG	29	112	RIF	BW	NO	20	PF	33	0	Backwa	NP

***117* mean depth** 27.6 cm (RIFFLE) 27.8 cm (POOL)	***118* maximum depth (in the river)** 150 cm
***119* mean current velocity** 144,7 giri/30" (RIFFLE) 30.5 giri/30" (POOL)	***120* maximum current velocity (in the river)** 250 giri/30"

Depending on river type, it is sometimes unfeasible to distinguish any *lotic* and *lentic* sites (erosional and depositional units) aligned along the longitudinal axis of the river. This is, for example, the case for the small streams on the Alps (>800 m a.s.l., Bolzano, Italy: Fig. 9). In general, for alpine streams, it is possible to recognise a step-pool sequence in the channel, usually originating a mosaic of unregularly spaced substrate and flow habitats. The identification of any regular sequence along the river is here often quite unreliable.

Figure 9. Example of river site on the Alps, where it is unfeasible to recognise any lentic/lotic regular sequence (Bolzano, Northern Italy).

Figure 10. Example of river site in the lowlands of the Po Valley, where flow types and substrate are quite uniform for large areas (i.e. it is arduous to recognise any lentic/lotic sequence (Novara, Northern Italy).

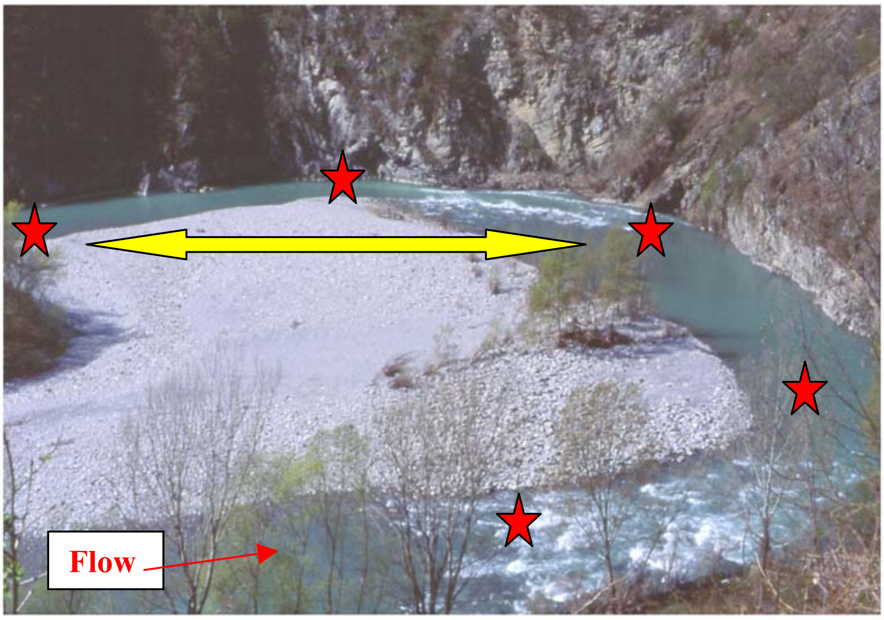
In small streams of lowland areas (Fig. 10), where extensive areas are uniform concerning flow type and substrate, distinguished *lentic* and *lotic* sites may not be perceptible.

6.5 Positioning of the 9th RHS spot-check according to the invertebrate/phytobenthos sampling area

After having identified the *lentic/lotic* sequence (if present) to settle the single invertebrate replicates, it is possible to place the spot-checks position to start with the RHS application. The second most downstream transect (9th spot-check) should be settled inside the *lentic/lotic* sequence previously identified and selected for the invertebrates sampling. More in detail, it has to be set in the *lentic* site if this is most representative or, *vice-versa,* in the *lotic* site if faster flows are prevailing in the river (see AQEM Site form – small version Parameter 28 [to be confirmed]: relations *riffles/pools*). Where a *lentic/lotic* sequence is not recognisable, the ninth spot-check can be settled in the middle of the sampling area. Even if this does not reflect the standard RHS random positioning of the spot-checks in the river continuum, it is proposed here to increase the comparability and interpretation of STAR biological data (mainly invertebrates and macrophytes).

