ANNEX 1

HYDROMORPHOLOGICAL ASSESSMENT PROTOCOL FOR THE SLOVAK REPUBLIC

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1 INTRODUCTION

Assessment of the hydromorphological quality (structure of the physical environment and volume of flow) of streams and rivers are an integrated part of the Water Framework Directive (WFD). The hydromorphology is the basic component of streams and rivers on which the biotic communities depend. Rivers are characterised by a dynamic environment that is under constant change due to variations in flow. The physical structure and variations in flow is thus a basic part of the stream ecosystem. In the WFD equal attention is therefore assigned to assessing the hydromorphological characteristics and quality and the quality of different biotic variables.

Development of a protocol that addresses the assessment of the hydromorphological features is required to comply with the WFD. There are already existing protocols for assessing the hydromorphological features of rivers and streams, which are used in some European countries. The aim of the TWINNING project is to evaluate the protocols used throughout Europe and to establish a set of parameters necessary for the assessment of the hydromorphological quality of all types of rivers in the Slovak Republic.

The protocol proposed here is based on a draft protocol for the Slovak Republic by Adamkova et al. (2004), developed for the Slovak Hydrometeorological Institute (SHMI). The draft protocol is based on the methodology applied in Germany for large rivers (Fleischhacker and Kern, 2002) and modified to suit Slovak conditions.

The proposed protocol includes guidance on sample site selection, field procedures and the scoring system for the assessment as well as guidance on training, certification and intercalibration procedures. By integrating the abovementioned elements into the protocol it is assured that the protocol will be in compliance with the CEN standard on assessing the hydromorphological features of rivers (CEN, 2003). The protocol also considers the use of hydrological time series in the assessment of hydromorphological features. This aspect is not covered by the CEN standard.

2 ASSESSMENT STRATEGY

Underlying principles

The assessment is based on the principle that the highest quality is obtained when the hydromorphological conditions are as close to the reference situation as possible and when the spatial variation is as large as possible. When a comparison with the reference situation is possible, this is given priority. For example with plan form, a good score is given to rivers where the plan form is the same as in the reference condition and not to a specific plan form (e.g., a straight stream is given a good score if it is also straight in the reference condition). These principles have been applied in the assessment of the hydromorphological features of streams and rivers in many European countries, e.g. The River Habitat Survey in Great Britain (Raven et al., 1998), the Danish Stream Habitat Index (Pedersen and Baattrup-Pedersen, 2003), Large River Survey in Germany (Fleischhacker and Kern, 2002).

Definition of the reference condition

The reference condition is the original state of the river before it was affected by human influences. Knowledge of the reference condition is a prerequisite for correct interpretation of the hydromorphological quality within the concept of the Water Framework Directive (WFD). Old maps are a key source of information for setting the reference condition for some hydromorphological parameters. Field surveys on reference sites may be needed to identify the reference conditions for other parameters. Parameter values may differ between streams even though they are in a reference condition. This simply reflects the natural variation in parameters values found in natural systems.

Reaches and survey length

The river types and the water body delineation (definition of reaches) are carried out as part of the implementation of the WFD. In this protocol the word reach (used in the CEN standard) is used synonymously with the word water body (used in the WFD). Guidance of how to define river types and individual reaches is given in detail in the CEN standard (CEN, 2003). Typology and reach definition will be carried out as part of the WFD implementation and is not included in this protocol.

The basis for the hydromorphological survey is the survey unit (SU). The survey unit is sub-divided into 5 sub survey units (SSU) of equal length. The surveys are carried out in the five SSUs, although some parameters, such as the channel plan form of the riverbed (e.g., degree of sinuosity) are assessed for longer reaches. The survey strategy is thus hierarchical (Table 1). The size of morphological forms and features changes as river size increases and therefore the length of the SU and SSUs is scaled according to the size of rivers (Church, 2002). Adamkova et al. (2004) studied morphological variation in rivers in the Slovak Republic and proposed a classification of rivers in three size groups for the purpose of defining survey lengths (Table 2). The boundaries between river size classes were established based on the evaluation of accessible data concerning river channel width (maps at scale 1:25,000) and field observations. Channel width is used as the basis for size definitions rather than discharge because it is easily measured in the field or it can be interpreted from a map or aerial photograph.

The length of the reaches defined will vary from river system to river system and from upland to lowland streams. The exact location of the hydromorphological survey within the reach will depend on the environmental variation along the reaches defined. The selected survey unit should therefore be representative of the river reach in question with respect to channel morphology, land use, geology and geomorphology.

Table 1. Overview of the hierarchical survey strategy.

Reach	Identified as part of the WFD implementation process (equals the water body)
Survey unit (SU)	One survey unit on a representative part of the reach
Survey sub-unit (SSU)	Five sub-units on each SU, see lengths in Table 2

Table 2. Length of survey units (SU) and survey sub-units (SSU) used in the hydromorphological survey.

	Channel width	Length of SU	Length of SSU
Small river	< 10 m	200 m	40 m
Medium river	10 – 30 m	500 m	100 m
Large river	> 30 m	1000 m	200 m

Survey width

The floodplain parameters, that are included in the hydromorphological survey, are based on the whole floodplain. Riparian vegetation is assessed in a 20-meter wide zone along both sides of the river. All other parameters are based on the stream channel.

Timing of field survey

Surveys should be carried out during low flow periods when the riverbed structure and substrate is visible. In addition, the field survey should be carried out in the vegetation period from June to September, as several parameters rely on assessing the vegetation structure. The vegetation period may differ throughout Slovakia due to climatic and topographic differences, and the survey period should be adjusted to the climatic conditions.

3 SURVEY PROCEDURE

The survey procedure consists of five different steps:

1. Collection of data
2. Defining survey units within the reaches
3. Assessing map based parameters
4. Field survey
5. Assessment and presentation

Step 1. Collection of data
Data sources are maps, aerial photographs and GIS layers, as well as maps showing the water body delineation within catchments. The following material can be used for the survey:

- Topographic maps 1:10,000 or 1:25,000 for the definition of the current plan form
- Historical maps for comparison of sinuosity. Preferably Slovak Military maps or older.
- GIS databases layers or maps for land use analysis on the floodplain and in the catchment
- Geological maps (1:50,000)
- Aerial photographs and / or vegetation maps for estimation of the land use and the vegetation on the floodplain and riparian areas
- Other material regarding water abstraction, reservoir management etc.

Step 2. Defining survey units within the reaches
Representative sites should be selected based on the guidance given above and the exact location of the survey units and subunits should be determined from a map survey. The basis for this work is the delineation of the rivers into water bodies (reaches), carried out prior to the assessment described in this protocol. The locations of the units to be surveyed are marked on a topographic map and the exact boundaries of the different survey units and sub-units should also be marked.

Step 3. Assessing map based parameters
Map based parameters include catchment parameters and parameters related to channel modifications. Furthermore, parameters related to river valley form and maps and aerial photographs can also assist in the assessment of land use and floodplain structure. The results can then be checked in the field afterwards. The results are entered in the survey forms. Many site protocol parameters can also be obtained from maps. This should also be carried out prior to the field survey. In some cases the assessment of the map-based parameters will be substituted by expert judgements. This will be case where map data are unavailable. Expert judgements will typically involve transfer of data or knowledge from similar sites in other catchments or nearby sites up- or downstream from the reach under survey (Thorne *et al.*, 1997).

Step 4. Field survey
The field survey should be carried out in the survey units as defined from maps. Any changes to the location of survey unit decided in the field should be mapped and documented for future use. The exact location of survey units should be altered only where field surveying is impossible due to restrictions on access to the river.

Parameter descriptions (and pictures showing the different features) should be taken to the field in order to enhance the quality of the assessment. The field survey forms should be completed in the field and any map survey parameters should be checked whenever possible.

The field survey should be carried out by walking along the watercourse, and by wading the stream. For large rivers and waterways, that are too deep for wading, inspections are carried out by boat and occasional landings.

Step 5. Assessment

The site protocol parameters are collected to characterise the overall landscape features at the sites and in the catchment (Table 3). The assessment parameters are divided into two main groups, the morphology parameters and the hydrology parameters.

The morphology parameters can be separated into four categories: Channel form, Instream features, Bank / riparian zone and Floodplain parameters (Table 4). Each parameter is described in detail below. Each parameter is assigned a score from 1 to 5, with 1 indicating the 'best' state and 5 indicating the 'worst' state. The score for each parameter is averaged for the SU, (if the assessment is carried out on the SSU level), and the SU parameter values within each of the four categories are averaged to give a SU category score. The final morphology score is the average of the morphology category (1 – 4) values.

The hydrology category includes four parameters. The final hydrology score is the average of the four parameter scores. This score is not combined with the morphology score.

The final morphology and hydrology scores are used to determine the morphological and the hydrological quality classes (Table 5).

Table 3. Parameters to be included in the site protocol.

Parameter	Description / source of information
1 IDENTIFICATION	
1.1 Stream (River) name	Name
1.2 Site name	Name
1.3 Number of stream / site	Number
1.4 Name of river system	Name
1.5 Map reference	Number
1.6 Stream order	Number
1.7 Latitude	Co-ordinate
1.8 Longitude	Co-ordinate
1.9 Site altitude (m.a.s.l.)	Number
1.10 River width type	Type
1.11 River type (WFD)	Type
1.12 Sketch / Photo	Picture
1.13 Surveyor	Name
1.14 Surveyor certification number	Number
1.15 Date of survey	Date
1.16 River use	Type
2 CHANNEL AND SITE PARAMETERS	
2.1 Catchment area	Map or GIS
2.2 Distance to source	Map or GIS
2.3 Mean slope of the river channel	GIS or map
2.4 Cross-section type of the channel	Type
2.5 Bank stabilisation	Field survey / Type
2.6 Cross section dimensions	Field survey
2.7 Channel plan form (present)	Type
2.8 Valley type	Type
2.9 Presence of migration barriers	Field survey / expert knowledge

3 RIPARIAN ZONE AND FLOODPLAIN	
3.1 Non-natural vegetation in 20m riparian zone	Field survey / Type
3.2 Predominant land use on floodplain	Field inspection
4 CATCHMENT ATTRIBUTES	
4.1 Predominant geology	Map or GIS
4.2 Predominant soil type	Map or GIS
4.3 Predominant land use	Map or GIS
4.4 Catchment topography (min. and max.)	Map analysis
5 HYDROLOGICAL CONDITIONS	
5.1 Mean flow	Time series
5.2 Changes to the hydrological regime	Field survey / Expert knowledge

Table 4. List of parameters included in the assessment of the hydromorphololgical quality of streams in Slovakia.

Category/Parameter	Obtained from	Score for each
1 CHANNEL PLANFORM		
1.1 Sinuosity	Map / Field survey	SU
1.2 Channel type	Map / Field survey	SU
1.3 Channel shortening	Map / Field survey	SU
2 IN-STREAM		
2.1 Bed elements	Field survey	SSU
2.2 River bed substrate	Field survey	SSU
2.3 Spatial variation in width	Map / Field survey	SU
2.4 Flow types	Field survey	SSU
2.5 Large woody debris	Field survey	SU
2.6 Artificial bed features	Field survey	SSU
3 BANK /RIPARIAN ZONE		
3.1 Riparian vegetation	Field survey	SSU L / R
3.2 Bank stabilisation	Field survey	SSU L / R
3.3 Bank profile	Field survey	SSU L / R
4 FLOODPLAIN		
4.1 Flooded area	Map / Field survey	SSU L / R
4.2 Floodplain vegetation	Map / Field survey	SSU L / R
5 HYDROLOGY		
5.1 Mean flow	Data / other information	SU
5.2 Low flow	Data / other information	SU
5.3 Water level range	Data / other information	SU
5.4 Frequent flow fluctuations	Data / other information	SU

Table 5. Preliminary delineation of the hydromorphological quality classes defined from the final score.

Hydromorphological quality class		Final score	Colour
1	High	1,0 – 1,7	Blue
2	Good	1,8 – 2,5	Green
3	Moderate	2,6 – 3,4	Yellow
4	Poor	3,5 – 4,2	Orange
5	Bad	4,3 – 5,0	Red

Survey forms
Three survey forms are to be completed for each survey unit (SU): the site protocol, an assessment form for the structural features and a form for the hydrology. The site protocol holds the general descriptions of the SU, including identification, site attributes and catchment attributes. The assessment form holds the actual assessment. The site protocol describes the present state of the river, whereas many of the assessment parameters describe the present state compared to the reference situation.

4 ASSESSMENT PARAMETERS

4.1 SITE PROTOCOL

The site protocol includes a number of parameters used to characterise the river and the surroundings. It is also used to identify the survey site and includes many relevant parameters that will enable a variety of analyses. Most parameters can be used to group streams with identical features thereby enabling comparison of hydromorphological and biological parameters among identical streams.

The site protocol consists of 5 separate parts: Identification, channel parameters, riparian and floodplain features, catchment features and hydrological parameters. The first parameters are used to identify the site and the exact location within the catchment. Many of the parameters can be assessed from maps; the remaining should be assessed from other relevant sources. Individual map parameters should preferably be derived from maps having identical scales to ensure consistent parameter estimation. The surveyor, date of survey, and a photo or a sketch of the site is also included in the identification part of the protocol. The site form is supplied in Annex A.

1.1 Stream / River name
Name of the river or stream where the survey is carried out.

1.2 Site name
The exact location of the survey. Usually the name of a nearby bridge or town.

1.3 River log
Distance to river mouth (in km) of most downstream end of SU

1.4 Number of stream / site
The number according to the Slovak hydrometric network.

1.5 Name of river system
The name of the river system where the river / stream is located, e.g. Morava or Váh.

1.6 Map reference
Identification number of the map (1:50,000) where the site is located. E.g. 34-42.

1.7 Stream order
Stream order number according to the delineation of the rivers in Slovakia, e.g. Danube has stream order 1 and Morava has stream order 2.

1.8 Latitude and 1.9 Longitude
Exact latitude and longitude of the site extracted from map (1:50,000) or GIS.

1.10 Site altitude
Approximate site in meters above sea level (m a.s.l.) altitude taken from the map (1:50,000).

1.11 River width type
Small, medium or large river type as defined by the width of the water surface at the day of survey.

1.12 River type (WFD)
The river type according to the national Slovak typology according to the WFD.

1.13 Sketch / Photo
A sketch or photo showing the characteristics of the site should be included in the protocol

1.14 Surveyor
Name of the surveyor carrying out the field survey.

1.15 Surveyor certification number
For quality assurance only certified surveyors should carry out the surveys and the identification number should be supplied with every survey form.

1.16 Date of survey
The date of survey should be stated for later use.

1.17 River use
Human use of the river for different purposes might affect the conditions at the site and is characterised using the following categories:
- Transport
- Waste water
- Water abstraction
- Recreational use
- Power production
- No use

Each parameter affecting the natural conditions at the site is marked with “X” in the protocol.

2.1 Catchment area
Catchment area (km^2) should be determined from maps (1:50,000) or using GIS. Catchment area should include the entire SU and should therefore be calculated from the downstream part of SU.

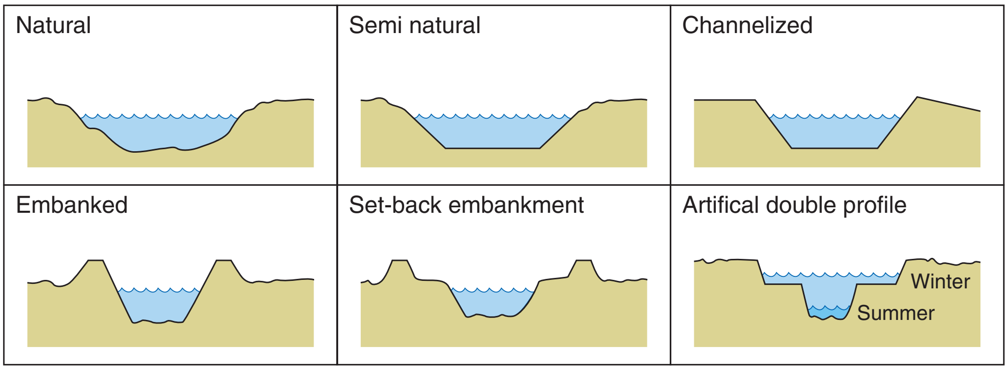
2.2 Distance to source
Distance to source (km) should be determined from maps (1:50,000) or using GIS. Distance is calculated from downstream end of SU

2.3 Mean slope of the river channel
The stream slope is calculated as the difference in elevation (in meters) between two points on the reach divided by the distance (in kilometres) between the two points. The stream slope should be determined from maps using the following minimum lengths:
- Small rivers: 2,000 m
- Medium sized rivers: 5,000 m
- Large rivers: 10,000 m.

The survey unit should be situated within slope assessment length. If there are any significant tributaries entering the river or other significant changes to the river planform (e.g. dam) within the defined length, the assessment length should be reduced to exclude these changes in planform.

2.4 Cross-section type of the channel
The predominant channel cross section type should be assessed in the field and marked with “X” in the site protocol (Fig. 1).