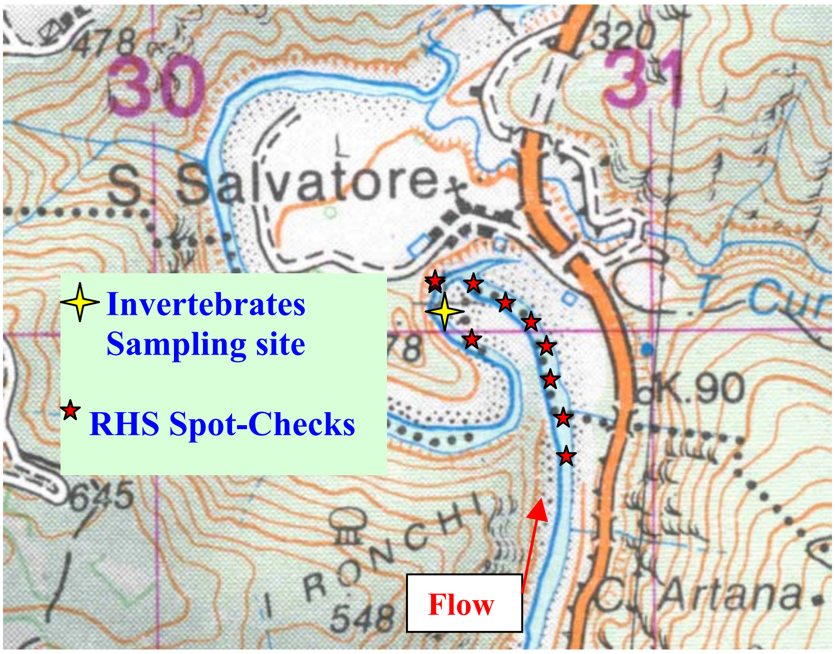
Figure 11 shows the location of the five downstream spot-checks in the Trebbia river (Reference site, spring) positioned for the RHS application during the AQEM Project. At this site, the ninth spot-check is located in the *lentic* site (depositional unit).

Figure 11. Positioning of the five downstream RHS spot-checks (red stars) in the Trebbia river (North Apennine, Italy) and of the invertebrate sampling site (yellow arrow).



In Figure 12, the location of the full set of RHS spot-checks in the same site of the Trebbia river together with the invertebrate sampling area are displaied.

Figure 12. Map of the area where the studied site of the Trebbia River (AQEM Project Reference site) is located. The positioning of the full set of RHS spot-checks is indicated (red stars) together with the centre of the invertebrate sampling site (yellow star).



7. Season of hydromorphological assessment

The hydromorphological assessment should be conducted during low flow periods, avoiding extremely dry periods, especially in Southern Europe. Also, the investigation period must be selected to allow a good description of the vegetation features of the site required by RHS. In most Counties, winter should not be contemplated and a period when the aquatic macrophytes are well developed is suggested for the assessment. The hydromorphological survey, when feasible, should be carried out in the same period of the macrophytes survey.

For the general STAR purposes, hydro-morphological surveying has to be conducted in one season only. Further sampling in additional seasons would be at the discretion of individual partners, and may support a better definition of river types within the Ecoregion (e.g. where flow variations show a high seasonality), or an improved multi-scale interpretation of benthic invertebrates data. As far as possible, when RHS will be applied in more than one season at the same site, it is suggested to maintain the same spot-checks positioning.

8. Safety

Fieldwork always holds a potential for personal injury from equipment operation and exposure to environmental hazards. Every effort should be made to minimise risks in the field. Besides the scientific aspects, criteria for safe sampling should also be regarded when investigating a site. For more detailed safety recommendations, see the "Description of the macroinvertebrate sampling methods to be applied in STAR".

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10. Annexes and Attachments

Annex 1 – U.K. Standard RHS form 1997 version and spot-check key (PDF version)
Annex 2 – South Europe RHS form (PDF version)
Annex 3 – Key to determine when the application of SE_RHS may result especially useful for STAR purposes (PDF version)
Annex 4 - U.K. Standard RHS form 2002 version (PDF version)

Attachment 1 - River Habitat Quality River Habitat Quality: the physical character of rivers and streams in the UK and Isle of Man. (Raven *et al.*, 1998) (PDF file)

Attachment 2 – Looking beyond the shores of the United Kingdom: *addenda* for the application of River Habitat Survey in South European rivers. (Buffagni & Kemp, in press) (PDF file)

CEN documents (CEN/TC230/WG2/TG5), to be requested (if available) to CEN National delegates:

N 14 - A Summary Description of River Habitat Survey (UK) (Paul Raven)
N 15 - River Habitat Survey in the Federal Republic of Germany (Walter Binder & Claudia Leuckel)
N 16 - Summary description of habitat assessment systems in Austria (Susanne Muhar)
N 17 - Presentation of the Physical SEQ (France) (Stephane Stroffek)
N 18 – Similarities and differences between river habitat assessment systems (Second draft: August 1999) (Phil Boon)
N 22 – A guidance standard for assessing the hydromorphological features of rivers (Fifth revision: March 2002)