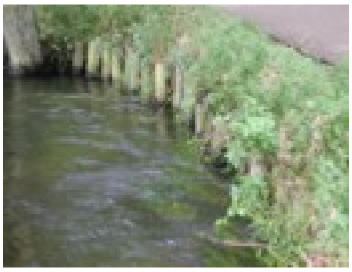
Figure 1. Cross section types.



2.5 Bank stabilisation

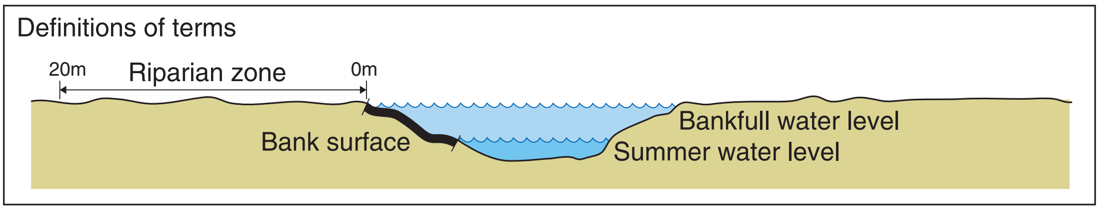
If the bank has been artificially stabilised the type of stabilisation used is marked with "X". The different types comprise resectioned banks, wood piling, boulders, brickwork, steel piling and concrete. Pictures of the different bank stabilisation types are shown in figure 2.

Figure 2. Bank stabilisation types.

Resectioned banks (Photo: Ovesen, 2004) 	Wood piling (Photo: Ovesen, 2004) 
Boulders / gabions (broken surface) (Photo: Ovesen, 2004) 	Brickwork / boulders (unbroken) (Photo: Lehotský & Grešková, 2004) 
Steel piling (Photo: Ovesen, 2004) 	Concrete (Photo: Ovesen, 2004) 

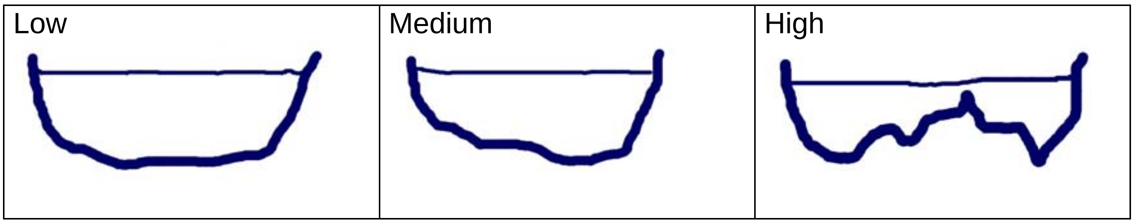
2.6 Cross section dimensions
The cross section dimensions should preferably be measured at a riffle or a glide/run. Actual width of the river is measured and the bankfull width is also measured/estimated. Bankfull width is the distance between the top of the left bank and the top of the right bank (Fig. 3). Bankfull width in streams in narrow valleys can be estimated from debris lines along the valley sides.

Figure 3. Identification of the bankfull width.



2.7 Depth / Variation in depth
The deepest point on the reach is measured. For safety reasons, if the deepest point is above 1 m the field (> 1m) is ticked. The variation in depth is assessed as either low, medium or high depending on the variation in depth in the cross sections (Fig. 4)

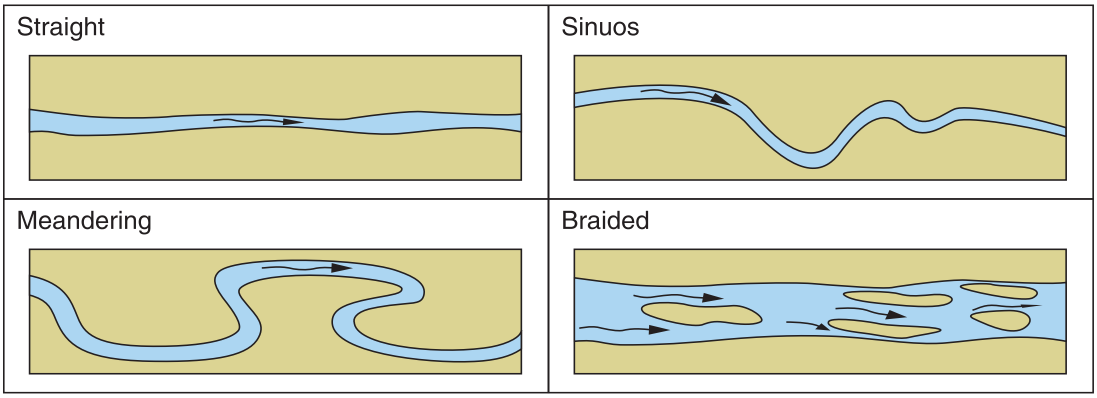
Figure 4. Variations in depth.



2.8 Macrophyte coverage
The coverage of macrophytes is estimated as either: none, low coverage (1-20%), medium coverage (20-50%) or high coverage (>50%).

2.9 Channel plan form
The predominant channel planform should be assessed in the field and marked with "X" in the site protocol (Fig. 5).

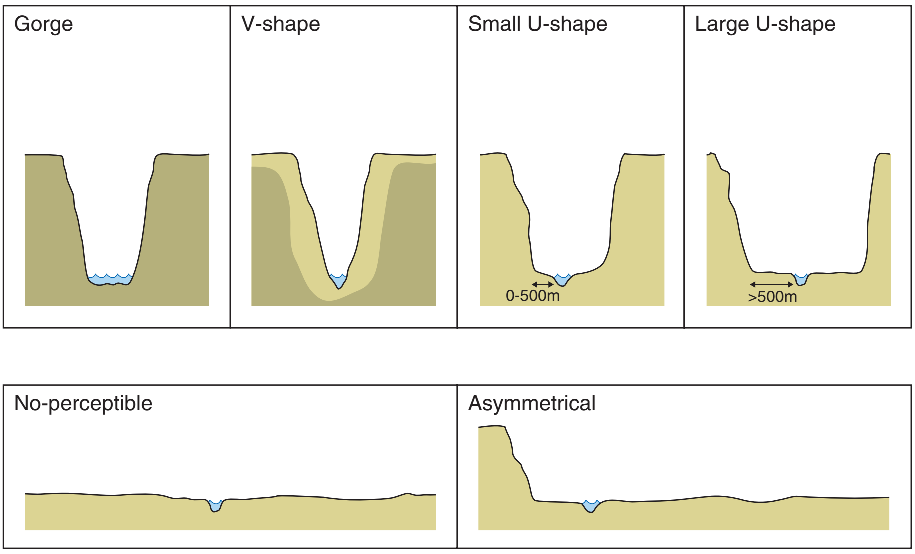
Figure 5. Channel planform



2.10 Valley type

The predominant river valley type should be assessed in the field and marked with "X" in the site protocol (Fig. 6).

Figure 6. River valley form.



2.11 Presence of migration barriers

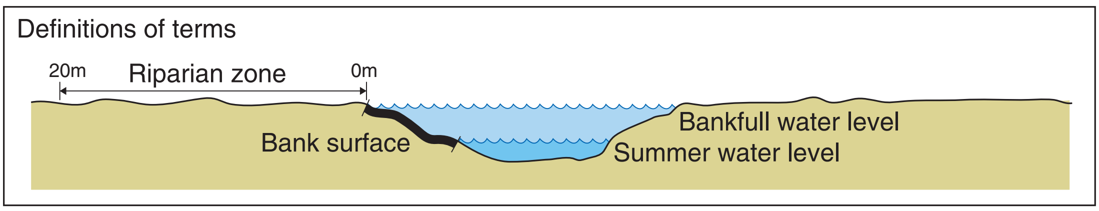
The presence of natural and/or artificial migration barriers in the river is assessed by identifying the type of barrier, the distance from the survey site, height and the possibility for migration by an artificial structure. This information can be obtained from maps or expert knowledge (river managers).

3.1 Non-natural vegetation in 20 m riparian zone

The riparian zone extends 20 m from the top of the bank (Fig. 7). The non-natural vegetation present in this 20 m zone should be assessed in the field, and the coverage (to nearest 5%) should be assigned to one of the following categories:

- Closed line of native trees
- Isolated native trees
- Tall herbs / shrubs
- Isolated not-native trees
- Closed line of alien trees
- Plantation
- Grass
- Crop field
- Destruction by erosion
- Artificial structure

Figure 7. Extension of the riparian zone.



3.2 Predominant land use on floodplain

The land use on the entire floodplain should be assessed from aerial photos and maps and should be checked in the field where possible. The assessment should distinguish between the following land use categories (to nearest 5%):

- Buildings (houses, cities, roads)
- Natural or semi-natural open land
- Agriculture
- Freshwater (lakes etc.)
- Natural forest
- Wetlands
- Plantation

4.1 Predominant geology and 4.2 predominant soil type

The predominant hard rock geology and soil types in the catchment is marked with and “P” in the site protocol. Other types of hard rock geology and soil types present should be marked with “X” in the protocol. The geology types comprise:

- Crystalline
- Carbonate
- Flysch
- Neovolcanics
- Non-coherent predominantly lutaceous
- Non-coherent predominantly psammtious

and the soil types include:

- Sand
- Fine sand
- Clayey sand
- Sandy clay
- Clay
- Heavy clay
- Organic soils
- Other special soil type

4.3 Predominant land use

Using the same land use categories as on the floodplain the predominant land use is marked with “P” and other types present with “X” in the site protocol.

4.4 Catchment topography

The highest and the lowest point (sampling site altitude) in the catchment should be extracted from either a digital terrain model or topographic maps (preferably 1:50,000). These parameters will yield information on topographic differences in the catchment and will enable a grouping of sites by altitude in later analyses.

5.1 Long-term mean flow

If there are any hydrological time series at the station or can be transferred to the station by correcting for the catchment area, the long-term mean flow can be calculated for the site. This will enable analysis of hydromorphological conditions for sites with different flow regimes when data from many sites are collected. This parameter is optional.

5.2 Changes to the hydrological regime

Expert knowledge of changes to the hydrological regime at the site can be described using the following categories:

- Unaffected/slightly modified
- Moderate
- Major

Both changes due to groundwater and surface water abstraction can be described in the site protocol. Information on changes to the hydrological regime can be obtained from either the national hydrometric network or from the water managers (primary source).

4.2 ASSESSMENT PROTOCOL

The assessment protocol is divided into five categories or groups of parameters. Four parameters are each targeting different aspects of the hydromorphological structure of the river/stream and the fifth target the hydrological aspects of the hydromorphological quality. All parameters and the methods for assessing these either in the field or on maps are described in detail below. The assessment or survey form is shown in Annex B.

1. Channel plan form parameters

The parameters are assessed according to their current state relative to the historical and non-degraded state. They are found by comparing present day features from the 1:25,000 maps with features from historical maps (for instance the First Military Cartographic Mapping of the Slovak territory). All three parameters should be assessed over longer distances, using the following minimum lengths: Small rivers: 2,000 m, Medium sized rivers 5,000 m, Large rivers 10,000 m (see definition of size of rivers in Table 2). If there are any significant tributaries entering the river or other significant changes to the river planform (e.g. dam) within the defined length the assessment length should be reduced to exclude these changes in planform.

If no old maps exists or the channel on the old maps shows sign of modification, the three channel parameters have to be assessed by expert judgement. This should include an analysis of the land use, river valley slope, geology and geomorphology, from which the natural type can be interpreted with help from the literature (e.g., Rosgen, 1996; Thorne *et al*., 1997; Thorne, 1998). Another possibility is that the historic type and channel pattern can be inferred from a similar site with similar characteristics and data available. Alternatively, remnants of the old channels in the flood plain can potentially be identified on aerial photos, from which the historic channel type, length and sinuosity can be estimated.

The Channel planform score (CPS) is calculated as the average of the scores given for channel sinuosity, channel type and channel shortening:

CPS = (1.1 + 1.2 + 1.3)/3

<u>1.1 Channel sinuosity</u>

Sinuosity is found by measuring the length of the channel thalweg and dividing it by the length of the valley (Fig.8). The sinuosity (SI) is calculated from the following equation:

SI = Distance in stream channel/distance in straight line along the river valley floor

The SI values from the historic map and the new map are compared and the score is found from Table 6.

Figure 8. Two examples from River Váh, Slovakia showing calculation of SI and sinuosity. The blue line is the river and the red line is the straight line along the river valley.

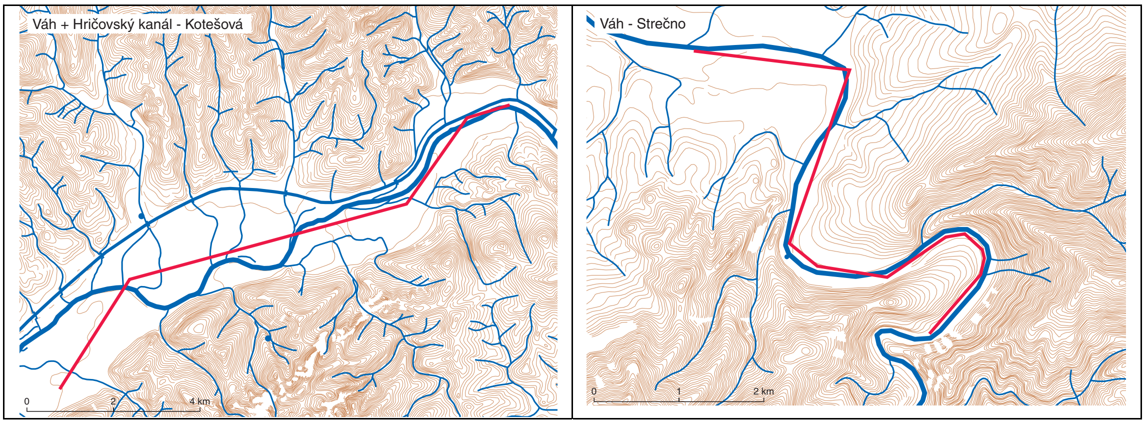


Table 6. Table for evaluating parameter 1.1 Channel sinuosity.

		Historic (reference)		
		Straight	Sinuous	Meandering
Present	Straight (1.00-1.05)	1	4	5
	Sinuous (1.05-1.50)	1	1	2
	meandering (>1.50)	1	1	1

1.2 Channel type

The channel type is identified using the following definitions:

Single thread — Single channel river. If there are gravel bars or islands, the channel is no wider than the respective channel without bars or islands.

Parallel channels — Anastomosing and anabranching rivers, where the channel is split into two or more persistent branches.

Braided — River divided by gravel bars that are wider than the average width of the unbraided channel or where there are three or more overlapping bars.

The score is found from Table 7.

Table 7. Table for evaluating parameter 1.2 Channel type.

		Historic (reference)		
		Single channel	Parallel channels	Braided
Present	Single channel	1	3	5
	Parallel channels	1	1	3
	Braided, anastomosing	1	1	1

If there are no historic maps, the natural type has to be estimated from the literature using information on geology and geomorphology (e.g., Rosgen, 1996; Thorne *et al*., 1997). Alternatively remnants of the old channels in the flood plain can potentially be identified on aerial photos and the historic channel type can thus be estimated.

1.3 Channel shortening

Channel shortening is measured directly on the maps. Shortening of a river is expressed as a percentage of the original channel length. The score is determined from Table 8. If the channel shortening cannot be assessed and it appears that the stream channel has been shortened or otherwise modified, the score is 3.

Table 8. Table for evaluating parameter 1.3 Channel shortening.

Shortening	Score
<10 %	1
10-30 %	3
>30 %	5

2. In-stream features

The in stream parameters are assessed in field and comprise several parameters related to the current conditions in the stream and on the stream bed. The in-stream parameters should be surveyed from within the stream. The in-stream features are all evaluated at the scale of the SSU. After the in-stream features have been assessed, the scores of all SSUs are first averaged and then the in-stream feature score (IFS) is calculated as the average of the scores given for the SU, i.e.:

IFS = (2.1 + 2.2 + 2.3 + 2.4 + 2.5 + 2.6)/6

2.1 Bed elements

This parameter gives the number of individual bed elements such as islands, various bar forms and rapids (bedrock bars). If the river is too large for bed elements to be identified, this parameter is excluded from the assessment. The minimum size (either width or length) of the individual structure must reach 1/3 of the channel width (which is defined here as the distance between the left bank and the right bank at the time of the survey at the location of the structure). The different structures considered are (Fig. 9):

Bars — Bed-load/sediment accretions not flooded at mean water level, e.g. point bars, channel junction bars, mid-channel bars.

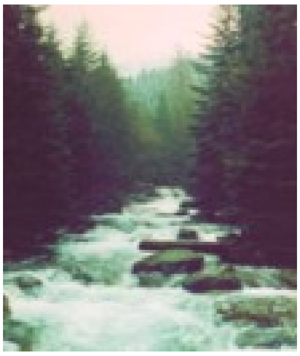
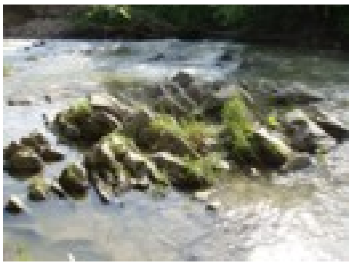
Islands	Distinctly higher than bars and often almost at level with the adjacent floodplain. They are therefore less frequently flooded and carry trees that are several years old. Islands which have developed as a result of the construction of weir systems are also recorded as it is not possible to fully establish the origin of their formation.
Riffles/rapids	Riffles are shallow flooded ridges composed of coarser sediment. The water surface is distinctly disturbed, forming upstream-facing wavelets. Rapids consist exclusively of solid rocks protruding from the riverbed and generating a rapid flow.
Rocks	Large isolated rocks that are partly above the water level. The rocks must cover more than 5% of the surface area (the rocks themselves and the flow conditions they modify).
Step/pool	The upland equivalent of the riffle pool sequence in lowland streams. The streambed is usually made up of steps of stones and boulders where the water flow is either a chute or free fall or chaotic flow. Between the steps the pools are found. These are characterised by low flow and (usually) finer material.

The score for each SSU is determined from Table 9.

Table 9. Table for evaluating parameter 2.1 Bed elements.

	% area of SSU (all elements)		
Number of bed elements	< 10 %	10-50 %	>50 %
3 or more	1	1	1
2	3	2	1
1	4	3	1
None	5		

Figure 9. Bed elements

Bar (Photo: Lehotský & Grešková, 2004) 	Island (Photo:Ovesen, 2004) 
Riffle (Photo: Lehotský & Grešková, 2004) 	Rapid (Photo: Lehotský & Grešková, 2004) 
Rocks (Photo: Lehotský & Grešková, 2004) 	Step pool sequence (Photo:Ovesen, 2004) 

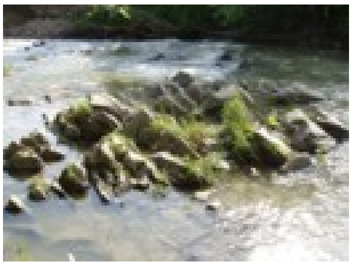
2.2 Bed substrates

The assessment is carried out while standing in the river. The natural bed substrate is assessed by counting the number of different types that cover more than 5% of the bed in the SSU. The abbreviations for the substrates that cover more than 5% of the bed are circled in the assessment form. The abbreviations stated below are also used on the assessment form.

The different substrate types considered are:

Bedrock (BE)	exposed solid rock	
Boulder (BO)	loose rocks	> 256 mm diameter
Cobble (CO)	loose material	64 – 256 mm diameter
Gravel/pebble (GR)	loose material	2 – 64 mm diameter
Sand (SA)	particles	0.06 – 2 mm diameter
Coarse debris (CD)	Organic matter > 1 mm (leaves, twigs, small pieces of wood etc.)	
Silt/mud (MU)	very fine deposits < 1 mm	
Clay (CL)	solid surface comprising sticky material	
Peat (PE)	predominantly or totally peat, organic origin	

Figure 10. Bed substrate types

Bedrock (Photo: Lehotský & Grešková, 2004) 	Boulder (Photo: Lehotský & Grešková, 2004) 
Cobble (Photo: Ovesen, 2004) 	Gravel / Pebble (Photo: Ovesen, 2004) 
Sand (Photo: Ovesen, 2004) 	Coarse debris (CPOM) (Photo: Ovesen, 2004) 
Silt / Mud (Photo: Skriver, 1998) 	Peat (Photo: Pedersen, 2004) 

Artificial substrate, e.g., concrete, is not considered as a bed substrate.

The score for each SSU is determined from Table 10. If all coarse substrate types (boulder, cobble and gravel/pebble) are present, the SSU automatically scores 1. If the inorganic substrates are estimated to be covered by more than 25% silt/mud or more than 75% bio-film (e.g. filamentous algae) scores below 5 should be added +1. If silt/mud cover is estimated to cover more than 50%, scores below 4 should be added +2 and the score 4 should be added +1. If the riverbed is completely covered by artificial substrate the score is 5. The score for the SU is determined as the average score of the five SSU scores.

Table 10. Table for evaluating parameter 2.2 Bed substrates.

Number of substrate types	Score
1	4
2	3
3	2
4 or more	1
If mud covers >25% or biofilm >75%	+1
If mud covers >50% and score is 1,2,3	+2
If mud covers >50% and score is 4	+1
100% artificial substrate	5
100% boulders, cobble, gravel	1

2.3 Variation in width

Variation in width is defined as the largest channel wetted width divided by the smallest channel wetted width in the SU at the time of the survey. The width is the distance from the right bank to the left bank perpendicular to the current, independent of whether islands occur in the cross-section. For large rivers, the value is found from topographic maps (scale 1:10,000 or 1:25,000) or on aerial photographs. Man-made structures such as port entries, etc., and small-scale protrusions are not taken into account. For smaller rivers the variation of width is measured in the field. The smallest and largest river widths are measured in each SSU and added to the assessment form. The ratio between the largest and the smallest width considering all measurements within all the SSUs is calculated. The score is found from Table 11.

Table 11. Table for evaluating parameter 2.3. Variation in width.

Variation in width	Score
Very low (1.00-1.10)	5
Low (1.11–1.25)	4
Moderate (1.26-1.50)	3
High (1.51-2.00)	2
Very high (>2.00)	1

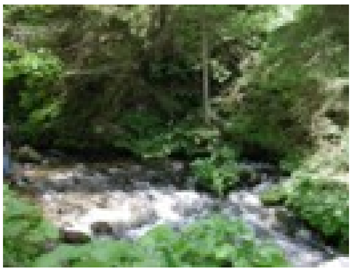
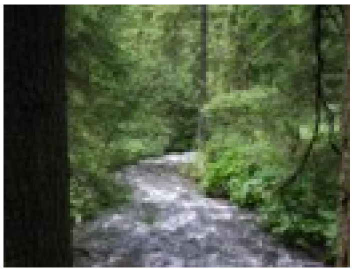
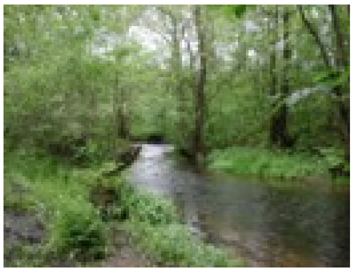
2.4 Flow types

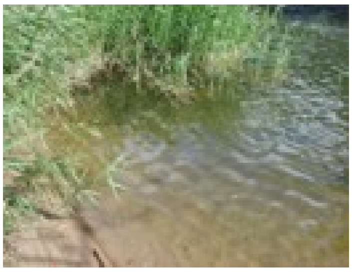
This parameter is the number of different flow types in the SU. The flow types included in the assessment are based on the flow types defined in the River Habitat Survey in the UK. The abbreviation stated below are also used on the assessment form. The flow types are defined as:

Freefall (FF)	The flow separates clearly from the back wall of a distinct vertical feature. Generally associated with waterfalls.
Chute (CH)	A low curving fall with substantial flow contact with the substratum. There may be multiple chutes in a short distance often over boulders or bedrock outcrops. Associated with cascades.
Chaotic (CA)	No clearly distinctive flow patterns when more than one flow type are occurring close together.
Broken standing waves (BS)	Mostly associated with rapids and riffles. White water tumbling wave is present.
Unbroken standing wave (US)	Often associated with riffles. This flow type has a disturbed surface with upstream facing wavelets.
Rippled (RP)	No coherent pattern in the flow direction and no waves. Wavelike ripples are asymmetrical and only a centimetre or so in height. Be aware that wind can

	affect the assessment as it can create a rippled surface (and in a few cases standing waves).
Upwelling (UP)	Occurs where the water surfaces ‘heave’ as upwelling reach the surface, e.g. at tight bends or below cascades and behind in-stream vegetation.
Smooth (SM)	Moving water without a disturbed surface. Associated with glides.
No perceptible flow (NO)	Associated with pools and ponded reaches. No overall movement of the water is visible.

Figure 11. Flow types.

Freefall (Photo: Lehotský & Grešková, 2004) 	Chute (Photo: Lehotský & Grešková, 2004) 
Chaotic (Photo: Ovesen, 2004) 	Broken standing waves (Photo: Ovesen, 2004) 
Unbroken standing waves (Photo: Ovesen, 2004) 	Rippled (Photo: Ovesen, 2004) 
Upwelling (Photo: Ovesen, 2004) 	Smooth (Photo: Ovesen, 2004) 

No perceptible flow (Photo: Ovesen, 2004) 	

Each flow type should cover > 5% of the surface area to be scored with the exception of flow types free fall and chute which only have to be present. On the assessment form all substrate types that are present in the amounts needed for scoring are circled and subsequently counted and the score for each SSU is determined from Table 12. The score for the SU is determined as the average of the five SSU scores.

Table 12. Table for evaluating parameter 2.4 Flow types.

Number of flow types	Score
1	5
2	4
3	3
4	2
>4	1

2.5 Large woody debris

The parameter is the density of large woody debris (LWD). LWD is defined here as trees or substantial parts of trees that are either at least 3 metres long or have a diameter of more than 30 cm (Large Woody Debris, LWD) for medium sized and large rivers, and for small rivers the dimensions are half of these values. LWD is found in the channel and must be partly under water at the time of the survey. Forty pieces of LWD per km are considered to represent the potential natural state. If aggregations of LWD are present each individual LWD is counted. This value is based on results obtained in navigable rivers in North America and has been verified during the mapping of the lower course of the Mulde in Germany (Kern *et al.*, 2002). Above the treeline the LWD score is set to 1.

LWD is recorded for the each SSU and the value is scaled to represent the number of LWD per km reach. The score is determined from Table 13. Note that if the LWD is smaller than the limit set here, it should be assessed as CPOM substrate and thus count in the bed substrate assessment, if coverage exceeds 5% in total (2.2).

Table 13. Table for evaluating parameter 2.5 Large woody debris.

No. of LWD km^{-1}	Score
>40	1
21 – 40	2
11 –20	3
1 – 10	4
None	5

2.6 Artificial bed features
This covers constructions such as fairway, bed reinforcement, parallel structures, groynes, ground sills, pipeline crossing and colmatage. Artificial bed features are always made of artificial materials that are not endemic to the stream / river. The score is given according to the length of the affected river, see Table 14.

Table 14. Table for evaluating parameter 2.6 Artificial bed features.

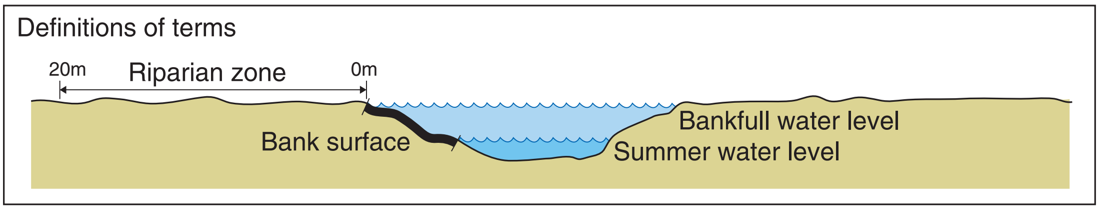
% coverage of length	Score
None	1
Low (< 10%)	2
Some (10 – 50%)	3
Many (> 50%)	5

3. Bank / Riparian zone parameters
Bank and riparian parameters are assessed separately for the left and the right side of the stream in each SSU. The scores for each parameter are first averaged for all SSU and then bank and riparian score (BRS) is calculated as the average of the three bank and riparian parameters.

BRS = (3.1 + 3.2 + 3.3)/3

3.1 Natural riparian vegetation
This includes vegetation in the riparian zone along both channel banks. The riparian zone is here defined as a 20-metre strip with the lower boundary at bankfull level (Fig. 12). Islands are not included in the survey. Note that in the case of trees it is the projected area of the canopy that is used for the coverage and not the stem of the tree.

Figure 12. Identification of the riparian zone where vegetation is assessed.



The land-use in the riparian zone is categorised in 4 groups, and the percentage coverage of the area of the 20-metre strip is estimated.

Natural riparian vegetation:
Natural riparian vegetation includes stands of natural riparian forest or single trees (alluvial river banks); bank areas of bedrock (narrow valleys); reed wetland (occasionally in lowland rivers).

Other vegetation types:
Herbs, tall herbs and shrubs, meadow, pasture, non-native trees.

Managed land:
Arable land, parkland, gardens, golf courses etc.

Artificial structures:
Roads, rail, urban, industrial etc.

Footpaths are not considered as an artificial structure. The survey is carried out separately for the left and the right side of the river in each sub-unit. Scores are given according to the extent of the different groups:

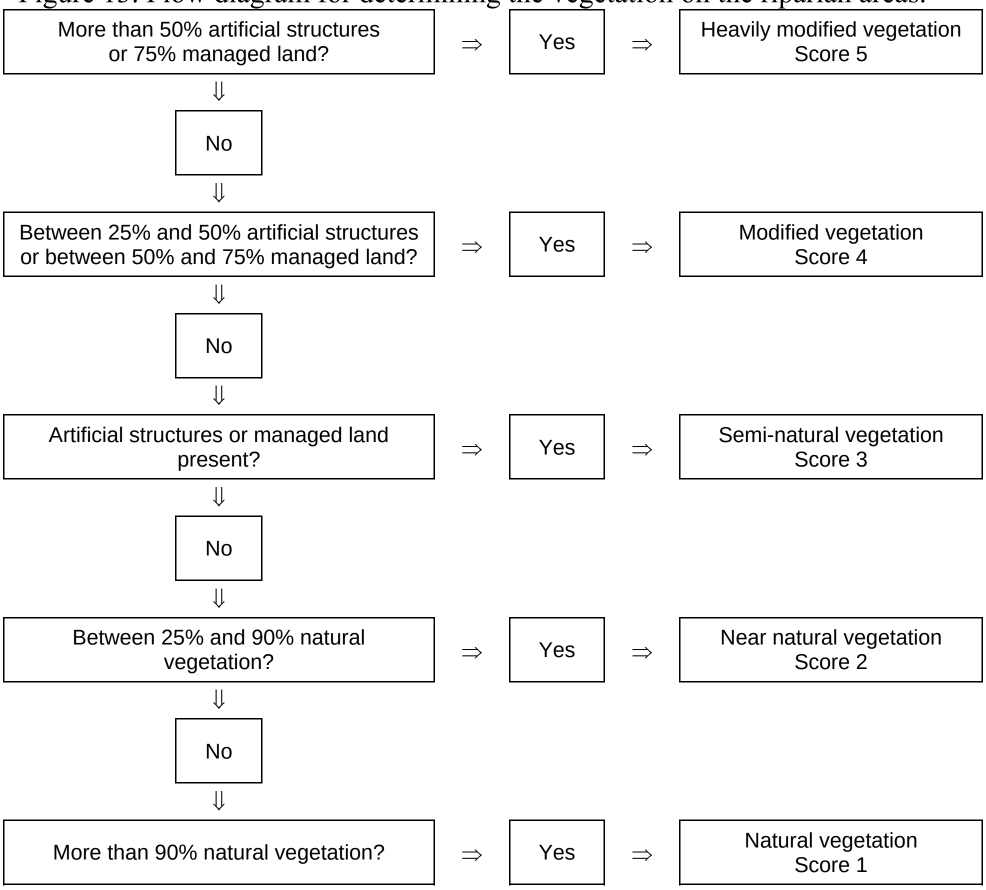
Natural: >90% natural vegetation. Rest: other vegetation types. No artificial structures or managed land.
Near natural: 25% - 90% natural vegetation. Rest: other vegetation types. No artificial structures or managed land.
Semi-natural: <25% artificial structures or <50% managed land
Modified: 25-50% artificial structures or 50-75% managed land
Heavily modified: >50% artificial structures or >75% managed land

Table 15. Table for evaluating parameter 3.1 natural riparian vegetation.

Natural riparian vegetation	Score
Natural	1
Near natural	2
Semi-natural	3
Modified	4
Heavily modified	5

The flow diagram in figure 13 can be used to determine the vegetation quality class and the score for the riparian vegetation.

Figure 13. Flow diagram for determining the vegetation on the riparian areas.



3.2 Bank stabilisation

This parameter is used to assess the restriction of natural lateral dynamics due to stabilised banks and a separate assessment for the left and right bank is carried out. The survey is field based and is carried out in each of the 5 sub-units. The percentage length of the river bank affected by stabilisation structures is assessed in the field.

The survey only includes the actual riverbanks; banks of islands are not to be taken into account. The following definitions apply to the assessment and field survey:

Bank stabilisation: This comprises any structure that impedes the lateral movement of the river. In small rivers, such structures usually consist of rip-rap or set rubble stone, while waterways are mainly stabilised with groynes, revetments and parallel structures. Also to be taken into account are therefore stabilisation's near bridges and moorings.

Groynes: Groynes are considered as bank stabilisation features, if the distance between the groynes is less than or equal to 1.5 times the length of the groynes. The area where the groynes are connected to the bank is also stabilised (generally < 10 % of the unit length).

Parallel structures: Relevant is the length of the bank that is protected by the structure.

If coarse sediment (boulders) is occasionally added to the bank, the degree of stabilisation can normally be set between 10 and 50 %. If more than 50% of the bank is stabilised the differentiation between score 4 and 5 is based on the extent of the stabilisation. If only a minor part (corresponding the bank foot) is stabilised a score 4 is given. If the extent of the stabilisation exceeds this a score 5 is given.

Table 16. Table for evaluating parameter 3.2 Bank stabilisation

Extent of bank stabilisation in percentage of length	Score
None	1
<10 %	2
10-50 %	3
>50 % part of the bank surface affected	4
>50 % entire bank surface affected	5

3.3 Bank profile

The assessment focuses on the length of natural riverbanks in the SSU. The habitat quality of profiled and stabilised banks is considered additionally. The survey is carried out for both left and right bank. The determination of the share of natural banks in a unit requires a field survey for all river sizes. In order to distinguish between natural and artificial banks short descriptions of the characteristic features for each type are given.

Natural banks

Natural banks include all banks that are not stabilised or modified in shape by river training. Areas of erosion and accretions generally represent natural banks. Revetments covered by sediments are considered as natural banks, as the aspect of habitat quality is relevant for the assessment.

Artificial bank structures

Resectioned banks or bio-engineering: Banks with artificial shapes or banks with bioengineering techniques for stabilisation. Banks with artificial shapes that has regained some natural variation after a period of time (5 – 10 years) are evaluated as semi-natural.

Wood piling: All stabilisation techniques based on timber, (excluding bio-engineering techniques).

Boulders, gabions (open space): Rip-rap revetments, set rubble stones with large damaged sections (i.e. with gaps), rubble stones combined with rip-rap.

Boulders, brickwork (unbroken): Cobble, set rubble stones, bricks, walls, concrete surfaces. In case of modified banks only the predominant type is to be taken into account. If boulders are occasionally added to the bank, the profile for the reach is set to semi natural.

Artificial two stage channel: This is where the bank has been excavated laterally into the floodplain to create a shallow shelf above dry-weather flow. Water spills into the second stage channel during flood event.

Poached: Bank significantly trampled or puddled by livestock. Includes banks tramped as a result of human activities.

Embanked: Embankment created to artificially increase the banktop height. Forms an integral part of the bank.

Set-back embankment: Artificial embankment to increase flood capacity but set back from the river channel and forming a distinct landscape feature. In small and medium sized streams (<30 m) embankment within 5 m from then channel counts and set-back embankment within 10 m count in large rivers (> 30 m).

Table 17. Table for evaluating parameter 3.3 bank profile.

Length of natural bank	Score
>90% Natural	1
90-60% Near natural	2
60-30% Semi natural	3
10-30% Modified	4
<10% Heavily modified	5

4. Floodplain parameters

Subject of the assessment is the extent of the current floodplain exposed to frequent flooding compared with the extent of the natural (historic) floodplain and the natural vegetation/land use in the current floodplain. The assessment considers the extent of natural alluvial habitats (i.e. alluvial forest including abandoned channels such as oxbows, side-arm systems and cut-off meanders) and the type of land use in cultivated areas. Undisturbed floodplains are characterised by wetland vegetation, natural forests and/or natural water bodies. These water bodies must be in contact with surface water channel. The floodplain is identified based on geological/soil/morphological criteria (map and field). The assessment is carried out in each of the survey sub-units and on the both sides of the river. Results are averaged for all SSUs and sides and then the floodplain score (FPS) is calculated as:

FPS = (4.1 + 4.2)/2

The field survey/assessment involves two parameters:

1. Size (percentage) of present natural floodplain area compared to potential (historical)
2. Land use / natural vegetation in floodplain

Along major rivers, the floodplain is defined as the area over alluvial deposits (refer to geological maps). The survey is based on aerial photographs, topographic maps and other specialised maps available (vegetation maps, habitat maps, forestry maps, geological maps, etc.). Site inspection of floodplain areas can be omitted in very large rivers or where floodplains are very wide. In these cases the floodplain can be identified on geological/soil/morphological criteria (map and field).

4.1 Flooded area

The flooded area is here defined as that part of the floodplain that has the potential of being flooded.
Subject of the assessment are the retention function of the floodplain and its function as a meander corridor (morphodynamic channel migration). Therefore the actually flooded area must be estimated in relation to the old alluvial floodplain. Flood controlling structures such as guide dykes must be taken into account.

The survey and assessment are carried out separately for each section of the floodplain and the L and R bank. This parameter is only relevant in alluvial valleys. The survey is fully based on maps and existing information (no field survey) and is concentrated in the survey unit. In case of multiple discrete sub-units the entire length from the upstream to the downstream sub survey unit is considered.

Inundated area: Determine the current flooded area (active floodplain); calculate its share of the old natural alluvial floodplain (geological map: area of alluvial deposits). The frequency of flooding is not relevant for this parameter.

Guiding/summer dykes: All dykes located within the inundated floodplain (e.g. summer dykes, remainder of old dykes or road dykes) that affect flooding. The presence of such structures in relation to the section length of the river axis is not included in the score but has to be registered in the site protocol. The score is given from Table 18

Table 18. Table for evaluating parameter 4.1 Floodplain area.

Size of present potentially inundated floodplain area related to historic area	Score
0 %	5
<10 %	4
10-50 %	3
>50 %	2
Entire floodplain *	1

* If there is no floodplain and the river is unaffected (typical upland stream), the score is 1.

4.2 Natural vegetation / land use on floodplain

Natural floodplain (floodplain forest, wetland and abandoned channels): The area covered by natural or secondary forest, wetlands and abandoned channels in relation to the total survey section area must be estimated for each side of the river. The share of non-indigenous species may not exceed 10%. Abandoned channels must be connected to the flow regime of the river (surface connection to the river or connection by groundwater), in order to be part of the natural floodplain area.

Land use in remaining area: Subject to the assessment score is only the relation between natural/not natural land use. Registration of the types of not natural land use on each side of the river is to be registered in the site protocol.

The percentage of the actual floodplain covered by natural vegetation is estimated for each bank of the sub-unit, and the score is set according to Table 19. The arithmetic mean of the 5 assessments from each side of the in sub-unit is used as the final score. The final score is subsequently included as a decimal value in the assessment.

In case of narrow valleys lacking a floodplain, the natural floodplain vegetation scores 1.

Table 19. Table for evaluating parameter 4.2 Natural vegetation / land use on floodplain area.

Natural vegetation in floodplain area	Score
>90 %	1
90-60 %	2
60-30 %	3
10-30 %	4
<10 %	5
No floodplain	1

5. Hydrological regime assessment

This group of parameters is used to evaluate the effect of artificial impacts on the hydrological regime in the SU. Artificial impacts include changes caused by hydropower dams and operation, abstractions (for irrigation, water supply, etc.) and industrial outlets to the stream.

The hydrological quality is assessed by 4 parameters, one describing the change in mean flow, one describing the change in low flow, one describing the change in water level range and one describing the impact of artificial frequent flow fluctuations, all compared to the reference state. Preferably the estimates are based on hydrological records. If records are not available, the parameters are estimated from available data of abstraction rates, outlet rates from power stations, industrial discharges, etc. Another option is to obtain estimates of mean flow, low flow and high flow from before and after the artificial impact from other sources (recorded observations, general knowledge).
The hydrological regime score (HRS) is calculated as the average of the scores given for mean flow, low flow, water level range and frequent flow fluctuations:

HRS = (5.1 + 5.2 + 5.3 + 5.4)/4

5.1 Mean flow

The score is based on the reduction in mean flow from the mean flow in the reference state (Table 20).

Table 20. Table for evaluating parameter 5.1 Mean flow

Reduction in mean flow	**Score**
None or minor (app. 0-10%)	1
Moderate (app. 10-50%)	3
Major (>50%)	5

5.2 Low flow

The score is evaluated based on the reduction in low flow from the low flow in the reference state (Table 21). If hydrological records are available, Q_{355} can be used. Otherwise the low flow is the typical flow during low flow periods.

Table 21. Table for evaluating parameter 5.2 Low flow

Reduction in low flow	**Score**
None or minor (0-10%)	1
Moderate (10-50%)	3
Major (>50%)	5

5.3 Water level range

The range in water level is defined as (Hc / Hr) x 100, where

Hc is the current difference between the mean annual maximum water level and the mean annual minimum water level, and
Hr is the difference between the mean annual maximum water level and the mean annual minimum water level in the reference condition.

The score is based on the change in water level range from the reference state (Table 22)

Table 22. Table for evaluating parameter 5.3 Water level range.

Change in water level range	Score
None or minor (0-10%)	1
Moderate (10-50%)	3
Major (>50%)	5

5.4 Frequent flow fluctuations

Frequent flow fluctuations occur typically below hydropower plants where the operation of the turbines changes on a short-term (often daily) basis. The score is based on the magnitude of the frequent flow fluctuations, which is assessed as minor, moderate or major (Table 23).

Table 23. Table for evaluating parameter 5.4 Frequent flow fluctuations.

Impact on water level/flow dynamics	Score
None or minor	1
Moderate	3
Major	5

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ANNEX A: HYDROMORPHOLOGICAL SURVEY – SLOVAKIA SITE PROTOCOL

1 Site identification

1.1. Stream / River name	**1.2. Site name**	**1.3. River log**	**1.4. Site / River number**

1.5. River system	**1.6. Map reference**	**1.7. Stream order**
1.8 Latitude	**1.9. Longitude**	**1.10. Site altitude (m.a.s.l)**

1.11. River width type (small, medium, large)	**1.12. River type (WFD type)**

1.13. Sketch / Photo

1.14. Surveyor	**1.15. Surveyor number**	**1.16. Date of survey**

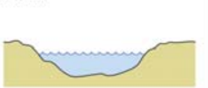
1.17. River use affecting conditions at the site (mark with "X")

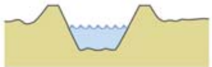
Transport		Recreational use	
Waste water		Power production	
Water abstraction		No use	

2 Channel and site parameters

2.1. Catchment area (km^2)	2.2. Distance to source (km)	2.3. Mean river slope at site (‰)

2.4. Channel cross section

Natural [ ] 

Embanked [ ] 

Semi-natural [ ] 

Set back embankment [ ] 

Channelised [ ] 

Artificial double profile [ ] 

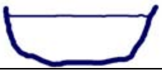
2.5. Bank stabilisation (indicate type of stabilisation used with "X")

Resectioned banks		Wood piling	
Boulders / gabions (broken surface)		Brickwork / boulders (unbroken)	
Steel piling		Concrete	

2.6. Cross sectional dimensions

Actual wetted width [ ]m Estimated bankfull width [ ]m

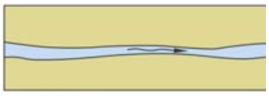
2.7. Depth / variation in depth

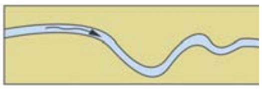
Low  Medium  High 

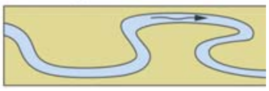
2.8. Macrophyte coverage None [ ] Low [ ] Medium [ ] High[ ]

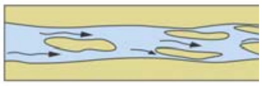
2.9. Channel plan form

Single channel [ ] Multiple channels [ ]

Straight [ ] 

Sinuous [ ] 

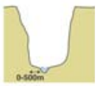
Meandering [ ] 

Braided/Anastomosing [ ] 

2.10. River valley form

Gorge [ ] 

V-shaped valley [ ] 

Small U-shape (<500 m wide) [ ] 

Wide U-shape (>500 m wide) [ ] 

No perceptible river valley [ ] 

Asymmetrical [ ] 

2.11. Presence of migration barriers

Is the migration barrier: Natural [ ] Artificial [ ]

Presence of migration barriers that potentially affect biological conditions on the site

Yes, downstream [ ] Yes, upstream [ ] No [ ]

Height of obstruction < 0.3 m [ ] 0.3 – 1 m [ ] > 1 m [ ]

Distance to obstruction: Downstream [ ]km Upstream [ ]km

Presence of artificial structures for migration enhancement (Indicate presence with "X")

No structure for migration		Fish ladder or elevator	
By-pass migration – partial ramp		By-pass migration – Full ramp	

3 Riparian zone and floodplain

3.1. Non natural vegetation structure in riparian zone (coverage to nearest 5%)

Closed line of native trees		Isolated native trees	
Tall herbs / shrubs		Isolated alien trees	
Closed line of alien trees		Plantation	
Grass		Crop field	
Destruction by erosion		Artificial structure	

3.2. Land use on floodplain (coverage to nearest 5%)

Buildings (houses, cities, roads)		Natural or semi-natural open land	
Agriculture		Freshwater (lakes etc.)	
Natural forest		Wetlands	
Plantation			

4 Catchment

4.1. Hard rock geology (indicate all types present with "X". Use P for predominant geology)

Crystalline	
Carbonate	
Flysch	
Neovolcanics	
Non-coherent lutaceous	
Non-coherent psammtious	

4.2. Soil types (indicate all types present with "X". Use P for predominant soil type)

Sand	
Fine sand	
Clayey sand	
Sandy clay	
Clay	
Heavy clay	
Organic	
Special	

4.3. Land use (indicate all types present with "X". Use P for predominant land use)

Buildings cities etc.	
Agriculture	
Forest	
Plantation	
Natural or semi-natural open land	
Wetlands	
Freshwater	

4.4. Topography

Highest point in catchment		m.a.s.l.
Station altitude		m.a.s.l.
Difference		m

5 Hydrological conditions

5.1. Mean annual long-term discharge ($m^3 s^{-1}$)

5.2. Changes to the hydrological regime

Influence by groundwater abstraction

Unaffected/slightly[ ] Moderate[ ] Major[ ]

Influence by surface water abstraction

Unaffected/slightly[ ] Moderate[ ] Major[ ]

ANNEX B: HYDROMORPHOLOGICAL SURVEY – SLOVAKIA
ASSESSMENT FORM – Structural features

Stream / River name: ____________ Site name:________________ Date: ___________
Surveyor: _____________________ Surveyor Cert. No.:_________

Category	Parameter	SSU1		SSU2		SSU3		SSU4		SSU5		SU Score
		L	R	L	R	L	R	L	R	L	R	
1 Channel	1.1 Channel sinuosity											
	1.2 Channel type											
	1.3 Channel shortening											
	Channel planform score, CPS: (1.1+1.2+1.3)/3											
2 In-stream	2.1 Bed elements[1)]	BA/IS/RI/RA/RO/SP		BA/IS/RI/RA/RO/SP		BA/IS/RI/RA/RO/SP		BA/IS/RI/RA/RO/SP		BA/IS/RI/RA/RO/SP		
	2.2 Substrate[2)]	BE/BO/CO/GR/SA/CD		BE/BO/CO/GR/SA/CD		BE/BO/CO/GR/SA/CD		BE/BO/CO/GR/SA/CD		BE/BO/CO/GR/SA/CD		
		MD/CL/PE		MD/CL/PE		MD/CL/PE		MD/CL/PE		MD/CL/PE		
	2.3 Variation in width[3)]	W:	S:	W:	S:	W:	S:	W:	S:	W:	S:	
	2.4 Flow types[4)]	FF/CH/CA/BS/US/RP/UP		FF/CH/CA/BS/US/RP/UP		FF/CH/CA/BS/US/RP/UP		FF/CH/CA/BS/US/RP/UP		FF/CH/CA/BS/US/RP/UP		
		SM/NO		SM/NO		SM/NO		SM/NO		SM/NO		
	2.5 Large woody debris[5)]	Number:		Number:		Number:		Number:		Number:		
	2.6 Artificial bed features											
	Instream feature score, IFS: (2.1+2.2+2.3+2.4+2.5+2.6)/6											
3 Bank and riparian	3.1 Riparian vegetation											
	3.2 Bank stabilisation											
	3.3 Bank profile											
	Bank and riparian score, BRS: (3.1+3.2+3.3)/3											
4 Floodplain	4.1 Flooded area											
	4.2 Natural vegetation											
	Floodplain score, FPS: (4.1+4.2)/2											
Hydromorphological Quality Score (CPS+IFS+BRS+FPS)/4												

1) BA: Bars, IS: Islands, RI: Riffles, RA: Rapids, RO: Rocks, SP: Step/pools
2) BE: Bedrock, BO: Boulders, CO: Cobble, GR: Gravel, SA: Sand, CD: Coarse debris, MD: Mud/silt, CL: Clay, PE: Peat
3) Measure widest and smallest width in each SSU. Calculate variation in width overall smallest and widest width
4) FF: Freefall, CH: Chute, CA: Chaotic, BS: Broken standing waves, US: Unbroken standing waves, RP: Rippled, UP: Upwelling, SM: Smooth, NO: No perceptible flow
5) Count number of woody debris in all SSU and scale total number for the whole SU to numbers per km

ANNEX C: HYDROMORPHOLOGICAL SURVEY – SLOVAKIA
ASSESSMENT FORM – Hydrological features

Stream / River name: ____________ Site name:________________ Date: ___________
Surveyor: _____________________ Surveyor Cert. No.:_________

Category	Parameter	SU Score
5. hydrological regime	5.1 Mean flow	
	5.2 Low flow	
	5.3 Water level range	
	5.4 Frequent flow fluctuations	
	Hydrological regime score, HRS: (5.1 + 5.2 + 5.3 + 5.4)/4	